Pediatric Health, Medicine and Therapeutics

REVIEW

Impact of Covid-19 on Pediatric Ophthalmology Care: Lessons Learned

Kirandeep Kaur[1], Janani Muralikrishnan[2], Jameel Rizwana Hussaindeen[3], Nilutparna Deori[4], Bharat Gurnani[5]

[1]Children Eye Care Center, Department of Pediatric Ophthalmology and Strabismus, Sadguru Netra Chikitsalya, Shri Sadguru Seva Sangh Trust, Chitrakoot, Madhya Pradesh, India; [2]Department of Pediatric Ophthalmology and Strabismus, Aravind Eye Hospital, Chennai, India; [3]Department of Optometry, Rivoli Vision Academy, Rivoli Groups LLC, Dubai, United Arab Emirates; [4]Department of Pediatric Ophthalmology and Strabismus, Sri Sankaradeva Nethralaya, Guwahati, Assam, India; [5]Department of Cornea and Refractive Services, Sadguru Netra Chikitsalya, Shri Sadguru Seva Sangh Trust, Chitrakoot, Madhya Pradesh, India

Correspondence: Bharat Gurnani, Department of Cornea and Refractive services, Sadguru Netra Chikitsalya, Shri Sadguru Seva Sangh Trust, Chitrakoot, Madhya Pradesh, 485334, India, Tel +919080523059, Email drgurnanibharat25@gmail.com

Abstract: The COVID-19 pandemic came with many new challenges that forced personal and professional lifestyle modifications. Medical facilities were in scarcity against this new unknown enemy and were challenged with the overloaded patient flow, scarcity of healthcare staff, and evolving treatment modalities with a better understanding of the virus each day. Ophthalmology as a "branch of medicine" suffered challenges initially because of a lack of guidelines for patient management, close working distance during routine examinations, and halt of major surgeries, including cataracts. Pediatric ophthalmology had major implications, as reduced outpatient visits would mean deeper amblyopia, and changed lifestyles, including online classes and home refinement, predisposing children to myopia, digital eye strain, and worsening of strabismus. COVID-19 also unveiled underlying accommodation and convergence anomalies that predisposed pediatric and adolescent patients to an increased prevalence of headache and acute onset esotropia. Teleophthalmology and other innovative solutions, including the use of prism glasses, safe slit-lamp shields, alternative ways of school screening with the use of photoscreeners, performing retinoscopy only when needed, and using autorefractors were among the few guidelines or modifications adopted which helped in the efficient and safe management of pediatric patients. Many pediatric ophthalmologists also suffered in terms of financial constraints due to loss of salary or even closure of private practices. School screening and retinopathy of prematurity screening suffered a great setback and costed a lot of vision years, data of which remains under-reported. Important implications and learnings from the pandemic to mitigate future similar situations include using tele-ophthalmology and virtual platforms for the triage of patients, managing non-emergency conditions without physical consultations, and utilizing home-based vision assessment techniques customized for different age groups. Though this pandemic had a lot of negative implications, the innovations, modifications, and other important learnings helped pediatric ophthalmologists in navigating safely.

Keywords: pediatric ophthalmology, COVID-19, digital eye strain, myopia, amblyopia

Introduction

The COVID-19 pandemic was declared a global pandemic by World Health Organisation on 11th March 2020.[1] The virus has caused immense disruption to our healthcare system, creating challenges for medical providers and patients alike. The COVID-19 pandemic brought unprecedented challenges to healthcare sectors worldwide, and pediatric eye care was no exception.[2] As children's routines underwent significant shifts, with increased screen time and limited outdoor play, concerns about their visual health emerged.[3] Ophthalmologists noted a rise in cases related to digital eye strain and myopia progression among the young.[4] Moreover, interruptions in regular eye check-ups and treatments posed potential risks for the early detection and management of pediatric eye disorders.[5] Adapting to these new scenarios, pediatric ophthalmology began emphasizing telemedicine, preventive measures, and innovative approaches to safeguard children's vision during and post-pandemic.[6] Compared to most other specialties, the risk of patient-physician

Received: 27 June 2023
Accepted: 4 October 2023
Published: 12 October 2023

transmission in ophthalmology was more remarkable due to the necessity of close contact during examination and difficulties in using medical equipment with protective gear. The risk was higher among pediatric ophthalmologists due to the higher chance of aerosols from patients, the inability of children to don the masks during examinations, and the potential of children with pre- or asymptomatic infections.[7,8] Telemedicine proved to be an effective solution in such times, providing healthcare to patients while reducing the potential exposure of the public, healthcare workers, and patients to COVID-19.[9,10] Although various promising teleophthalmology options are available, pediatric ophthalmology patients still require an in-person evaluation.

COVID-19 has significantly impacted the field of ophthalmology, with studies showing that 72.5% of ophthalmic institutes had utterly stopped all clinical work during the nationwide lockdown period. Hospitals were open for emergency and critical care services, while elective surgeries were canceled.[11,12] During the pandemic's peak, patient visits at a tertiary eye care hospital dropped to 5.3% of the preceding year's figure.[13] A similar scenario was likely experienced across the globe.[14] Compared to secondary or tertiary eye hospitals, vision centers (primary eye care centers) witnessed a less drastic reduction in their number of outpatients with the relaxation of lockdown. These results further highlight the importance of providing access to care, particularly in underprivileged and rural areas.[13] The proportion of females, patients aged 61 years and older or 21 years and younger, decreased significantly across all eyecare levels during the *pandemic* relative to the previous year.[13–16] Trauma-related pathologies, retinal detachment, and wet age-related macular degeneration (ARMD), which could cause severe visual damage, comprised a smaller number of cases but still represented a more significant proportion of the overall total.[17] An estimated 92,150 ophthalmic surgeries in Ontario were postponed due to the pandemic in 2020. Cataract surgeries accounted for a significant 90% of the postponed operations, and retinal detachment surgeries constituted 4% of the total. Although emergency retinal detachment surgeries were allowed throughout the pandemic, the 4% retinal detachment surgical backlog suggests possible delays in diagnosis, including access to assessments or patient hesitancy.[18]

During the early phases of the COVID-19 pandemic, there was a decline in the number of children and adolescents seen in ophthalmology emergency departments, falling from 10% to 5.3%.[16] In another study, there was a 60% reduction in the average number of daily urgent ophthalmic consultations and an 80% reduction in the average number of daily ophthalmic surgeries, elective and emergent, in 2020 compared to previous years.[19] Lack of self-reporting among pediatric patients make them at risk of undetected visual problems that can have long-term implications.[20] In a multi-national cross-sectional survey, almost one in five caregivers reported delay in seeking treatment in an emergency department out of fear of being exposed to COVID-19. More particularly, mothers, younger caregivers, caretakers of children with chronic health conditions, and those who feared missing work were more inclined to report such delays.[21] There was a decline in visits for ocular trauma by 60% in 2020 compared to 2019, likely due to the lockdown and cancellations of sports activities. There was a noticeable decline in conjunctivitis cases during 2020 compared to earlier times, probably attributed to the strict practice of social distancing and improved hand hygiene.[19,22] The diagnosis of contagious diseases, like conjunctivitis, was consistent among both genders. Ocular trauma was more frequent among males, while diagnoses such as chalazion/hordeolum were common among females.[23]

Teleophthalmology solutions, while successfully integrated into adult eye care, may pose challenges when applied to pediatric eye care.[24–26] Additionally, timely appointments in pediatric ophthalmology are crucial. Delays can result in irreversible visual damage in pathologies, such as retinopathy of prematurity, amblyopia, cataracts, and uveitis, or can hinder the timely detection of potentially life-threatening conditions.[27] The impact on pediatric ophthalmology was vast, but some major conditions that significantly impacted visual outcomes or presented in a different form with undefinable underlying mechanisms during the COVID-19 pandemic era have been described here.

