Children's vision health during the COVID-19 pandemic

Moustafa Abdalhade Timorkhan (1)
Mouazzar yusuf Thani Ibraheem (2)

(1) Consultant ophthalmologist, Primary Health Care Corporation (PHCC), Qatar
(2) Specialist ophthalmologist, Primary Health Care Corporation (PHCC), Qatar

Corresponding author:
Dr Moustafa Abdalhade Timorkhan
Master's degree Ophthalmology,
Damascus University,
Syria
Consultant ophthalmologist,
Primary Health Care Corporation (PHCC),
Qatar
Email: mtimorkhan@phcc.gov.qa

Received: February 2022 Accepted: March 2022; Published: April 1, 2022.
Citation: Moustafa Abdalhade Timorkhan, Mouazzar yusuf Thani Ibraheem. Children's vision health during the COVID-19 pandemic. World Family Medicine. 2022; 20(4): 52-61. DOI: 10.5742/MEWFM.2022.9525024

Abstract

During the peak months of the COVID-19 pandemic, several countries elected to close schools and adapted to online learning. The aim of the article is to review the impact of lockdown measures instituted during the COVID-19 pandemic on children's vision health and to make recommendations for mitigating potential visual impairment.

Methods: We reviewed studies focused on digital device usage, near work, and outdoor time in relation to myopia onset and progression in children during the COVID-19 pandemic. Studies focused on the relation between screen time, asthenopia and dry eyes in children during COVID-19.

Results: Increased digital screen time, near work and limited outdoor activities were found to be associated with the onset and progression of myopia during the COVID-19 pandemic period. Screen time was positively associated with asthenopia and dry eye in children during COVID-19.

Conclusion: The COVID-19 pandemic has led to dramatic changes in many aspects of daily life. Online learning has become the mainstream public learning mode during the pandemic. Several studies indicate accelerated myopic progression during the COVID-19 pandemic in children and the increase has been found to be related to excessive use of digital screen devices and the decrease of outdoor activities duration. Also prolonged screen time, and online-course time can significantly increase asthenopia and dry eye risk. Several studies have recommended to decrease screen time and to increase outdoor activities.

Key words: Myopia progression, digital screen time, near work, outdoor activity time, asthenopia and dry eye

Introduction

On December 30, 2019, a novel coronavirus disease 2019 (COVID-19) was initially described and rapidly spread worldwide. (1) A few months later, the World Health Organization (WHO) declared COVID-19 a "pandemic" outbreak (2) .

Governments worldwide have implemented various measures to contain the spread of the pandemic, including strict travel bans, social distancing, quarantine policies and school closures. These measures have affected school-age children and students in general. During the peak months of the pandemic, 195 countries elected to close schools, affecting nearly 1.5 billion children and young people (3).

In addition to the negative physical and mental effects of school closures, the children during the home education process were more exposed to smartphones, computers, tablets and television (4). Children's visual system is extremely delicate and is in a phase that is characterized by critical development. Studies have suggested that early decline in eye health is associated with increased risks of developing macular degeneration, glaucoma, and other myopia-related complications (5,6).

Myopia progression

According to the World Health Organization, at least 2.2 billion people worldwide suffer from impaired vision, among whom a significant proportion are those under 18 years old (7). Research has suggested that close to 50% of the world's population may be myopic by 2050, with as much as 10% highly myopic (8).

In addition to genetics (9), there is strong evidence that environmental factors (10) such as time spent outdoors (11), sustained near vision (12) and prolonged higher education (13) play a significant role in the onset of myopia.

Pelligrini et al (14) noted the possibility that prolonged home confinement due to the COVID-19 pandemic would very likely have a significant impact on the global incidence of myopia and worsening of pre-existing myopia among children. The authors termed this quarantine myopia and observed that this would represent a serious public health concern because of the visual disability associated with uncorrected myopia that would particularly affect children in low- and middle-income countries and the sight-threatening complications in later life associated with high myopia.

There is supportive evidence from several studies documenting what was considered a possibility has indeed happened.

Wang et al (15) evaluated non-cycloplegic refractive error values of 123,535 children aged 6 to 13 years from 10 elementary schools in Shandong, Feicheng, China. They found that, in the annual screenings conducted from 2015 to 2019, the mean SER (spherical equivalent refraction) findings were relatively stable for all age groups, whereas in the June 2020 screenings that took place when schools reopened after 5 months of home confinement, the mean SER reflected a myopic shift of about − 0.3 diopters (D) and the prevalence of myopia (defined as an SER of −0.50 D or less) increased 1.4 to 3 times in 2020 compared with the previous 5 years especially among younger children.

In another study, 2 groups of students from 12 primary schools in Guangzhou, China, were prospectively enrolled and monitored from grade 2 to grade 3. A non-exposure group (n=1060) included students who were examined in late 2018 (grade 2) and then in late 2019 (grade 3), and an independent exposure group (n=1054) included students examined in late 2019 (grade 2) and again in late 2020 (grade 3). Compared with the unexposed group, the exposed group experienced a -0.36 D greater myopic shift in SER, an increased axial length of 0.08 mm, and a 7.9% higher incidence of myopia (defined as a SER <−0.5 D). (16)

And in another report, students from primary grades through high school from Chongqing, China, were randomly selected from the 2019 and 2020 surveys (n=1728 and 1733, respectively), which included refractive data recorded by an optometry unit. The percentage of myopia (defined as a mean uncorrected visual acuity <5.0 with a mean SER <−0.50 D) in 2019 was 44.62% and increased to 55.02% in 2020 (P<0.001), and the mean spherical equivalent (SE) refraction (−1.94 ± 2.13 D) in 2020 was lower than that in 2019 (−1.64 ± 5.49 D, P < 0.001) (17).

