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Perspective

Digital Screen Time During the COVID-19 Pandemic: Risk for a Further Myopia Boom?

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• PURPOSE: **To review the impact of increased digital device usage arising from lockdown measures instituted during the COVID-19 pandemic on myopia and to make recommendations for mitigating potential detrimental effects on myopia control.**
• DESIGN: **Perspective.**
• METHODS: **We reviewed studies focused on digital device usage, near work, and outdoor time in relation to myopia onset and progression. Public health policies on myopia control, recommendations on screen time, and information pertaining to the impact of COVID-19 on increased digital device use were presented. Recommendations to minimize the impact of the pandemic on myopia onset and progression in children were made.**
• RESULTS: **Increased digital screen time, near work, and limited outdoor activities were found to be associated with the onset and progression of myopia, and could potentially be aggravated during and beyond the COVID-19 pandemic outbreak period. While school closures may be short-lived, increased access to, adoption of, and dependence on digital devices could have a long-term negative impact on childhood development. Raising awareness among parents, children, and government agencies is key to mitigating myopigenic behaviors that may become entrenched during this period.**
• CONCLUSION: **While it is important to adopt critical measures to slow or halt the spread of COVID-19, close collaboration between parents, schools, and ministries is necessary to assess and mitigate the long-term collateral impact of COVID-19 on myopia control policies. (Am J Ophthalmol 2021;223:333–337. © 2020 Published by Elsevier Inc.)**

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On December 30th, 2019, Dr Wenliang Li alerted the world about the possibility of a severe acute respiratory syndrome–like virus outbreak in Wuhan, China.[1] Several months later, the World Health Organization (WHO) declared COVID-19 a "pandemic" outbreak.[2] As of November 13th, 2020, there were >53 million infected patients worldwide, with >1.3 million deaths.[3] The exponential increase in infections has alarmed citizens across the globe, including heads of state and WHO leaders.[4–6] Research has focused mainly on the epidemiology, risk modelling, pathophysiology, and clinical features of severe acute respiratory syndrome-CoV-2,[7,8] but the impact of increased digital screen time caused by the lockdown and quarantine measures in many cities worldwide on myopia has largely been unnoticed. By 2050, it is estimated that 5 billion people worldwide will be myopic,[9–11] prompting many governments to implement nationwide myopia control policies in the past decade. The rise in usage of digital technology and online e-learning during this pandemic outbreak may jeopardize the effectiveness of these policies.[12] We discuss the disruption of the COVID-19 pandemic lockdown measures on the learning environment of children and adolescents, review the evidence on digital screen time and its impact on myopia, and make recommendations to reduce the detrimental effects on myopia during and beyond this outbreak.

GLOBAL TIGHTENING OF INFECTION CONTROL MEASURES

At present, many governments are imposing strict quarantines and travel bans on an unprecedented scale,[13] based on a modelled study (N. M. Ferguson et al, unpublished data, March 2020). In this study, 2 fundamental strategies were proposed to control the spread of COVID-19 among the community: mitigation and suppression. With the mitigation approach, the study found that 8 of 10 people may still be affected, resulting in 510,000 deaths in the United Kingdom and 2.2 million deaths in the United States by the end of the pandemic (N. M. Ferguson et al,

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unpublished data, March 2020). Infected cases could be significantly decreased with the suppression strategy, which advocates closure of schools/universities, case isolation, household quarantine, and social distancing. Before this study, China locked down many cities; draconian restrictions were implemented nationwide in Italy, schools and universities were closed in both the United Kingdom and the United States, and many were subjected to legally enforced quarantines or are in "self-quarantine."[13] These measures have kept children away from schools and led to extensive disruptions in elementary education. Many children are now compelled to learn via digital platforms. According to the United Nations Educational, Scientific and Cultural Organization, approximately 1.37 billion students (80% of the world's student population) from >130 countries globally are affected by these lockdown measures,[14] with digital or e-learning approaches replacing face to face, classroom-based learning.

LOCKDOWN, DIGITAL LEARNING, AND RISKS OF MYOPIA

THE WORLD HAS NEVER EXPERIENCED THE EXTENT AND INtensity of measures taken to curb the COVID-19 pandemic. Many digital technologies, including the Internet of Things, are currently heavily used in various domains,[12] including digital virtual learning for the children. There is a possibility that a prolonged battle against the COVID-19 virus may lead to an increase in the incidence of myopia by shaping long-term behavioral changes conducive for the onset and progression of myopia.

First, widespread school closures, in-house quarantine, and the proliferation of online learning increases digital screen time and the overall time spent on near work while decreasing outdoor time among school-going children. Although school closures may be short-lived, increased access and adoption of such platforms may accelerate the widespread acceptance of digital tools in the longer term. Behavioral changes that arise from the growing dependence on digital devices may persist even after the COVID-19 pandemic, and this is a possibility that cannot be underestimated.