Literature Search

To explore the impact of COVID-19 on pediatric ophthalmology care and the lessons learned, we began with a comprehensive search of electronic databases, such as PubMed, Medline, Scopus, and Google Scholar. The search was performed using a combination of specific keywords and phrases related to the topic. This included broader terms like "COVID-19", "pediatric", and "ophthalmology", "Pediatric Ophthalmology Care" then narrow down by using Boolean operators, combining them with more specific terms, such as "impact", "healthcare disruption", "telemedicine", "outpatient care", "surgical delays", and "lessons learned". The results were filtered by peer-reviewed articles, clinical trials, case studies, and reviews published within the COVID period to ensure relevancy. Additionally, review references within identified articles to discover other pertinent studies. Out of 169 articles reviewed, pertinent clinical studies were discussed in tabular format and rest of the articles were discussed or quoted in the manuscript text.

Accommodation Anomalies

The prevalence of accommodation anomalies has shown considerable variation across studies and ethnicity. Anomalies of accommodation impact the visual system significantly due to the nature of symptoms, especially visual blur that affects an individual's overall quality of life. Accommodative insufficiency, infacility, and spasm of accommodation are the most common anomalies discussed in the literature, with prevalence ranging between 2% and 42%.[28] The diagnostic criteria, hospital or community-based study population, and ethnicity-specific normative data primarily contribute to this variability.[29]

The etiology for accommodation anomalies includes uncorrected refractive errors, inaccurate refractive correction, coexisting vergence dysfunctions, and psychogenic considerations. The management of accommodation anomalies thus includes careful evaluation of the refractive error, use of cycloplegic agents in the diagnosis and management protocol, treatment of co-existing vergence dysfunctions, and vision therapy.[30] Holistic management includes addressing any underlying psychological issues that could play a significant role in the etiology of the anomaly.[31]

Acute Onset Esotropia

The etiology of acute onset esotropia remains unclear and is generally considered rare.[32,33] The three main types are (1) Swan type: esotropia due to the disruption of fusion, (2) Burian-Franceschetti type: esotropia characterized by minimal hypermetropia and diplopia; and (3) Bielschowsky type: esotropia that occurs in adolescents and adults with varying degrees of myopia and shows equal deviation at a distance and near fixation.[34,35] Other types of acute onset esotropia include the refractive accommodative type and esotropia associated with accommodative spasm or intracranial diseases.[33,36] A high index of clinical suspicion is pivotal to rule out the infrequent but possible presence of any underlying or co-existent neurological pathology. Lee et al[31] reported that excessive smartphone use might induce the development of acute onset esotropia in patients with myopia or mild hyperopia, good corrected visual acuity, and binocularity. It is suggested that abnormalities in accommodation and vergence in adolescents with low fusional divergence capacity or previous latent esophoria with excessive smartphone use at a close reading distance can lead to increased tonus of the medial rectus muscles and may result in the development of manifest esotropia.[37]

Conjunctivitis

Several reports of conjunctivitis as an ocular manifestation of SARS-CoV-2 infection during the COVID-19 pandemic have been documented.[4,38] From the ophthalmology standpoint, utmost care had to be taken while managing these patients. Given the many potential etiological factors responsible for follicular conjunctivitis, a systematic approach to investigate and identify the causative organism helps facilitate targeted treatment. Cultures for viruses, bacteria, and chlamydia, as well as PCR testing of conjunctival swabs, are of great value in the analysis of ocular specimens. To reduce the transmission rate, the need for adherence to strict standard operating protocols (SOP), such as regular hand-washing, use of sanitizer, and disinfection of applanation tonometers, gonioscope, etc., was also emphasized. Promoting eye health education, knowledge, and practice was prioritized among the masses. Proper nourishment is of paramount importance in improving the health hygiene of children.

Digital Eye Strain/ Computer Vision Syndrome

Digital eyestrain (DES), earlier referred to as computer vision syndrome (CVS), has become a buzzword in the post-COVID-19 era due to the increased dependence on digital devices and has been termed a "Shadow pandemic".[39] DES has a multifactorial etiology with increasing prevalence across all age groups and many symptoms encompassing ocular, visual, systemic, and ergonomic manifestations.[40,41] Dry eye-related risk factors and associated health conditions results in increased symptomatology toward the manifestation of DES.[39]

Evidence from various studies suggests increased screen time >4–5 hours/day and poor ergonomic factors to be substantial risk factors for DES. Treatment modalities using specialized filter glasses and optimizing the screens of digital devices have been explored with equivocal results.[42] Meanwhile, adjunctive nutraceutical strategies involving xanthophyll macular carotenoids have shown promising results in ameliorating DES-related visual symptoms and enhancing cognitive functions.[43]

Dry Eyes

Dry eye Disease (DED) is another growing public health concern with a multifactorial etiology, and the global prevalence varies between 5% and 50%.[44] The disease is characterized by a qualitative or quantitative tear film deficiency leading to loss of ocular surface homeostasis. Aqueous deficiency and evaporative are the primary etiological subtypes, with evaporative being the most commonly identified presentation, primarily due to Meibomian Gland Dysfunction (MGD). Though there is no current consensus on a uniform management protocol, identifying and addressing the etiological nature of the disease is imminent, along with relevant environmental and lifestyle modifications, as the primary management option. The vicious nature of the inflammatory cycle results in variable clinical presentations, increasing the risk of the disease entering the chronic continuum if not managed appropriately. This also demands long-term management and follow-up, and the options include various pharmacologic, or non-pharmacologic treatments aiming at restoring tear film homeostasis and improvements in visual symptoms.[45] Mask Associated Dry Eyes (MADE) was also very common during the pandemic as dry eye disease was also significantly aggravated by prolonged usage of mask due to less air flow and poor quality of the tear film.[46]

Emergency Conditions/ Reduced Surgeries

Pelligrini et al rightly pointed out that to avoid the risk of COVID-19 transmission, there was an intentional drop in the health-seeking behavior of patients with injuries, including even the serious ones potentially associated with vision loss.[46]

Myopia and Progression

The growing burden of myopia has been well-established globally, with myopia being the leading cause of visual impairment.[47,48] Prediction models for myopia aim at understanding the impact of epigenetic risk factors and how they can be mitigated towards achieving the outcome of reduced incidence and prevalence of myopia.[49]

Recent findings suggest that myopia progression is limited to childhood and extends to more than one-third of adults until the third decade. COVID-19 pandemic also impacted myopia management strategies due to alarming increase in number of these patients due to excessive digital device usage and less turn out of these patients to the clinics. These findings emphasize the need to focus on myopia preventative and control strategies as a means to prevent and reduce the risk of myopia-related complications until middle and older age.[50]

Myopia control options broadly categorized under Optical and pharmacological interventions have been researched extensively. Atropine eye drops, optical treatments to reduce peripheral defocus, and orthokeratology contact lenses are the most commonly studied and clinically applied treatment options. Novel treatment modalities, such as low-level red light therapy have also been explored and shown to be promising alternative treatments for myopia control in children.[51] Conservative options, including increased time outdoors, reducing near work hours, and extending the relative working distances, have been proposed as preventative visual hygiene options in myopia management.[52]

Every eyecare practitioner must equip themselves with evidence-based practice options for myopia management consistently to be able to provide patients with the most appropriate myopia control option and to follow up regularly.