Also, in Hong Kong, a study with a total of 1793 subjects were recruited, of whom 709 children comprised the COVID-19 cohort with 7.89±2.30 months of follow-up, and 1084 children comprised the pre-COVID- 19 cohort with 37.54 ± 3.12 months of follow-up. The overall incidence was 19.44% in the COVID-19 cohort, and 36.57% in pre-COVID-19 cohort. During the COVID-19 pandemic, the change in SER was –0.50 ± 0.51 D. The authors observed that the COVID-19 cohort over 8 months showed a faster SER progression (−0.50 D) during the current pandemic compared with the studies in Shanghai (−0.27 D), (18) Guangzhou (−0.31), (19) and Taipei of Taiwan (−0.42D), (20) over a 1-year follow-up before COVID-19 (21).

Furthermore, Aslan F et al (22) evaluated the myopic progression of 115 children aged 8–17 years in Turkey between 2017 and 2020 and found that the annual myopic progression amount 0.49±0.26, 0.41±0.36 and 0.54 ±0.43 diopters (D) for the 2017, 2018 and 2019 years and 0.71±0.46 D in 2020, and the increase in myopic progression in 2020 compared to the 2019 and 2018 years, was statistically significant (P < 0.003).

In another study of 201 myopic children aged 7 to 12 years with regular follow-up visits every half a year from April 2019 to May 2020 in Shanghai, China, there was a significantly greater change in spherical equivalent at visit 2 (−0.98 ± 0.52 D) than at visit 1 (−0.39 ± 0.58 D; P < 0.001), whereas the second (visit 2) was four months after the home quarantine (23).

Similarly, in a study in India, a total of 133 children (266 eyes) aged 6–18 years were included in the study. Mean annual myopia progression was found to be statistically significant during COVID-19 as compared with pre-COVID-19 (0.90 vs 0.25 D, P < 0.00001) and a total of 45.9% of children showed an annual progression of ≥1 D during the pandemic as compared with 10.5% before the COVID-19 pandemic (24).

In another study in China of two groups with a total of 154 children, the exposed group was formed from 77 children aged 8 to 10 years who studied at home in the 7-month period during the COVID-19 pandemic (follow-up period: January – August 2020) and did not study at home in the 7-month period before the COVID-19 outbreak (baseline period: July 2019 – January 2020). Seventy-seven children who did not undergo study-at-home (baseline period: 7 months in 2015, follow-up period: 7 months in 2016) were included in the control group. Myopia progression was similar between the two groups in the baseline period. However, in the follow-up period the exposed group had a greater change in refraction toward myopia (−0.83 ± 0.56 D) than the control group (−0.28 ± 0.54 D; P < 0.001). In addition, the exposed group exhibited a significantly greater change in refraction toward myopia in the follow-up period (−0.83±0.56 D) than in the baseline period (−0.33±0.46 D; P < 0.001). (25)

In Spain, 1600 children between 5 and 7 years old were examined in September and October of 2020 and compared with the 4227 examined during the same months of 2019. There was a significant decrease of the spherical equivalent (mean ± standard deviation; 0.66 ± 2.03 D in 2019 vs. 0.48 ± 1.81 D in 2020; P ≤ 0.001) (26).

A summary of myopia progression in these studies is shown in Table 1.

Reference	Location	Age, y	Sample size	Duration	SE pre COVID-19 (D)	SE during COVID-19 (D)	SE Change during COVID-19 (D)	SE Change pre COVID - 19 (D)	P value
Hu Y et al. (16)	Guangzhou, China	6 – 8	1054	1 year	0.86 ± 0.94	0.20 ± 1.15	– 0.67 ± 0.56	– 0.31 ± 0.46 *	– 0.36 D P < 0.001
Wang W et al. (17)	Chongqing, China	7 – 12	1733	1 year	−1.64 ± 5.49	−1.94 ± 2.13	P < 0.001	#	#
Zhang X et al. (21)	Hong Kong	6 – 8	709	8 months	0.32 ± 1.16	– 0.19 ± 1.33	– 0.50 ± 0.51	– 1.27 ± 1.34 **	-
Aslan F et al. (22)	Turkey	8 – 17	115	1 year	– 1.99 ± 1.04	– 2.7 ± 1.21	– 0.71 ± 0.46	– 0.54 ±0.43	– 0.17 ±0.6 D P 0.003
Ma M et al, (23)	Shanghai, China	7 – 12	201	6 months	– 2.25 ± 0.75	– 3.23 ± 0.65	– 0.98 ± 0.52	– 0.39 ± 0.58	< 0.001
Mohan A et al. (24)	India	6 –18	133	1 year	– 4.54 ± 2.70	– 5.12 ± 2.70	– 0.45 ± 0.48	– 0.12 ± 0.18	< 0.00001
Ma D et al. (25)	Hebei, China	8 - 10	77	7-month	– 0.26 ± 0.93	– 0.75(−1.13, −0.50)	– 0.83 ± 0.56	−0.28 ± 0.54	<0.0001
Alvarez-Peregrina et al. (26)	Spain	5-7	5827⁂	1 year	0.66 ± 2.03	0.48 ± 1.81	– 0.13 D	#	#

Table 1: Key results of myopia progression according to the previous studies.

SE spherical equivalent, D diopter, * Myopia progression pre COVID 19 in the non-exposure group (n=1060). ** Myopia progression pre COVID 19 cohort (1084) for 3 years follow up duration. ⁂ Total of (4227) children examined in 2019 and (1600) children examined in 2020. # Not reported in the study.

Digital screen time and near work

The evidence concerning the role of screen time and near work in myopia onset and progression is conflicting. In a meta-analysis involving 15 studies with a total of 49,789 children 3-19 years of age, Lance et al reported mixed findings with respect to an influence of screen time on myopia (27).