Second, public policies for the control of myopia in countries of East Asia, such as Taiwan and Singapore, are closely integrated within the education systems, particularly with respect to the incorporation of outdoor activities into school time.[15] The widespread closure of schools jeopardizes the implementation and continuity of these programs. Admittedly, children may have more time and flexibility to engage in outdoor activities if they choose. However, in most countries it is projected that medium-to long-term social distancing measures may curtail outdoor activities, leading to the undesirable effect of more time spent indoors on recreational digital screen time.

DIGITAL SCREEN TIME, NEAR WORK, AND OUTDOOR TIME

IT MAY BE INTUITIVE TO LINK DIGITAL DEVICE USAGE TO increased time spent indoors and on near work, thus conferring an increased risk of myopia onset and progression in children. However, the current evidence is inconclusive. A large cohort study of 5074 children in Rotterdam (the Generation R study), found an association between increased computer use and myopia at 9 years of age (odds ratio = 1.005 [95% confidence interval, 1.001-1.009]). The combined effect of near work, including computer use, reading time, and reading distance, increased the odds of myopia at 9 years of age (odds ratio = 1.072 [95% confidence interval, 1.047-1.098]).[16] A study of 418 students found that device-recorded smartphone data usage, an objective surrogate for time spent using the smartphone, was independently associated with myopia in a study of 418 students (odds ratio = 1.08 [95% confidence interval, 1.03-1.14]).[17]

In a meta-analysis involving 15 studies with a total of 49,789 children 3-19 years of age, Lanca and Saw[18] found that screen time was not associated with prevalent or incident myopia, although there were several reasons for the lack of association in their report. First, these studies used self-reported measurements of screen time. This is subject to recall bias and more objective measures of time spent on digital devices is needed. Second, the number of studies included in the meta-analysis was small (5 of 15 studies). This may have affected the validity of the pooled estimates. Third, there was no proven spike in near work, despite the increase in screen time,[19] indicating a substitution effect with traditional reading/writing being replaced by educational screen time, while recreational screen time might already have been limited because of the widespread belief that near work causes myopia.

How strong is the evidence that near work causes myopia? A meta-analysis spanning 12 cohort studies, 15 cross-sectional studies, and including 25,025 children 6-18 years of age concluded that there was an evidence rating of II for recommending a reduction in time spent with reading to reduce the risk of myopia.[20] This suggests that there is substantial evidence supporting this recommendation. The effect of near work on myopia development appeared to be related only to reading but not watching television, playing computer games, or even studying.[21] The relationship between near work and myopia was further elucidated in the Collaborative Longitudinal Evaluation of Ethnicity and Refractive Error Study.[22] Interestingly, differences in time spent reading, watching television, playing computer games, and studying only became apparent after the onset of myopia and not before.

Increased outdoor activities in children have been shown to protect against myopia onset, with a meta-analysis reporting a reduction in both incident myopia and prevalent myopia. In addition, pooled results from clinical trials found a reduced myopic shift of 0.30 diopters (D) after 3 years in both myopes and nonmyopes compared with control subjects. The protective effect on myopia progression is less clear, with the same study finding no relationship between time outdoors and myopic progression.[23] He and associates[24] showed that an additional 40 minutes of outdoor time per day achieved a 23% reduction in the incidence of myopia. Wu and associates[25] showed a 54% lower risk of myopia progression among both myopic and nonmyopic children who spent ≥11 hours outdoors per week. Reduced myopic shift (0.23 D) was further observed within the myopic subgroup of children randomized to the outdoor time intervention compared with myopic control subjects.[25] Importantly, activities with exposure to moderate light intensities such as in hallways or under a tree were sufficient to achieve this reduction in myopia progression.[25] The effectiveness of a public policy intervention to promote increased outdoor time for Taiwanese school children was further demonstrated in a recently published study by Wu and associates.[26] After the implementation of a myopia prevention program (Tian-Tian 120 outdoor program) in which schools were encouraged to take their students outdoors for 120 minutes per day, the long-term trend of increasing prevalence of reduced visual acuity (defined as uncorrected visual acuity ≤20/25) in schoolchildren from 2001 to 2011 (34.8%-50%) was reversed from 2012-2015 (49.4% to 46.1%). However, the optimal outdoors time and actual clinical impact on myopia progression requires further study. Nonetheless, from a public health perspective, encouraging outdoor time of 2 hours per day for school children has been deemed as a practical intervention that may reduce myopia progression with additional health benefits,[27] although this has been met with parental resistance in countries with high educational pressure.