Impact of COVID-19 on Amblyopia, Glasses, and Squint

COVID-19 came with many restrictions leading to a mass reduction in mobilization. As a result, recreational activities halted, and a more significant negative effect was experienced by patients who could not reach medical facilities for non-emergency conditions. Amblyopia is one of the conditions in which treatment results vary with delay in presentations.[53] Timely management not only results in better final corrected visual acuity but also has a long-lasting impact on daily interactions, better social life, self-dependency, and better work opportunities. COVID-19 saw a reduction of more than 80% in pediatric eye care. This can result in delayed presentations of patients leading to a dramatic increase in disability and unsustainable costs for families/governments to sustain.[54]

Impact of COVID-19 on School Screening

COVID-19 impacted lifestyles in a significant way. The children were significantly affected as they had to face a major transformation in their schooling and learning patterns apart from restrictions faced by others. They were restricted from going out and playing, and learning changed to a more virtual environment. Children have become addicted to screens and spend most of their time on digital devices. Environmental risk factors, including home confinement and excessive screen time among children, continues even when schools and offline classes have resumed, and lifestyles have returned to normal. An overall estimated increase in screen time by 1.3 to 7.8 times has been reported since the COVID-19 pandemic.[55,56] Outdoor activity among children has reportedly declined by 48.6% to 62.8%.[57] Outdoor physical activity is essential not only for ocular health but also for children's physical health.[58] This addiction has predisposed children to myopia, dry eyes, digital eye strain, and squints. The impact on children's lifestyle and home confinement with a predisposition to screens emphasizes the need for screening them in preschools and schools.

School screening has been a boon since this helps in early detection and is very important. COVID-19 impacted school screening greatly because of obvious restrictions due to school closures in the early phases of the pandemic. This impact has continued because of fear of contamination, intermittent school closures, lack of proper guidelines for screening post-COVID-19, and lowered motivation from authorities for active school screening, which has been added for another two years.[59,60] Over 50 million students were impacted in the United States alone because of halted school screening during the pandemic.[61] Apart from the in-person screening, screening with vision screeners also suffered a significant setback. There is a lack of data on children that suffered loss from vision screening during COVID-19 times. Screening delays timely referrals and predisposes children to progressive myopia, amblyopia, and squinting of eyes.[62] These further indirectly impact the academic success of these children.

Impact on Pediatric Ophthalmologists

COVID-19 negatively impacted most lives, from physical and mental stress to financial crises. Risk of contamination, decreased patient load, closure of non-emergency services, and the additional cost of personal protective equipment like medical scrubs, gloves, respirators, goggles, face shields, etc. A survey among pediatric ophthalmologists assessed the economic challenges they faced during COVID-19.[63] It showed that 65.1% met a decrease in revenue from OPD greater than 10%, and another 64.3% agreed to a more than 10% decrease in surgical revenue. 20.9% of pediatric ophthalmologists were forced to plan premature retirement because of COVID-19. 4.7% had sold their practice because of the pandemic. Another study conducted in the United States among pediatric ophthalmologists showed a 10–25% increase in expenditure faced by 52% of the respondents because of the pandemic.[64] Another 44% reported a drop in surgical revenue between 10–25% and 45.6% a decline in overall revenue. 11.1% stopped operating because of reimbursement cuts, and 37.8% said that they would not recommend residents to pursue pediatric ophthalmology fellowship.

Another survey raised concerns among pediatric ophthalmologists due to progressive reimbursement cuts and fewer residents opting for pediatric ophthalmology fellowships. This has led to a discrepancy in the provider population ratio leading to overburden among those involved in this field. Further raised concerns of COVID-19 spread with aerosols produced during general anesthesia gases hindered admission of routine cases.[65] The Royal College of Anaesthetists and Association of Anaesthetists advised using local or regional anaesthesia wherever possible, saving the resources and financial costs of personal protective equipment and preserving immune function.[66]

Positive Effects of COVID-19

Our experience at Aravind Eye Care System, Pondicherry, and major centers in India during the pandemic, an upsurge in the number of diseases and delayed presentations leading to poorer outcomes was experienced. There were some positive impacts of COVID-19 secondary to lifestyle modifications, lesser exposure to allergens, and limited exposure to outdoor sports and work-related injuries. A systematic review and meta-analysis by Liang et al showed a reduction in overall eye injuries and substantial differences in the spectrum of ocular trauma with an increased proportion of domestic ocular trauma, while a decline in sports-related trauma during the COVID-19 pandemic.[66] This article further emphasized the need for strengthening proper health education and supervision to prevent ocular injuries beyond the COVID-19 pandemic. Conde Bachiller et al, in their study, found a significant reduction in conjunctivitis, with the most significant decrease in viral conjunctivitis cases during COVID-19.[67]

Innovations in Pediatric Ophthalmology During COVID-19

The physical and mental chaos created by the COVID-19 pandemic posed numerous challenges for healthcare workers across the globe, and ophthalmology as a subspeciality was not left behind.[68] Children are the future and backbone of society, and Pediatric Ophthalmology as a subspeciality was also faced with multiple collateral challenges.[69] This gave birth to numerous Pediatric Ophthalmology innovations to facilitate the examination and management of these children and also, at the same time, prevent the spread of deadly viruses without compromising the quality of care. Kaur et al described their experience managing children with few incremental innovations during the pandemic. They used disposable intravenous (IV) tubing to make loops for face masks, ensuring good fitting in pediatric cases.[70] To maintain social distancing and prevent the risk of transmission, a photoscreener was used to screen patients with an acrylic sheet in between, thus separating the patient and the photoscreener. The refraction cubicles were modified, and an acrylic shield was instilled to prevent aerosol-based transmission. While examining the patients, a safe slit-lamp shield with self-designed breath protectors was instilled. Head loupes were used to examine the children to prevent exposure to aerosols. Bifocal prisms were used for the examination of infants. This helped examine infants on the mother's lap, maintaining a safe distance. The indirect ophthalmoscope was covered with cling wrap or plastic sheep to prevent surface transmission. Also, it prevented aerosol exposure generated by children while examining them while lying down or in a difficult position. These have been depicted in Figure 1. Nayak et al designed a cost-effective virus containment box for retinopathy of prematurity screening and laser.[71] The

Figure 1 (**a**)Image depicting intravenous plastic tubing piece used on the ear loops of the mask (white arrowhead) for pediatric patients. (b) Image depicting modified refraction cubical with an acrylic sheet (white arrowhead) allowing safe examination by the refractions. (**c**) Image of the Safe Slit lamp Shield (SSS) of size 67.30×44.45 cm with inverted U-shaped cuts at the bottom (white arrowhead) installed on a slit lamp for facilitating examination. (**d**) Image depicting Pediatric Ophthalmologist safely examining the child with the help of prism glasses (Lazy eyeglasses){white arrowhead}.