Also, many authors report that increased near work is associated with higher incidence of myopia in school age children, (28-30) while others did not observe such a relationship (31-32).

Several studies found that children worldwide had spent extended periods of time with digital media during COVID-19 lockdown, Table 2.

The association between e-learning screen use, near work, and myopia development during COVID 19 was investigated by several studies.

In a study of 3,831 Chinese adolescents during the COVID-19 pandemic, researchers found that every 1-hour increase in daily digital screen use is associated with 1.26 OR [Odds Ratio] higher risk of myopic progression. And using smartphones and computers is shown to be associated with higher risks of myopic progression than television use (41).

In another survey involving 2234 subjects enrolled in 1st to 6th grade in primary schools in China. each additional diopter hour increase in electronic screen use per day was associated with 1.036 odds ratio (OR) increased likelihood of near-sighted refractive error, whereas diopter hour is the proximity-weighted eye use that is computed based on an average distance from electronic screens. It found that the subjects reporting occurrence of near-sighted refractive error on average indicates 3.64 dh additional exposure to electronic screens per day than subjects who did not experience near-sighted refractive error (42).

Similarly, in a study of 3405 children from primary to upper-secondary school, findings show that each diopter hour increase in daily e-learning screen use is significantly associated with progression of myopia symptoms (OR: 1.074). It found an average daily screen time of 3.9 ± 2.3 hours/day. Subjects who reported myopic symptoms on average engaged in 1.4 more hours than subjects who did not ($P < 0.001$) (43).

Also, Ma M et al (23) in their study found that an increase of 1 h/day spent on digital devices for online learning corresponded with a myopia progression of 0.21 D. They observed that an average of 0.67 h/day was spent on digital screen devices for online learning before the COVID-19 pandemic and increased to 5.24 h/day during COVID- 19 pandemic, nearly 10 times longer than before. A significant difference in change of SE was found between different types of digital devices used (mobile phone: −1.63 ± 0.20 D; tablet: −1.00 ± 0.29 D; television: −0.69 ± 0.25 D; projector: −0.61 ± 0.27 D; $P < 0.001$). Children using televisions and projectors had significantly less myopic shift than those using tablets ($P < 0.001$), who had slower myopia progression than those using mobile phones ($P < 0.001$). More time spent on digital devices for online learning and doing other near work was significantly correlated to faster myopia progression ($P < 0.001$ for digital screen time; $P = 0.015$ for other near work).

Also, in the above mentioned study of Wang W (17), the researchers found that the mean SE in the television group (−1.10 ± 1.49 D) was better than that in the computer group (−2.03 ± 2.37 D, $P = 0.0017$) and in the cell phone group (−2.02 ± 2.09 D, $P = 0.0028$) for the students who used digital devices for online courses (17).

Table 2: Children's screen time during COVID-19 in different studies

Country	Age/ year	Screen time effect
Canada	5 - 11	Only 4.8% of children were meeting combined movement behavior guidelines during COVID-19 restriction due to sedentary behavior including screen time (5.1 hours/day) (33)
China	6 - 17	Screen time increased during the pandemic in total (+1730 min [or approximately 30h] per week on average (34)
France	6 - 10	65% of children had increased screen time (35)
Germany	4 - 17	61.2 minutes more screen time per day (36)
Italy	6 - 18	Screen time increased by 4.85 h/day (37)
India	10 - 18	average screen time (3.9 ± 1.9 h) vs (1.9 ± 1.1) pre COVID-19 (38)
Netherlands	4 - 18	screen time increased by 1 hour (39)
Spain	8 - 16	screen time increased by 1.9 ± 2.6 h/d (40)

In addition to that, in a study in India, 96.7% of the children were using smartphones to attend online classes. They noted increase in the duration of mobile game playing (P < 0.0001) during the COVID-19 period and found video game playing on smartphones ≥1 h per day was a significant risk factor for rapid annual myopia progression during the COVID-19 pandemic (OR = 3.46, P = 0.01) (24).

In Hong Kong, Zhang X et al found that screen time had increased from 2.45 ± 2.32 to 6.89 ± 4.42 hours/day (P < 0.001) in 709 children who comprised the COVID-19 cohort group. During the same period, total near work time increased from 3.42 ± 2.50 hours/day to 8.05 ± 4.49 hours/day (P < 0.001). The study also showed association of reading time with SER progression (21).

Also, Ma D et al (25) found that the amount of time spent performing near-work increased during the study-at-home period from 2.96 ± 1.05 hours per day to 4.33 ± 1.04 hours per day (P < 0.001), where near work included homework, reading books, painting, playing chess, using computers and using mobile phones.

In a study in USA, forty children (ages 14.6 ± 0.4 years) simultaneously wore two sensors for one week; a Clouclip for objective measurement of near viewing and light exposure and an Actiwatch for objective measurement of activity and sleep. Objectively measured daily near viewing duration during COVID-19 was 6.9 ± 0.3 hrs. Myopes spent more time in near + intermediate viewing than non-myopes (P = 0.008) and had higher diopter hours (P = 0.03) and electronic device use was (12.0 ± 0.7 hrs per day) (44). Similarly, in another study of 53 children in the USA, the daily electronic device use increased on weekdays and weekends during COVID-19 (7.3 ± 0.6 and 7.9 ± 0.7 hours) compared to a typical summer (4.9 ± 0.5 and 6.1 ± 0.5 hours, P < 0.001 for both weekdays and weekends) and to a typical school session (3.4 ± 0.3 and 5.4 ± 0.5 hours, P < 0.001 for both weekdays and weekend) (45).