RECOMMENDATIONS FOR MYOPIA PREVENTION

THE WORLD HEALTH ORGANIZATION'S GUIDELINES ON physical activity, sedentary behavior, and sleep recommends <1 hour of sedentary screen time for children 1-5 years of age.[28] Governments have also imposed limits on digital device usage in order to prevent myopia.[29] In China, where nearly half the population has myopia, aggressive government policies have been implemented to combat the myopia epidemic. The culprits identified and targeted in these policies include heavy study load, use of digital devices, and a lack of outdoor activities. With regard to digital devices, the Ministry of Education restricted the use of electronics as a teaching tool to no more than 30% of overall teaching time, <20 minutes per day spent on electronic homework (no more than 20 minutes), and prohibition of phones and tablets in classrooms.[18] Students are also encouraged to rest their eyes for 10 minutes after 30-40 minutes of educational screen time. The continuous use of digital devices for noneducational purposes should be limited to <15 minutes per day and a cumulative duration of <1 hour a day. In addition, regulations have been put in place to curb excessive online video gaming including restricting playing time and developing an age-based restriction system. In Taiwan, as part of their efforts to control myopia, lawmakers expanded legal regulations that ban children <18 years of age from smoking, drinking, and using drugs to include the use of digital devices for an unreasonable period of time.[30] The regulation, however, did not define what would be considered "unreasonable," reflecting the lack of evidence and official guidelines for both the duration and type of digital device usage that would have an impact on myopia. The American Academy of Pediatrics recommends restricting screen time to 1 hour per day of high-quality content for children 2-5 years of age and suggests consistent limits for children ≥6 years of age, but stops short of prescribing specific limits for this age group.[31]

In the United States, a national random sample of 40,337 children 2-17 years of age was assessed for the associations between screen time and psychological well-being. The study found moderate use of screens (4 hours/day) to be associated with lower psychological well-being, including less curiosity, lower self-control, more distractibility, more difficulties in making friends, less emotional stability, being more difficult to care for, and inability to finish tasks.[32] Once home-based digital learning is no longer a supplementary activity but instead a necessity in everyday learning, the number of hours of indoor time and screen time that school children will be exposed to may insidiously increase even after the COVID-19 pandemic. Moreover, many schools may also request that parents increase their children's access to screen-based devices to perform home-based learning programs.

What can be done to mitigate myopigenic behaviors that emerge during the COVID-19 pandemic and may subsequently be entrenched? First, public education to increase parent awareness about the effects of indoor near work and reduced outdoor time on the incidence and progression of myopia is important over the long term. Parents need to understand the importance of maintaining good eye habits during the pandemic lockdown and beyond, including frequent breaks from near work and limiting recreational screen time. Second, the government agencies for health and eye care professionals should continue to engage with schools to shape a holistic home-based learning curriculum that encourages creative learning not just from reading and study at home, but also include frequent breaks and indoor physical or household activities—cooking, baking, and cleaning, for example. Third, where it is safe and legal to do so, outdoor activities with adequate social distancing should continue and be encouraged in school-going children. Outdoor time of 2-3 hours per day may be even more achievable now with the flexibility of home-based learning.[16] The health benefits of outdoor activities and an active lifestyle should not be stifled by COVID-19.[33]

Amidst the worst outbreak known to human history, the world has been pushed to embrace digital technology at an unprecedented scale and pace. There is no denying the benefits of digital technology in a time like this. Notwithstanding the global pandemic, it is of paramount importance that parents help their children develop a healthy relationship with digital devices. First, digital detox is a method to encourage healthy digital device habits, using digital applications to consciously monitor device usage and reminding users to disconnect from the digital world. Parents can set limits using in-device applications to restrict the total screen time spent per day or per session. Second, supervising digital content is important to ensure that time spent on digital devices is maximized for learning experiences. Guiding the child through digital device usage helps to improve their ability to process and interpret digital content and thereby decrease the overall time spent online. Third, having a daily schedule to allocate time for specific activities and setting boundaries on when and where digital devices can be used can be an effective approach, while simultaneously building routine and discipline during the COVID-19 pandemic where days are largely unstructured. Fourth, parents should act as role models by reducing their own digital device usage, spending more time with their children outdoors, engaging their children in offline playtime, and involving them in nondigital indoor activities, such as chores, arts and crafts, and music.[31,34]

CONCLUSION

THE UNPRECEDENTED SCALE OF THE COVID-19 PANDEMIC has disrupted our lives beyond recognition. While the world reels from the global impact of COVID-19, governments are also adjusting to allow everyday life to continue, such as the closure of schools with the education of our school children using online platforms. In this regard, digital technology has been immensely beneficial in cushioning the disruption to school education, but it is crucial to be cognizant of the impact of increasing dependence on digital devices. While it is important to adopt strict measures (eg, lockdown and home quarantine) to slow or halt the spread of COVID-19, multidisciplinary collaboration and close partnerships between ministries, schools, and parents are necessary to minimize the long-term collateral impact of COVID-19–related policies on various health outcomes, such as myopia, which was already a major public health concern before the pandemic.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

CHEE WAI WONG: WRITING - ORIGINAL DRAFT, CRITICAL appraisal of the scientific content and final approval. **Andrew Tsai:** Writing - original draft, critical appraisal of the scientific content and final approval. **Jost B. Jonas:** critical appraisal of the scientific content and final approval. **Kyoko Ohno-Matsui:** critical appraisal of the scientific content and final approval. **James Chen:** critical appraisal of the scientific content and final approval. **Marcus Ang:** Writing - review and editing. **Daniel Shu Wei Ting:** Writing - original draft, critical appraisal of the scientific content and final approval.

ALL AUTHORS HAVE COMPLETED AND SUBMITTED THE ICMJE FORM FOR DISCLOSURE OF POTENTIAL CONFLICTS OF INTEREST.

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