Notes: Reproduced from Kaur K; Kannusamy V; Gurnani B. Incremental innovations in pediatric ophthalmology department during the COVID-19 pandemic: An experience from a tertiary eye care hospital. *Indian Journal of Ophthalmology*. 2021;69(4):1000–1001. Creative Commons.[70]

authors suggested that there is always a risk of aerosol transmission while examining children and unsedated neonates. The virus containment box was prepared from transparent acrylic material, had four walls and a roof, and the floor was open to accommodate the infant. The box has two types of opening, one for passing hands while examining the baby and another smaller one to allow passage of oxygen tubing when needed. The advantages of this box are that it is cost-effective, can be assembled locally with the help of craftsmen, and the baby can be examined easily inside the box.

Teleophthalmology during the COVID-19 pandemic played a crucial role in redefining the scope of eye care delivery to children.[72] Pediatric teleophthalmology care was subdivided into three major subdivisions: video visits, telephonic consultation, and short message service or email.[73] The audio and video telecommunication was provided through Health Insurance Portability and Accountability Act (HIPAA) compliant platforms, such as Zoom, Vsee, Doxyme Pro, Facetime, Facebook, WhatsApp, and Google Hangouts.[74] These platforms facilitate didactic communication but are relatively less secure and limited by the type of device used for communication, as some devices may not support video consultation. The role of teleophthalmology in pediatric screening can be better defined in the form of a telehealth visit cycle.[75] This includes patient scheduling, history and demographic details, ocular examination, investigation, and intervention needs. Ophthalmologists play a crucial role in triage; meticulous planning and consideration are required to schedule an objective assessment. Visual acuity assessment at home, general ocular inspection, corneal reflex, strabismus screening, and gross oculoplastic and posterior segment (ROP) examination can be performed through telemedicine screening. It should be remembered that teleophthalmology can also invite several medicolegal issues due to patient confidentiality, data transmission through electronic media platforms, and cybersecurity concerns.[19] Table 1 [74,76–81] highlights the summary of recently published literature on digital eye strain during COVID-19.

Future Measures to Mitigate the Negative Impact of COVID-19 on Pediatric Ophthalmology

The COVID-19 pandemic drastically impacted pediatric ophthalmology services across the globe.[82] In the future, ophthalmologists, optometrists, and the support staff must remain proactive in dealing with such a pandemic emergency.

Adaptations During COVID-19

The COVID-19 pandemic gave big learning lessons in the form of social distancing, limited capacity seating in the outpatient department, hand sanitization, regular and mandatory use of personnel protective equipment, frequent sanitization and cleaning of instruments and equipment, and mass vaccination to protect against the deadly virus.[83] We have proposed safe flow of pediatric patients in the outpatient department that can be replicated in any such pandemics in future, as shown in Figure 2. In the future, these changes can be replicated in case of a similar emergency. The other innovation was the setup of virtual ophthalmic clinics, teleophthalmology, virtual clinical consultations, rescheduling elective surgeries, weekend clinics, and waiting list validation.[84]

Role of Teleophthalmology

Teleophthalmology-assisted triage was found to be crucial in reducing the base hospital's patient load and minimizing the transmission risk.[85] The pandemic shook many lives, and many families suffered as we lost many front-line workers and colleagues. Hence, all pediatric ophthalmologists should be mentally prepared for a similar emergency in the future. During the pandemic, there was disproportionate staff reduction, many lost employments, and many felt unemployed.[86] Therefore, it is imperative for the policy makers to implement effective strategies to support healthcare professionals who have selflessly committed themselves to saving lives. During unpredictable events like the COVID-19 pandemic, with an increasing number of patients waiting for

Table 1 Summary of Recently Published Literature on Digital Eye Strain During COVID-19

S. No	Authors	Title	Aim	Methodology	Results	Conclusion
1	Neena R et al.[80] Oman J Ophthalmol. 2023 Feb 21;16(1):45–50.	Impact of online classes on eye health of children and young adults in setting of COVID-19 pandemic: A hospital-based survey	To assess the effects of virtual learning on the eye health of children and young adults amid the COVID-19 crisis.	Observational, questionnaire-based	Out of 496 patients, most were aged 5–10 years. 84.7% took online classes for less than 4 hours, 95.6% used gadgets post-class, and 28.6% for over 2 hours daily. 50.8% experienced DES, with headaches or eye aches being the top symptom (30.8%).	Excessive screen use, suboptimal lighting conditions, and prolonged close-up viewing can contribute to DES and exacerbate or introduce refractive issues and squint.
2	Wadhwani M et al.[81] *J Family Med Prim Care*. 2022;11(9):5387–5392.	Online survey to assess computer vision syndrome in children due to excessive screen exposure during the COVID-19 pandemic lockdown.	To assess the frequency of CVS symptoms in children, including blurred vision, headaches, and teary eyes, resulting from extended screen use during the COVID-19 lockdown.	Non-randomised questionnaire based survey. Inclusion criteria- Parents of children 6 to 16 years attending regular school.	145 parents took part. A notable link was observed between activity count and CVS symptoms (r=0.15, P=0.036). The most frequent symptom was headache, then eye pain and scratchy, watery eyes.	Lockdown from COVID-19 has led to increased myopia, dry eyes, and eye health issues in school children due to reduced outdoor activities and more screen time.
3	Pavel IA et al.[82] *Rom J Ophthalmol*. 2022;66(3):257–264. doi:10.22336/rjo.2022.48	Ocular and musculoskeletal changes in the pediatric population using gadgets.	Examination of eye and skeletal alterations due to the use of digital screen electronic devices like smartphones, laptops, and tablets.	Prospective observational study of 35 participants aged 6 to 17 years. A set of 14 questions on digital devices usage symptoms were recorded.	The average age was 11.29 years with a standard deviation of 3.54. Dry eye syndrome appeared in 9.1% of patients with accommodative issues and 18.2% of amblyopes. Smartphones were the predominant device used (77.1%). Boys (54%) typically used electronic devices for over 5 hours, while 54.5% of girls used them for 3–5 hours. The most frequent musculoskeletal complaints were neck, shoulder, and back pain.	Extended use of digital devices can worsens eye symptoms and affect musculoskeletal health.
4	Mohan A et al.[83] *Indian J Ophthalmol*. 2022;70(1):241–245. doi:10.4103/ijo.IJO_1721_21	Impact of online classes and home confinement on myopia progression in children during COVID-19 pandemic: Digital eye strain among kids (DESK) study 4.	This research aimed to evaluate the progression rate of myopia before and during the COVID-19 pandemic and to identify the contributing factors to accelerated progression.	Children with myopia of spherical equivalence ≤ −0.5 D with at least two prior documented refractions 6 months and 1 year before were included. Annual progression rate before and during COVID-19 was calculated.	During COVID-19, 133 children (266 eyes) aged 6–18 years showed a mean annual myopia progression of 0.90D, compared to 0.25D pre-COVID. 45.9% had a progression of ≥1 D during the pandemic, compared to 10.5% before. Rapid progression pre-COVID (P = 0.002) and sun exposure <1 h/day (P < 0.00001) were key risk factors for rapid myopia progression.	Provide kids with outdoor activities that maintain social distance to reduce myopia progression through sun exposure.