Outdoor activity time

The role of outdoor activity in decreasing myopia progression has been disputed. Outdoor activities have been reported to decrease the incidence and progression of myopia. (46-47). Wu et al. suggested that myopia progression in children who spent >11 h a week outdoors decreases by 53% (46). Also, He et al. reported that every additional 40 minutes of outside activities decreases myopia incidence by 23%, (47) While in another meta-analysis, improved outdoor time demonstrates a protective effect for onset but not progression of myopia (48).

Outdoor activity time and myopia progression during COVID 19 was investigated by several studies.

In a study of 1237 school children aged 9-14 years in India, a significant decline was noted in time spent on outdoor activity (from 8.5 hours/week in pre-COVID-19 time to 1.6 hours/week during COVID-19 lockdown; P < 0.001) (49).

Also, outdoor activities time decreased from 1.27 ± 1.12 hours/day at baseline recruitment to 0.41 ± 0.90 hours/day during COVID-19 (P <0.001) (21). Similarly, outdoor activities decreased from 1.84 ± 1.43 hours per day to 0.98 ± 1.01 hours per day (P < 0.001) (25).

Aslan F et al (22) noted that the mean myopic progression was 0.55 ± 0.42 D in children who spent time outside in the daylight for 2 hours a day, and 0.82 ± 0.45 D in children who did not (P = 0.003) and the mean myopic progression was 0.5 ± 0.41 D in children living in detached houses and 0.79 ± 0.45 D in those living in apartments (P = 0.006).

Liu J et al (43) reported that engaging in outdoor exercise four to six times per week (OR: 0.745, p = 0.034) and one to three times per week (OR: 0.829, p = 0.048) is associated with a lower likelihood of myopia progression, than none. Similarly, Wang W et al (17) reported that average time of outdoor activity was positively correlated with SE.

Also, in the abovementioned study in Spain (26), the authors found that 56% of the children changed the amount of time spent outdoors, and in 47% of the cases, this time decreased (P < 0.001), and the relationship between lifestyles and refractive errors showed that children who spent more time outdoors had higher SE in both cases: pre and post confinement (P < 0.001 and p = 0.049).

In another study, home confinement in the form of less sun exposure was found to be the most important risk factor for the rapid progression of myopia during the COVID-19 pandemic. Sun exposure <1 hour per day (P < 0.00001) was found to be an independent risk factor for rapid myopia progression of ≥1 D (24).

Furthermore, in another study, children demonstrated decreased activity and time outdoors during COVID-19, with myopic children exhibiting lower light exposure and activity than non-myopes. However, while myopic children tended to spend less time outdoors (0.7 ± 0.2 hours per day) than non-myopic children (1.0 ± 0.1 hours per day), the difference did not reach significance (P = 0.09) (45).
On the other hand, even the outdoor time during the home quarantine period significantly decreased from an average of 1.11 hours/day to 0.49 hours/day; no association between reduced outdoor time and faster myopia progression was observed (23). The authors noted that this might be because outdoor time was still less than 2 hours/day before the home quarantine, which is under the threshold required to have a positive effect or be due to the different influence of outdoor activities on myopia onset and its progression, with no protective effect in children who are already myopic.

Asthenopia and dry eye

Asthenopia is defined as a subjective sensation of eye strain, eye pain, dry eyes, itching eyes, and headaches, (50). Several previous studies have shown that increased use of digital tools is positively related to asthenopia risk among college students and school-aged children (51-52).

The prevalence of asthenopia among school-aged children and adolescents varies significantly across countries, ranging from (12.4-26.4%) (53) in one study up to 89.9% (54) in another.

During COVID-19, a study in India of 217 children (13 ± 2.45 year) found 36.9% (n = 80) were using digital devices >5 hours in the COVID era as compared to 1.8% (n = 4) before the COVID era. The prevalence of digital eye strain is 50.23% and was significantly associated with male gender, smartphone use, duration of digital device use >5 hours, digital device distance <18 inches, and use of mobile games >1 hour per day (38).

In another study of 654 students (mean age: 12.02 ± 3.9 years) in India, the average per day digital device exposure was 5.2 ± 2.2 hours. (92.8%) of the children reported experiencing at least one asthenopic/dry eye symptom (AS/DS). The most prevalent symptoms were eye redness (69.1%) and heaviness of eyelids (79.7%). Significant positive correlation was reported between age and per day duration of digital device exposure (P < 0.001). Computer vision syndrome (CVS) score for spectacle users was significantly higher (P < 0.001). CVS score was found to correlate significantly with age and duration of digital device exposure (P < 0.001) (55).
Also, in another study of 25,781 school-aged children in China, overall asthenopia prevalence was 12.1%, varying from 5.4 to 18.2%. Authors found that total screen time was positively associated with asthenopia risk and a 100-hour increment of total screen/online-course time was associated with an increased risk of asthenopia by 9% (56).

In Egypt, a study of 403 subjects with a mean age of 12.7 ± 1.9 years (range 10–18) during COVID-19 reported that the most frequent current symptom was eye fatigue followed by dryness/grittiness/scratchiness, then burning, watering, and irritation, and 16.6 % of the patients reported current use of artificial tears. Screen time for both education and leisure increased significantly compared to pre-COVID-19, with a mean difference of 1.06 ± 1.5 and 1.39 ± 2.04 hour per day, respectively (P<0.001). Increased screen time has been associated with increased dry eye symptoms (57).

Furthermore, in a study of 110 healthy children 10-17 years of age who were enrolled in full-time or hybrid virtual school during the COVID-19 pandemic, 61% of children had an increase in convergence insufficiency symptoms and 17% had severe convergence insufficiency symptoms after school, and 53% of children had an increase in asthenopia symptoms. (58)

In another study in China, 2005 children with mean 12 ± 3.0 years had mean screen time of 4.6 ± 3.4 hours/day. 77.0% of students reported at least one CVS symptom with eye dryness and itching the most common (48%). CVS score was independently associated with older age, children with myopia not wearing glasses, astigmatism, other ocular diseases, not complying with the 20-20-20 rule, more screen time and less outdoor activities (59).