5	Mohan A et al.[84] *Strabismus*. 2021;29(3):163–167. doi:10.1080/09273972.2021.1948072	Series of cases of acute acquired comitant esotropia in children associated with excessive online classes on smartphone during COVID-19 pandemic; digital eye strain among kids (DESK) study-3.	The DESK-3 study examined cases of acute acquired comitant esotropia (AACE) in children from online classes during the COVID-19 pandemic	Children aged 6–18 years with recent onset esotropia < 1-month duration without any similar history in past were evaluated.	Eight children, mean age 12.5 ± 4.2 years were included. All eight were males. All used smartphones for online classes with mean duration of 4.6 hours/ day, with average screen size 5.5 inches. Seven children experienced horizontal diplopia. Neurological examination was normal.	Prolonged near work during smart phone use for e-learning might lead to the development of AACE in children.
6	Mohan A et al.[85] *Indian J Ophthalmol*. 2021;69(1):140–144. doi:10.4103/ijo.IJO_2535_20	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).	This study sought to assess the prevalence, frequency of symptoms, and risk factors linked to digital eye strain (DES) in children participating in online classes amid the COVID-19 pandemic.	Online electronic survey	217 parents responded to questionnaire. Mean age of children was 13 ± 2.45 years. Mean duration of digital device used during COVID era was 3.9 ± 1.9 h which is more than pre COVID era (1.9 ± 1.1 h, P = <0.0001). 36.9% (n = 80) were using digital devices >5 h in COVID era. Most common digital device used were smartphones (n = 134, 61.7%). Prevalence of DES was 50.23%. Most common symptoms were itching and headache (53.9%).	During the COVID era, there's been a rise in cases of DES among children. Parents need to be mindful of the time spent, the kind of digital devices used, and the viewing distance to prevent DES in their children.
7	Jakhar F et al.[86] *Indian J Ophthalmol*. 2023;71(4):1472–1477. doi:10.4103/IJO.IJO_2760_22	Dry eye symptoms and digital eyestrain - Emerging epidemics among university students due to online curriculum amid the COVID-19 pandemic. A cross-sectional study.	The study examined the impact of online curricula on students' ocular health, specifically the rising trends in dry eye disease and digital eyestrain symptoms.	Cross-sectional survey among university students using pre-validated structured questionnaire	The average age of participants was 23.33 ± 4.604 years. 97.9% reported at least three DES symptoms. 88.1% had screen time exceeding 4 hours daily. The top symptoms were headache (69.9%), neck pain (65.3%), tearing (44.6%), eye pain (40.9%), and eye burning (40.1%).	During the COVID-19 pandemic, online classes led to a significant rise in dry eye and digital eyestrain symptoms among students. Preventive measures are essential.

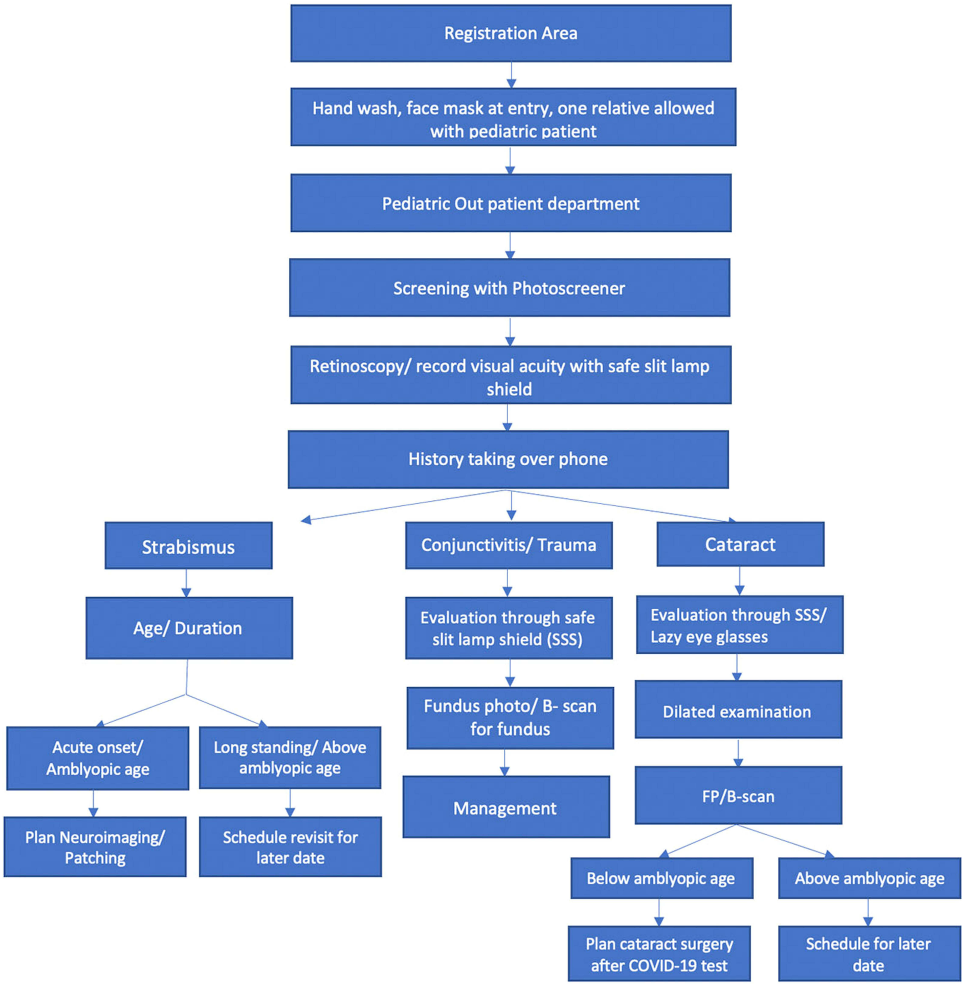

Figure 2 Flowchart depicting the safe flow of pediatric patients in the outpatient department during the pandemic.

treatment, clinicians and ophthalmic services worldwide need to be agile in their response. Insights gained from previous pandemic surges will be crucial in delivering safe, efficient, and effective eye care to patients.[87]

Conclusion

During the COVID-19 outbreak, while direct correlations between pediatric ophthalmology and the virus's pathophysiology were limited, eye-related symptoms, especially in conjunctivitis cases, sometimes emerged as a manifestation of the virus in children. Additionally, the outbreak prompted changes in clinical practice, with a shift towards telemedicine and prioritizing essential eye surgeries to limit disease spread. However, the most significant impact was indirect. Shutdowns and altered medical practices during the pandemic disrupted routine eye screenings and treatments for children, potentially leading to delayed diagnoses and interventions, underscoring the intricate relationship between specialized medical fields and global health crises. While we successfully addressed the pandemic using available resources and innovative strategies, there remains room for improvement in managing future pandemics and ensuring optimal eye care for children.

Disclosure

The authors report no conflicts of interest in this work.

References

1. World Health Organization. WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020. Available from: https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-The-media-briefing-on-covid-19—11-march-2020. Accessed March 12, 2023.
2. Filip R, Gheorghita Puscaselu R, Anchidin-Norocel L, Dimian M, Savage WK. Global challenges to public health care systems during the COVID-19 pandemic: a review of pandemic measures and problems. *J Pers Med*. 2022;12(8):1295. doi:10.3390/jpm12081295
3. Munsamy AJ, Chetty V, Ramlall S. Screen-based behaviour in children is more than meets the eye. *S Afr Fam Pract*. 2022;64(1):e1–e4. doi:10.4102/safp.v64i1.5374
4. Kaur K, Gurnani B, Nayak S, et al. Digital eye strain- a comprehensive review. *Ophthalmol Ther*. 2022;11(5):1655–1680. doi:10.1007/s40123-022-00540-9
5. Chen GLJ, Yam JCS, Pang CCP. Special issue "pediatric eye disease: screening, causes and treatment". *Children*. 2023;10(4):654. doi:10.3390/children10040654
6. Kapoor S, Eldib A, Hiasat J, et al. Developing a pediatric ophthalmology telemedicine program in the COVID-19 crisis. *J AAPOS*. 2020;24(4):204–208.e2. doi:10.1016/j.jaapos.2020.05.008
7. Breazzano MP, Shen J, Abdelhakim AH, et al. Resident physician exposure to novel coronavirus (2019-nCoV, SARS-CoV-2) within New York City during exponential phase of COVID-19 pandemic: report of the New York City residency program directors COVID-19 research group. *medRxiv*. 2020. PMID: 32511652; PMCID: PMC7277008. doi:10.1101/2020.04.23.20074310
8. Sommer AC, Blumenthal EZ. Telemedicine in ophthalmology in view of the emerging COVID-19 outbreak. *Graefes Arch Clin Exp Ophthalmol*. 2020;258(11):2341–2352. PMID: 32813110.
9. Ahmed S, Sanghvi K, Yeo D. Telemedicine takes centre stage during COVID-19 pandemic. *BMJ Innov*. 2020. PMCID: PMC7316111. doi:10.1136/bmjinnov-2020-000440
10. Brant AR, Pershing S, Hess O, et al. The impact of COVID-19 on missed ophthalmology clinic visits. *Clin Ophthalmol*. 2021;15:4645–4657. doi:10.2147/OPTH.S341739
11. Nair AG, Gandhi RA, Natarajan S. Effect of COVID-19 related lockdown on ophthalmic practice and patient care in India: results of a survey. *Indian J Ophthalmol*. 2020;68(5):725–730. doi:10.4103/ijo.IJO_797_20
12. Muralikrishnan J, Christy JS, Srinivasan K, et al. Access to eye care during the COVID-19 pandemic, India. *Bull World Health Organ*. 2022;100(2):135–143. PMID: 35125538; PMCID: PMC8795846. doi:10.2471/BLT.21.286368
13. Analysis: ophthalmology lost more patient volume due to COVID-19 than any other specialty. Available from: https://eyewire.news/articles/analysis-55-percent-fewer-americans-sought-hospital-care-in-march-april-due-to-covid-19/?c4src=article:infinite-scroll. Accessed March 12, 2023.
14. Sim H-E, Jeong K-D, Hwang J-H. Impact of the coronavirus disease 2019 pandemic on the ophthalmology department. *J Clin Med*. 2022;11(6):1722. doi:10.3390/jcm11061722
15. Pellegrini M, Roda M, Lupardi E, Di Geronimo N, Giannaccare G, Schiavi C. The impact of COVID-19 pandemic on ophthalmological emergency department visits. *Acta Ophthalmol*. 2020;98(8):e1058–e1059. PMID: 32483929; PMCID: PMC7300851. doi:10.1111/aos.14489
16. Salvetat ML, Salati C, Busatto P, Zeppieri M. The impact of COVID-19 related national lockdown on ophthalmic emergency in Italy: a multicenter study. *Eur J Ophthalmol*. 2022;32(3):1782–1794. PMID: 34219482; PMCID: PMC9111919. doi:10.1177/11206721211028046
17. Jin YP, Canizares M, El-Defrawy S, Buys YM. Backlog in ophthalmic surgeries associated with the COVID-19 pandemic in Ontario 2020. *Can J Ophthalmol*. 2022;4182(22):00213. PMID: 35905943; PMCID: PMC9257112. doi:10.1016/j.jcjo.2022.06.020
18. Chaudhry Z, Santhakumaran S, Schwartz J, Toffoli D. Impact of COVID-19 on pediatric ophthalmology in the epicentre of the Canadian outbreak. *Can J Ophthalmol*. 2023;58(1):e16–e17. PMID: 35271847; PMCID: PMC8841153. doi:10.1016/j.jcjo.2022.02.007
19. Robbins SL, Packwood EA, Siegel LM. AAPOS Socioeconomic Committee. The impact of the COVID-19 shutdown on US pediatric ophthalmologists. *J AAPOS*. 2020;24(4):189–194. PMID: 32730982; PMCID: PMC7384424. doi:10.1016/j.jaapos.2020.06.002
20. Davis AL, Sunderji A, Marneni SR, et al. Caregiver-reported delay in presentation to pediatric emergency departments for fear of contracting COVID-19: a multi-national cross-sectional study. *Can J Emerg Med*. 2021;23:778–786. doi:10.1007/s43678-021-00174-z
21. Poyser A, Deol SS, Osman L, et al. Impact of COVID-19 pandemic and lockdown on eye emergencies. *Eur J Ophthalmol*. 2021;31(6):2894–2900. PMID: 33213198; PMCID: PMC8606945. doi:10.1177/1120672120974944
22. Shah K, Camhi SS, Sridhar J, Cavuoto KM. Impact of the coronavirus pandemic on pediatric eye-related emergency department services. *J AAPOS*. 2020;24(6):367–369. PMID: 33144199; PMCID: PMC7605749. doi:10.1016/j.jaapos.2020.09.001
23. Bourdon H, Jaillant R, Ballino A, et al. Teleconsultation in primary ophthalmic emergencies during the COVID-19 lockdown in Paris: experience with 500 patients in March and April 2020. *J Fr Ophtalmol*. 2020;43(7):577–585. doi:10.1016/j.jfo.2020.05.005
24. Kilduff CLS, Thomas AA, Dugdill J, et al. Creating the Moorfields' virtual eye casualty: video consultations to provide emergency teleophthalmology care during and beyond the COVID-19 pandemic. *BMJ Health Care Inform*. 2020;27(3). doi:10.1136/bmjhci-2020-100179
25. Crossland MD, Dekker TM, Hancox J, et al. Evaluation of a home-printable vision screening test for telemedicine. *JAMA Ophthalmol*. 2021. doi:10.1001/jamaophthalmol.2020.5972
26. Wood M, Gray J, Raj A, Gonzalez-Martin J, Yeo DCM. The impact of the first peak of the COVID-19 pandemic on a paediatric ophthalmology service in the United Kingdom: experience from alder hey children's hospital. *Br Ir Orthopt J*. 2021;17(1):56–61. PMID: 34278219; PMCID: PMC8269790. doi:10.22599/bioj.164
27. Wajuihian SO. Characterizing refractive errors, near accommodative and vergence anomalies and symptoms in an optometry clinic. *Br Ir Orthopt J*. 2022;18(1):76–92. PMID: 35903147; PMCID: PMC9284986. doi:10.22599/bioj.267
28. Horwood AM, Waite P. Using evidence-based psychological approaches to accommodation anomalies. *Strabismus*. 2023;29:1–10. PMID: 36710250. doi:10.1080/09273972.2023.2171070
29. Scheiman M, Wick B. *Clinical Management of Binocular Vision: Heterophoric, Accommodative and Eye Movement Disorders*. 3rd ed. Philadelphia, PA: JB Lippincott; 2014.
30. Hussaindeen JR, Rakshit A, Singh NK, et al. Prevalence of non-strabismic anomalies of binocular vision in Tamil Nadu: report 2 of BAND study. *Clin Exp Optom*. 2017;100(6):642–648. PMID: 27859646. doi:10.1111/cxo.12496