Recommendation for screen time, outdoor activity time, and digital eye strain

The World Health Organization's guidelines on physical activity, sedentary behavior, and sleep recommends no more than 1-hour sedentary screen time for those aged 2-5 years, and less is better (60).

The American Academy of Child and Adolescent Psychiatry recommends restricting non-educational screen time to about 1 hour per weekday and 3 hours on the weekend days for children 2-5 years of age and for ages 6 and older, encourage healthy habits and limit activities that include screens (61).

In 2018, the Ministry of Education of China adopted a plan for control and prevention of myopia, which included the restriction of use of electronics as a teaching tool to no more than 30% of overall teaching time, prohibition of phones and tablets in classrooms, the use of electronic products for non-learning purposes should not exceed 15 minutes at a time and should not exceed 1 hour per day, and students are also encouraged to rest their eyes for 10 minutes after using electronic products for 30-40 minutes of learning (62).

In 2020, the National Health Commission of China issued the Guidelines for the Prevention of Myopia in Children and Adolescents During the COVID-19 Epidemic, which limited online learning time in primary school students to 2.5 hours per day, with each time not to exceed 20 minutes; and in secondary school students to 4 hours per day, and each time not to exceed 30 minutes, and video screen time for non-learning purposes to 1 hour per day. It was recommended to choose large-screen electronic products for online learning, with the priority a projector, TV, desktop computer, laptop, tablet, mobile phone, and the viewing distance should be more than 3 meters for projector, more than 4 times for TV and more than 50 cm (about an arm's length) for computer (63).

Increased outdoor activities in children have been shown to reduce the myopic change in both non-myopic and myopic children (43). After the implementation of a myopia prevention program (Tian-Tian 120 outdoor program) in Taiwan, in which primary 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%) (64).

In Taiwan, after launching the Yilan Myopia Prevention and Vision Improvement Program (YMVIP) from 2014 through to 2020, myopia prevention strategies such as increasing outdoor activities (2 hours/weekday) was promoted in all kindergartens. The myopia prevalence declined significantly from 2014 through to 2016 and remained stable afterward even during COVID-19 (no school closure or shifting to online education in Taiwan at that time). In total, the prevalence of myopia decreased by

5.2% from 2014 through to 2020 (15.5% to 10.3%) (65). In China, the National Health Commission recommended more than 2 hours of outdoor activity time every day and advocated myopic children and adolescents to spend more than 3 hours outdoor activities every day (63).

Recommendations to reduce digital eye strain include correct ergonomic practices, appropriate correction of refractive error, maintain normal blinking, the use of appropriate lighting, careful positioning of the digital device, adjusting image parameters (resolution, text size, contrast, luminance), taking breaks, and the use of lubricating eye drops (artificial tears) to help alleviate dry eye-related symptoms (66-67). The American Optometric Association promotes the 20-20-20 rule (take a 20-second break to view something 20 feet away every 20 minutes) to help alleviate digital eyestrain (68).

Conclusion

The COVID-19 pandemic has led to dramatic changes in many aspects of daily life. Online learning has become the mainstream public learning mode during the pandemic. Several studies indicate accelerated myopic progression during the COVID-19 pandemic in children; myopic progression ranges from 0.13 D in Spain (26) up to 0.98 D in China (23) and the increase has been found to be related to excessive use of digital screen devices and the duration of outdoor activities. The increase in daily digital screen use is associated with higher risk of myopic progression (41-43). Smartphones and computers are shown to be associated with higher risks of myopic progression than television and projector use (17, 23, 41). A significant decline was noted in outdoor activity time in several studies (21, 25, 49) and engaging in outdoor activities is associated with a lower risk of myopic progression (17, 43).

Asthenopia and dry eye in children has a prevalence between 5.4 % in China (56) up to 92.8% in India (55). Prolonged screen time, and online-course time were associated with higher risk for asthenopia and dry eye (55-59).

Children's health is a collective responsibility of parents, teachers and health care practitioners. Eye and vision health awareness need to be spread in all possible ways. Teachers and parents need to help students and children to develop healthy relationships with digital devices. They should encourage children to put their devices away for an hour or two each day, and to go outside and get some form of exercise. Parents can set limits using in-device applications to restrict the total screen time spent per day or per session and parents should act as role models by reducing their own digital device usage, and spending more time with their children outdoors. Eye care practitioners should educate parents to bring children who have refractive error and who are using spectacles for routine eye examination and emphasize on the importance of reducing screen time and increasing outdoor activity.