31. Lee HS, Park SW, Heo H. Acute acquired comitant esotropia related to excessive Smartphone use. *BMC Ophthalmol*. 2016;16(37). doi:10.1186/s12886-016-0213-5
32. Legmann Simon A, Borchert M. Etiology and prognosis of acute, late-onset esotropia. *Ophthalmology*. 1997;104:1348–1352.
33. Burian HM, Miller JE. Comitant convergent strabismus with acute onset. *Am J Ophthalmol*. 1958;45:55–64.
34. Hoyt CS. Acute onset concomitant esotropia: when is it a sign of serious neurological disease? *Br J Ophthalmol*. 1995;79:498–501.
35. Kemmanu V, Hegde K, Seetharam R, Shetty BK. Varied aetiology of acute acquired comitant esotropia: a case series. *Oman J Ophthalmol*. 2012;5:103–105.
36. Hussaindeen JR, Mani R, Agarkar S, Ramani KK, Surendran TS. Acute adult onset comitant esotropia associated with accommodative spasm. *Optom Vis Sci*. 2014;91:S46–51.
37. Bertoli F, Veritti D, Danese C, et al. Ocular findings in COVID-19 patients: a review of direct manifestations and indirect effects on the eye. *J Ophthalmol*. 2020;2020. doi:10.1155/2020/4827304
38. Sen M, Honavar SG, Sharma N. COVID-19 and eye: a review of ophthalmic manifestations of COVID-19. *Indian J Ophthalmol*. 2021;69(3):488–509. doi:10.4103/ijo.IJO_297_21
39. Mataftsi A, Seliniotaki AK, Moutzouri S, et al. Digital eye strain in young screen users: a systematic review. *Prev Med*. 2023;170:107493. PMID: 36977430. doi:10.1016/j.ypmed.2023.107493
40. Bhattacharya S, Heidler P, Saleem SM, Marzo RR. Let there be light-Digital Eye Strain (DES) in children as a shadow pandemic in the era of COVID-19: a mini review. *Front Public Health*. 2022;10:945082. PMID: 36033797; PMCID: PMC9403324. doi:10.3389/fpubh.2022.945082
41. Talens-Estarelles C, García-Marqués JV, Cerviño A, García-Lázaro S. Dry eye-related risk factors for digital eye strain. *Eye Contact Lens*. 2022;48(10):410–415. PMID: 36155946. doi:10.1097/ICL.0000000000000923
42. Lem DW, Gierhart DL, Davey PG. Can nutrition play a role in ameliorating digital eye strain? *Nutrients*. 2022;14(19):4005. PMID: 36235656; PMCID: PMC9570730. doi:10.3390/nu14194005
43. Sheppard J, Shen Lee B, Periman LM. Dry eye disease: identification and therapeutic strategies for primary care clinicians and clinical specialists. *Ann Med*. 2023;55(1):241–252. PMID: 36576348; PMCID: PMC9809411. doi:10.1080/07853890.2022.2157477
44. Rolando M, Merayo-Lloves J. Management strategies for evaporative dry eye disease and future perspective. *Curr Eye Res*. 2022;47(6):813–823. PMID: 35521685. doi:10.1080/02713683.2022.2039205
45. Pandey SK, Sharma V. Mask-associated dry eye disease and dry eye due to prolonged screen time: are we heading towards a new dry eye epidemic during the COVID-19 era? *Indian J Ophthalmol*. 2021;69(2):448–449. PMID: 33380621; PMCID: PMC7933894. doi:10.4103/ijo.IJO_3250_20
46. Pellegrini M, Roda M, Di Geronimo N, et al. Changing trends of ocular trauma in the time of COVID-19 pandemic. *Eye*. 2020;34:1248–1250. doi:10.1038/s41433-020-0933-x
47. Holden BA, Fricke TR, Wilson DA, et al. Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. *Ophthalmology*. 2016;123(5):1036–1042. doi:10.1016/j.ophtha.2016.01.006
48. Han X, Liu C, Chen Y, He M. Myopia prediction: a systematic review. *Eye*. 2022;36(5):921–929. PMID: 34645966; PMCID: PMC9046389. doi:10.1038/s41433-021-01805-6
49. Lee SS, Lingham G, Sanfilippo PG, et al. Incidence and progression of Myopia in early adulthood. *JAMA Ophthalmol*. 2022;140(2):162–169. doi:10.1001/jamaophthalmol.2021.5067
50. Jiang Y, Zhu Z, Tan X, et al. Effect of repeated low-level red-light therapy for Myopia control in children: a multicenter randomized controlled trial. *Ophthalmology*. 2022;129(5):509–519. PMID: 34863776. doi:10.1016/j.ophtha.2021.11.023
51. Shinojima A, Negishi K, Tsubota K, Kurihara T. Multiple factors causing Myopia and the possible treatments: a mini review. *Front Public Health*. 2022;10:897600. PMID: 35619815; PMCID: PMC9127355. doi:10.3389/fpubh.2022.897600
52. Ma D, Wei S, Li SM, et al. Progression of myopia in a natural cohort of Chinese children during COVID-19 pandemic. *Graefes Arch Clin Exp Ophthalmol*. 2021;259:2813–2820.
53. Birch EE, Kelly KR, Wang J. Recent advances in screening and treatment for amblyopia. *Ophthalmol Ther*. 2021;10(4):815–830. doi:10.1007/s40123-021-00394-7
54. Brettin K, Shah AS, Welcher J, Jastrzembski B. Reduced visits to pediatric eye care among socioeconomically disadvantaged patients during the COVID-19 pandemic. *J AAPOS*. 2022;26(4):195–196. doi:10.1016/j.jaapos.2022.03.006
55. Ma M, Xiong S, Zhao S, et al. COVID-19 home quarantine accelerated the progression of myopia in children aged 7 to 12 years in China. *Invest Ophthalmol Vis Sci*. 2021;62:37.
56. Ma D, Wei S, Li SM, et al. The impact of study-at-home during the COVID-19 pandemic on myopia progression in Chinese children. *Front Public Health*. 2022;9:720514.
57. Bingham DD, Daly-Smith A, Hall J, et al. COVID-19 lockdown: ethnic differences in children's self-reported physical activity and the importance of leaving the home environment; a longitudinal and cross-sectional study from the born in Bradford birth cohort study. *Int J Behav Nutr Phys Act*. 2021;18:117.
58. Nathwani G, Shoaib A, Shafi A, Furukawa TA, Huy NT. Impact of COVID-2019 on school attendance problems. *J Glob Health*. 2021;11:03084. doi:10.7189/jogh.11.03084
59. Johnson N, Veletsianos G, Seaman J. US Faculty and administrators' experiences and approaches in the early weeks of the COVID-19 pandemic. *Online Learn*. 2020;24(2):6–21.
60. Black E, Ferdig R, Thompson LA. K-12 virtual schooling, COVID-19, and student success. *JAMA Pediatr*. 2021;175(2):119–120. doi:10.1001/jamapediatrics.2020.3800
61. Collins ME, Mudie LI, Inns AJ, Repka MX. Pediatric ophthalmology and childhood reading difficulties: overview of reading development and assessments for the pediatric ophthalmologist. *JAm Assoc Pediatr Ophthalmol Strabismus*. 2017;21(6):433–436.e431. doi:10.1016/j.jaapos.2017.06.017
62. Thuma TBT, Sussberg JA, Nelson LB, Schnall BM. Economic impact of the COVID-19 pandemic post-mitigation on pediatric ophthalmologists. *J Pediatr Ophthalmol Strabismus*. 2022;59(5):291–295. doi:10.3928/01913913-20220623-01
63. Lee KE, Sussberg JA, Nelson LB, Thuma T. The economic factors impacting the viability of pediatric ophthalmology. *J Pediatr Ophthalmol Strabismus*. 2022;59(6):362–368. doi:10.3928/01913913-20220817-01