References

1. Morens DM, Daszak P, Taubenberger JK. Escaping Pandora's Box—another novel coronavirus. N Engl J Med. 2020 Apr 2; 382(14):1293–5. https://doi.org/10.1056/NEJMp2002106 PMID: 32101660
2. World Health Organization. Rolling Updates on Coronavirus Disease (COVID-19). Available online: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen
3. UNESCO. 1.3 billion learners are still affected by school or university closures, as educational institutions start reopening around the world, says UNESCO. Available at: https://en.unesco.org/news/13-billion-learners-are-still-affected-school-university-closures-educational-institutions
4. Sumitha M, Sanjay S, Kemmanu V, Bhanumathi MR, Shetty R. Will COVID-19 pandemic-associated lockdown increase myopia in Indian children? Indian J Ophthalmol. 2020; 68:1496.
5. Tideman JW, Snabel MC, Tedja MS, van Rijn GA, Wong KT, Kuijpers RW, et al. Association of axial length with risk of uncorrectable visual impairment for Europeans with myopia. JAMA Ophthalmol. 2016;134(12):1355–63.
6. Chua SY, Sabanayagam C, Cheung YB, Chia A, Valenzuela RK, Tan D, et al. Age of onset of myopia predicts risk of high myopia in later childhood in myopic Singapore children. Ophthalmic Physiol Opt. 2016;36(4):388–94.
7. WHO.World Report on Vision. Available online: https://www.who.int/publications/i/item/9789241516570.
8. Holden, B.A.; Fricke, T.R.; Wilson, D.A.; Jong, M.; Naidoo, K.S.; Sankaridurg, P.; Wong, T.Y.; Naduvilath, T.J.; Resnikoff, S. Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050. Ophthalmology. 2016, 123, 1036–1042.
9. Tedja, M.S.; Haarman, A.E.G.; Meester-Smoor, M.A.; Kaprio, J.; Mackey, D.A.; Guggenheim, J.A.; Hammond, C.J.; Verhoeven, V.J.M.; Klaver, C.C.W. IMI—Myopia genetics report. Investig. Ophthalmol. Vis. Sci. 2019, 60, M89–M105.
10. Mrugacz, M.; Gajecka, M.; Mrukwa-Kominek, E.; Witkowska, K.J. Myopia: Risk factors, disease mechanisms, diagnostic modalities, and therapeutic options. J. Ophthalmol. 2018, 2018, 1–2.
11. Wu, P.C.; Tsai, C.L.; Wu, H.L.; Yang, Y.H.; Kuo, H.K. Outdoor activity during class recess reduces myopia onset and progression in school children. Ophthalmology 2013, 120, 1080–1085.
12. Enthoven, C.A.; Tideman, J.W.L.; Polling, J.R.; Yang-Huang, J.; Raat, H.; Klaver, C.C.W. The impact of computer use on myopia development in childhood: The Generation R study. Prev. Med. 2020, 132, 105988.
13. Dirani, M.; Shekar, S.N.; Baird, P.N. The role of educational attainment in refraction: The genes in myopia (GEM) twin study. Investig. Ophthalmol. Vis. Sci. 2008, 49, 534–538.
14. Pellegrini M, Bernabei F, Scorcia V, Giannaccare G. May home confinement during the COVID-19 outbreak worsen the global burden of myopia? Graefes Arch Clin Exp Ophthalmol. 2020;258(9):2069-2070. Doi:10.1007/s00417-020-04728-2

15. Wang J, Li Y, Musch DC, et al. Progression of myopia in school-aged children after COVID-19 home confinement. JAMA Ophthalmol. 2021;139(3):293-300. doi:10.1001/jamaophthalmol.2020.6239
16. Hu Y, Zhao F, Ding X, et al. Rates of myopia development in young Chinese schoolchildren during the outbreak of COVID-19. JAMA Ophthalmol. Published online September 16, 2021. doi:10.1001/jamaophthalmol.2021.3563
17. Wang W, Zhu L, Zheng S, et al. Survey on the progression of myopia in children and adolescents in Chongqing during COVID-19 pandemic. Front Public Health. 2021; 9:646770. doi:10.3389/fpubh.2021.646770.
18. Li T, Jiang B, Zhou X. Axial length elongation in primary school-age children: a 3-year cohort study in Shanghai. BMJ Open 2019;9: e029896.
19. Liao C, Ding X, Han X, et al. Role of parental refractive status in myopia progression: 12-year annual observation from the Guangzhou twin eye study. Invest Ophthalmol Vis Sci 2019; 60:3499–506.
20. Hsu C-C, Huang N, Lin P-Y, et al. Risk factors for myopia progression in second-grade primary school children in Taipei: a population-based cohort study. Br J Ophthalmol 2017; 101:1611–7.
21. Zhang, Xiujuan et al. "Myopia incidence and lifestyle changes among school children during the COVID-19 pandemic: a population-based prospective study." The British journal of ophthalmology, bjophthalmol-2021-319307. 2 Aug. 2021, doi:10.1136/bjophthalmol-2021-319307.
22. Aslan, F., Sahinoglu-Keskek, N. The effect of home education on myopia progression in children during the COVID-19 pandemic. Eye (2021). https://doi.org/10.1038/s41433-021-01655-2.
23. Ma M, Xiong S, Zhao S, Zheng Z, Sun T, Li C. COVID-19 home quarantine accelerated the progression of myopia in children aged 7 to 12 years in China. Invest Ophthalmol Vis Sci. 2021;62(10):37.
24. 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; 70:241-5.
25. Ma D, Wei S, Li S-M, Yang X, Cao K, Hu J, Peng X, Yan R, Fu J, Grzybowski A, Jin Z-B and Wang N (2022) The Impact of Study-at-Home During the COVID-19 Pandemic on Myopia Progression in Chinese Children. Front. Public Health 9:720514. doi: 10.3389/fpubh.2021.720514
26. Alvarez-Peregrina, C.; Martinez-Perez, C.; Villa-Collar, C.; Andreu-Vázquez, C.; Ruiz-Pomeda, A.: Sánchez-Tena, M.Á. Impact of COVID-19 Home Confinement in Children's Refractive Errors. Int. J. Environ. Res. Public Health 2021, 18, 5347. https://doi.org/10.3390/ijerph18105347.
27. Lanca C, Saw SM. The association between digital screen time and myopia: a systematic review. Ophthalmic Physiol Opt. 2020; 40:216–129.
28. Lin Z, Vasudevan B, Mao GY, et al. The influence of near work on myopic refractive change in urban students in Beijing: a three-year follow-up report. Graefe's Arch Clin Exp Ophthalmol. 2016; 254:2247–2255.
29. Mutti DO, Mitchell GL, Moeschberger ML, et al. Parental myopia, near work, school achievement, and children's refractive error. Invest Ophthalmol Vis Sci. 2002; 43:3633–3640.
30. French AN, Morgan IG, Mitchell P, et al. Risk factors for incident myopia in Australian schoolchildren: the Sydney Adolescent Vascular and Eye Study. Ophthalmology. 2013; 120:2100– 2108.
31. Jones-Jordan LA, Sinnott LT, Cotter SA, et al. Time outdoors, visual activity, and myopia progression in juvenile-onset myopes. Invest Ophthalmol Vis Sci. 2012; 53:7169–1775.
32. Saw S-M, Shankar A, Tan S-B, et al. A cohort study of incident myopia in Singaporean children. Invest Ophthalmol Vis Sci. 2006; 47:1839–1844.
33. Moore, S. A. et al. Impact of the COVID-19 virus outbreak on movement and play behaviours of Canadian children and youth: a national survey. Int. J. Behav. Nutr. Phys. Act. 17(1), 85. https:// doi. org/ 10. 1186/ s12966-020- 00987-8 (2020).
34. Xiang, M., Zhang, Z. & Kuwahara, K. Impact of COVID-19 pandemic on children and adolescents' lifestyle behavior larger than expected. Prog. Cardiovasc. Dis. 63(4), 531–532. https:// doi. org/ 10. 1016/j. pcad. 2020. 04. 013 (2020).
35. Chambonniere, C. et al. Effect of the COVID-19 lockdown on physical activity and sedentary behaviors in French children and adolescents: new results from the ONAPS national survey. Eur. J. Integr. Med. 43, 101308. https:// doi. org/ 10. 1016/j. eujim. 2021. 101308 (2021).
36. Schmidt, S. et al. Physical activity and screen time of children and adolescents before and during the COVID-19 lockdown in Germany: a natural experiment. Sci. Rep. 10(1), 21780. https:// doi. org/ 10. 1038/ s41598- 020-78438-4 (2020).
37. Pietrobelli, A. et al. Effects of COVID-19 lockdown on lifestyle behaviors in children with obesity living in Verona, Italy: a longitudinal study. Obesity 28(8), 1382–1385. https:// doi. org/ 10. 1002/ oby. 22861 (2020).
38. 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; 69:140-4.
39. Ten Velde, G., Lubrecht, J., Arayess, L., van Loo, C., Hesselink, M., Reijnders, D., & Vreugdenhil, A. (2021). Physical activity behaviour and screen time in Dutch children during the COVID-19 pandemic: pre-, during and post-school closures. Pediatric Obesity, e12779. https:// doi. org/ 10. 1111/ ijpo. 12779.
40. Medrano, M., Cadenas-Sanchez, C., Oses, M., Arenaza, L., Amasene, M., & Labayen, I. (2020). Changes in lifestyle behaviours during the COVID-19 confinement in Spanish children: A longitudinal analysis from the MUGI project. Pediatric Obesity, e12731. Advance online publication. https:// doi. org/ 10. 1111/ ijpo. 12731
41. Liu J, Li B, Sun Y, Chen Q and Dang J (2021) Adolescent Vision Health During the Outbreak of COVID-19: Association Between Digital Screen Use and Myopia Progression. Front. Pediatr. 9:662984. doi: 10.3389/fped.2021.662984.
42. Liu, J., Chen, Q. & Dang, J. Understanding risks of refractive error among Chinese children amidst pandemic disruptions: results from a rapid survey. BMC Ophthalmol 21, 370 (2021). https://doi.org/10.1186/s12886-021-02133-9.
43. Liu, J.; Li, B.; Chen, Q.; Dang, J. Student Health Implications of School Closures during the COVID-19 Pandemic: New Evidence on the Association of e-Learning,