64. Odor PM, Neun M, Bampoe S, et al. Anaesthesia and COVID-19: infection control. *Br J Anaesth*. 2020;125(1):16–24. PMID: 32307115; PMCID: PMC7142687. doi:10.1016/j.bja.2020.03.025
65. Macfarlane AJR, Harrop-Griffiths W, Pawa A. Regional anaesthesia and COVID-19: first choice at last? *Br J Anaesth*. 2020;125(3):243–247. PMID: 32532429; PMCID: PMC7254013. doi:10.1016/j.bja.2020.05.016
66. Liang H, Zhang M, Chen M, Lin TPH, Lai M, Chen H. Ocular trauma during COVID-19 pandemic: a systematic review and meta-analysis. *Asia Pac J Ophthalmol*. 2022;11(5):481–487. PMID: 36094376. doi:10.1097/APO.0000000000000539
67. Conde Bachiller Y, Puente Gete B, Gil Ibáñez L, Esquivel Benito G, Asencio Duran M, Dabad Moreno JV. COVID-19 pandemic: impact on the rate of viral conjunctivitis. *Arch Soc Esp Oftalmol*. 2022;97(2):63–69. doi:10.1016/j.oftale.2022.01.001
68. Spoorthy MS, Pratapa SK, Mahant S. Mental health problems faced by healthcare workers due to the COVID-19 pandemic-A review. *Asian J Psychiatr*. 2020;51:102119. doi:10.1016/j.ajp.2020.102119
69. Parija S, Mahajan P. Is pediatric ophthalmology a popular subspecialty in India: present scenario and future remedies. *Indian J Ophthalmol*. 2017;65(11):1187–1191. doi:10.4103/ijo.IJO_548_17
70. Kaur K, Kannusamy V, Gurnani B. Incremental innovations in pediatric ophthalmology department during the COVID-19 pandemic: an experience from a tertiary eye care hospital. *Indian J Ophthalmol*. 2021;69(4):1000–1001. doi:10.4103/ijo.IJO_118_21
71. Nayak S, Reddy YP, Behera S, Adish TS, Satyanarayana D. Virus containment box for retinopathy of prematurity screening and laser. *Indian J Ophthalmol*. 2021;69(2):406–408. doi:10.4103/ijo.IJO_2304_20
72. Chakrabarti R, Stevenson LJ, Carden S. Tele-health in pediatric ophthalmology: promises and pitfalls. *Indian J Ophthalmol*. 2021;69(3):740–742. doi:10.4103/ijo.IJO_229_21
73. Blue R, Yang AI, Zhou C, et al. Telemedicine in the era of coronavirus disease 2019 (COVID-19): a neurosurgical perspective. *World Neurosurg*. 2020;139:549–557. doi:10.1016/j.wneu.2020.05.066
74. Li JO, Liu H, Ting DSJ, et al. Digital technology, tele-medicine and artificial intelligence in ophthalmology: a global perspective. *Prog Retin Eye Res*. 2021;82:100900. doi:10.1016/j.preteyeres.2020.100900
75. Mazzuca D, Borselli M, Gratteri S, et al. Applications and current medico-legal challenges of telemedicine in ophthalmology. *Int J Environ Res Public Health*. 2022;19(9):5614. doi:10.3390/ijerph19095614
76. Humphreys J. The importance of wearing masks in curtailing the COVID-19 pandemic. *J Family Med Prim Care*. 2020;9(6):2606–2607. doi:10.4103/jfmpc.jfmpc_578_20
77. Sreelatha OK, Ramesh SV. Teleophthalmology: improving patient outcomes? *Clin Ophthalmol*. 2016;10:285–295. doi:10.2147/OPTH.S80487
78. Baird MD, Cantor J, Troxel WM, Dubowitz T. Job loss and psychological distress during the COVID-19 pandemic: longitudinal analysis from residents in nine predominantly African American low-income neighborhoods. *Health Econ*. 2022;31(9):1844–1861. doi:10.1002/hec.4536
79. Khanna RC, Cicinelli MV, Gilbert SS, Honavar SG, Murthy GSV. COVID-19 pandemic: lessons learned and future directions. *Indian J Ophthalmol*. 2020;68(5):703–710. doi:10.4103/ijo.IJO_843_20
80. Neena R, Gayathri MS, Prakash N, Anantharaman G. Impact of online classes on eye health of children and young adults in the setting of COVID-19 pandemic: a hospital-based survey. *Oman J Ophthalmol*. 2023;16(1):45–50. doi:10.4103/ojo.ojo_57_22
81. Wadhwani M, Manika M, Jajoo M, Upadhyay AD. Online survey to assess computer vision syndrome in children due to excessive screen exposure during the COVID 19 pandemic lockdown. *J Family Med Prim Care*. 2022;11(9):5387–5392. doi:10.4103/jfmpc.jfmpc_1771_21
82. Pavel IA, Savu B, Chiriac CP, Bogdănici CM. Ocular and musculoskeletal changes in the pediatric population using gadgets. *Rom J Ophthalmol*. 2022;66(3):257–264. doi:10.22336/rjo.2022.48
83. Mohan A, Sen P, Peeush P, Shah C, Jain E. Impact of online classes and home confinement on myopia progression in children during COVID-19 pandemic: digital eye strain among kids (DESK) study 4. *Indian J Ophthalmol*. 2022;70(1):241–245. doi:10.4103/ijo.IJO_1721_21
84. Mohan A, Sen P, Mujumdar D, Shah C, Jain E. Series of cases of acute acquired comitant esotropia in children associated with excessive online classes on smartphone during COVID-19 pandemic; digital eye strain among kids (DESK) study-3. *Strabismus*. 2021;29(3):163–167. doi:10.1080/09273972.2021.1948072
85. 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;69(1):140–144. doi:10.4103/ijo.IJO_2535_20
86. Jakhar F, Rodrigues GR, Mendonca TM, et al. Dry eye symptoms and digital eyestrain - Emerging epidemics among university students due to online curriculum amid the COVID-19 pandemic. A cross-sectional study. *Indian J Ophthalmol*. 2023;71(4):1472–1477. doi:10.4103/IJO.IJO_2760_22
87. Gupta N, Dhamija S, Patil J, Chaudhari B Impact of COVID-19 pandemic on healthcare workers. *Ind Psychiatry J*. 2021;30(Suppl 1):S282–S284.