Outdoor Exercise, and Myopia. Healthcare 2021, 9, 500. https:// doi.org/10.3390/healthcare9050500.
44. Bhandari, Khob R. BOptom, PhD; Shukla, Divya; Mirhajianmoghadam, Hanieh MOptom, PhD; Ostrin, Lisa A. OD, PhD, FAAO Objective Measures of Near Viewing and Light Exposure in Schoolchildren during COVID-19, Optometry and Vision Science: January 25, 2022 - Volume - Issue - doi: 10.1097/OPX.0000000000001871.
45. Mirhajianmoghadam H, Piña A, Ostrin LA. Objective and subjective behavioral measures in myopic and non-myopic children during the COVID-19 pandemic. Transl Vis Sci Technol. 2021;10(11):4, https://doi.org/10.1167/tvst.10.11.4.
46. Wu PC, Chen CT, Lin KK, Sun CC, Kuo CN, Huang HM, et al. Myopia prevention and outdoor light intensity in a school-based cluster randomized trial. Ophthalmology. 2018; 125:1239–50.
47. He M, Xiang F, Zeng Y, Mai J, Chen Q, Zhang J, et al. Effect of time spent outdoors at school on the development of myopia among children in China: a randomized clinical trial. JAMA. 2015; 314:1142–8.
48. Xiong S, Ashby RS, Morgan IG, Rose KA. Time spent in outdoor activities in relation to myopia prevention and control: a meta-analysis and systematic review. Acta Ophthalmol. 2017; 95:551–566.
49. Saxena R, Gupta V, Rakheja V, Dhiman R, Bhardawaj A, Vashist P. Lifestyle modification in school-going children before and after COVID-19 lockdown. Indian J Ophthalmol 2021; 69:3623-9.
50. Portello JK, Rosenfield M, Bababekova Y, Estrada JM, Leon A. Computer-related visual symptoms in office workers. Ophthalmic Physiol Opt. (2012) 32:375–82. doi: 10.1111/j.1475-1313.2012. 00925.x.
51. Xu Y, Deng G, Wang W, Xiong S, Xu X. Correlation between handheld digital device use and asthenopia in Chinese college students: a Shanghai study. Acta Ophthalmol. (2019) 97:e442–e7. doi: 10.1111/aos. 13885.
52. Ichhpujani P, Singh RB, Foulsham W, Thakur S, Lamba AS. Visual implications of digital device usage in school children: a cross-sectional study. BMC Ophthalmol. (2019) 19:76. doi: 10.1186/s12886-019-1082-5.
53. Vilela MAP, Pellanda LC , Fassa AG , et al . Prevalence of asthenopia in children: a systematic review with meta-analysis. J Pediatr 2015; 91:320–5.
54. Reddy SC, Low CK, Lim YP, Low LL, Mardina F, Nursaleha MP. Computer vision syndrome: A study of knowledge and practices in university students. Nepal J Ophthalmol 2013; 5:161-8.
55. 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; 33:158-64.
56. Li L, Zhang J, Chen M, Li X, Chu Q, Jiang R, Liu Z, Zhang L, Shi J, Wang Y, Zhu W, Chen J, Xun P and Zhou J (2021) Contribution of Total Screen/Online-Course Time to Asthenopia in Children During COVID-19 Pandemic via Influencing Psychological Stress. Front. Public Health 9:736617. doi: 10.3389/fpubh.2021.736617.
57. Abdelrahman M. Elhusseiny, Taher K. Eleiwa, Magdi S. Yacoub, Joseph George, Reem H. ElSheikh, Abid Haseeb, James Kwan, Ibrahim A. Elsaadani, Sheren M. Abo Shanab, Omar Solyman, Hajirah N. Saeed, Relationship between screen time and dry eye symptoms in pediatric population during the COVID-19 pandemic, The Ocular Surface, Volume 22,2021, Pages 117-119, ISSN 1542-0124, https:// doi.org/10.1016/j.jtos.2021.08.002.
58. Hamburger, Jordan & Lavrich, Judith & Rusakevich, Alexander & Leibowitz, Jillian & Zhitnitsky, Michael & Zhang, Qiang & Makkena, Ajay & Liu, Catherine & Oh, Glenn & Sharpe, James & Gunton, Kammi (2022). The visual consequences of virtual school: acute eye symptoms in healthy children. Journal of American Association for Pediatric Ophthalmology and Strabismus. 10.1016/ j.jaapos.2021.10.003.
59. Rui Li, Bowen Ying, Yingxiao Qian, Danni Chen, Xiaoxiao Li, Hui Zhu & Hu Liu (2021). Prevalence of Self-Reported Symptoms of Computer Vision Syndrome and Associated Risk Factors among School Students in China during the COVID-19 Pandemic, Ophthalmic Epidemiology, DOI: 10.1 080/09286586.2021.1963786
60. World Health Organization website. WHO guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age. Available at: https://www.who.int/ publications/i/item/9789241550536
61. The American Academy of Child and Adolescent Psychiatry, Screen Time and Children. Available at: https:// www.aacap.org/AACAP/Families_and_Youth/Facts_for_ Families/FFF-Guide/Children-And-Watching-TV-054.aspx
62. Ministry of Education. People's Republic of China website. Notice of the Ministry of Education and other eight departments on printing and distributing the “Implementation Plan for the Comprehensive Prevention and Control of Myopia in Children and Adolescents”. Available at: http:// www.moe.gov.cn/srcsite/A17/moe_943/s3285/201808/ t20180830_346672.html
63. National Health Commission of the People's Republic of China. Guidelines for myopia prevention in children and adolescents during COVID-19 pandemic (updated version), 25 Apr 2020. Available at: http://www.nhc.gov.cn/xcs/fkdt/ 202004/8258621038d346659a64c69b06f46405.shtml
64. Pei-Chang Wu, Chueh-Tan Chen, Li-Chun Chang, Yu-Zhen Niu, Min-Li Chen, Li-Ling Liao, Kathryn Rose, Ian G. Morgan, Increased Time Outdoors Is Followed by Reversal of the Long-Term Trend to Reduced Visual Acuity in Taiwan Primary School Students, Ophthalmology, Volume 127, Issue 11, 2020, Pages 1462-1469, ISSN 0161-6420, https:// doi.org/10.1016/j.ophtha.2020.01.054.
65. Yang YC, Hsu NW, Wang CY, Shyong MP, Tsai DC. Prevalence Trend of Myopia after Promoting Eye Care in Preschoolers: A Serial Survey in Taiwan before and during the Coronavirus Disease 2019 Pandemic. Ophthalmology. 2022 Feb;129(2):181-190. doi: 10.1016/j.ophtha.2021.08.013. Epub 2021 Aug 21. PMID: 34425129.66. American Optometric Association. Computer vision syndrome. 2017. https://www.aoa.org/healthy-eyes/eye-and-vision-conditions/computer-vision-syndrome?sso=y
66. Sheppard AL, Wolffsohn JS. Digital eye strain: prevalence, measurement and amelioration. BMJ Open Ophthalmology 2018;3:e000146. doi:10.1136/ bmjophth-2018-000146
67. Coles-Brennan C, Sulley A, Young G. Management of digital eye strain. Clin Exp Optom. 2019 Jan;102(1):18-29. doi: 10.1111/cxo.12798. Epub 2018 May 23. PMID: 29797453.
68. American Optometric Association. Computer vision syndrome. 2017. Available at: https://www.aoa.org/ healthy-eyes/eye-and-vision-conditions/computer-vision-syndrome?sso=y