Myopia incidence and lifestyle changes among school children during the COVID-19 pandemic: a population-based prospective study

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ABSTRACT

Background The impacts of social restrictions for COVID-19 on children's vision and lifestyle remain unknown.

Aims To investigate myopia incidence, spherical equivalent refraction (SER) and lifestyle changes among schoolchildren during the COVID-19 pandemic.

Methods Two separate longitudinal cohorts of children aged 6–8 years in Hong Kong were included. The COVID-19 cohort was recruited at the beginning of the COVID-19 outbreak, whereas the pre-COVID-19 cohort was recruited before the COVID-19 pandemic. All children received ocular examinations, and answered a standardised questionnaire relating to their lifestyle, including time spent on outdoor activities and near work, both at baseline and at follow-up visits.

Results 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 and axial length was −0.50±0.51 D and 0.29±0.35 mm, respectively; the time spent on outdoor activities decreased from 1.27±1.12 to 0.41±0.90 hours/day (p<0.001), while screen time increased from 2.45±2.32 to 6.89±4.42 hours/day (p<0.001).

Conclusions We showed a potential increase in myopia incidence, significant decrease in outdoor time and increase in screen time among schoolchildren in Hong Kong during the COVID-19 pandemic. Our results serve to warn eye care professionals, and also policy makers, educators and parents, that collective efforts are needed to prevent childhood myopia—a potential public health crisis as a result of COVID-19.

INTRODUCTION

On 11 March 2020, the World Health Organization (WHO) declared COVID-19 to be a global pandemic. As of 27 October, more than 43.4 million confirmed cases and 1.1 million deaths have been reported in 200 countries across all continents except Antarctica.[1] In response, governments worldwide have implemented various measures to contain and mitigate the spread of the pandemic, including strict travel bans, quarantine policies, social distancing measures and even city- or territory-wide lockdowns. These measures have particularly affected school-age children and students in general. In September, more than 180 countrywide closures of educational institutions were in effect, affecting one billion learners, or 80% of the global student population.[2] The lives of schoolchildren have been profoundly disrupted for months in many countries, with outdoor activities being prohibited and daily routines being restricted to indoor activities. In the Hong Kong Special Administrative Region (HKSAR), the government ordered a school closure after 24 January, 2020, affecting more than 800 000 students citywide.[3] This unprecedented level of quarantine has resulted in the required use of digital platforms to continue learning; it has also significantly affected the well-being of children and their families in Hong Kong[4] (online supplemental table 1). As Hong Kong is one of the world's most densely populated cities, the overwhelming majority of the population lives in urban areas in high-rises and small apartments, where outdoor spaces such as backyards, gardens and outdoor playgrounds are hard to come by. Under these circumstances, schoolchildren are spending significantly less time outdoors and more time overall on near work.

Both increased near work time and decreased outdoor time have been implicated in the development of myopia,[5] the most common ocular disorder worldwide.[6] Myopia is a major cause of visual disability among children, and also predisposes them to multiple ocular complications that increase the risk of irreversible vision loss later in life.[7] Although household quarantining and school closures against the pandemic will not last forever, the increasing adoption of and reliance on digital devices, as well as behavioural changes resulting from extended home confinement, may have longlasting effects on myopia progression in the population, especially among children. This is a concern that is echoed by the international ophthalmic community.[8 9] In response, we conducted this population-based study to evaluate myopia incidence and progression, as well as the changes in lifestyle habits among school-age children during the COVID-19 pandemic in Hong Kong.

METHODS

Study Participants

This study includes two separate prospective longitudinal cohorts derived from the Hong Kong Children Eye Study (HKCES).[10–12] HKCES is an ongoing population-based study of eye conditions among primary school children aged 6–8 years; recruitment for baseline data has been ongoing every week since 2015 till the present (online supplemental figure 1) based on a stratified and clustered randomised sampling frame. The details of the protocol on sample size calculation and sample selection were described in our previous study.[10] In brief, all Education Bureau registered primary schools (n=571) were stratified into seven cluster regions used by the Hospital Authority services in Hong Kong. This division into seven clusters is determined by the Hong Kong government according to even distribution of population density in each cluster. The schools in each cluster region were then randomly assigned an invitation priority according to the ranking numbers generated by computer. Invitations to participate in the cohort were sent according to the ranking numbers until the required sample was achieved in each cluster region.

All recruitment was performed at Hong Kong Eye Hospital according to a unified protocol approved by the ethics committee of the Chinese University of Hong Kong.[10] All children and their parents signed written informed consent on participating in the study. Finally, all study procedures adhered to the Declaration of Helsinki.

COVID-19 cohort

The subjects who were recruited at baseline between 1 December 2019 and 24 January 2020 were chosen as the COVID-19 cohort. We then conducted a longitudinal follow-up of this group of children between 1 July and 31 August 2020, a period when school closures and restrictions on social activities were in place.

Pre-COVID-19 cohort

In March 2018, we commenced a one-time, 3-year longitudinal follow-up for subjects of HKCES who had been recruited at baseline since 2015. These 3-year longitudinal visits have been conducted every week since 2018. The subjects who had received their 3-year follow-up by January 2020, before the onset of COVID-19 in Hong Kong, were included in the pre-COVID-19 cohort.

Ocular examinations

Visual acuity was measured using a logarithm of the minimum angle of resolution chart (Nidek, Gamagori, Japan). Cycloplegic autorefraction was performed using an autorefractor (ARK-510A, Nidek, Gamagori, Japan). The cycloplegic regimen consisted of at least two cycles of eye drops of 1% cyclopentolate (Cyclogyl, Alcon-Convreur, Rijksweg, Belgium) and 1% tropicamide (Santen, Osaka, Japan). A third cycle was administered 30 min after the second cycle to ensure that the pupils were well dilated. Ocular biometry, including axial length (AL) was measured using a non-contact partial-coherence laser interferometer (IOL Master, Carl Zeiss Meditec, Oberkochen, Germany).

Questionnaires on children's outdoor time, screen time and total near work time

The validated questionnaires used in this study were mainly derived from Chinese translated versions that had been used in the Sydney Myopia Study[13] and adopted in the HKCES.[10] Questionnaires were administered both at baseline and follow-up, surveying the time children spent on outdoors, screens and total near work, for which the detailed definition and calculation are described in online supplemental table 2.

Physical examinations

Body height and weight were measured using a professional integrated set (seca, Hamburg, Germany). Body mass index (BMI) was then calculated as weight (in kg) divided by the square of height (in m^2).

Definition and outcomes

The incidence of myopia was defined as myopia detected during the follow-up ophthalmic examination among subjects who did not have myopia at baseline. Spherical equivalent refraction (SER) was defined as the sum of spherical diopters and one-half cylindrical diopters. Myopia was defined as SER less than or equal to –0.50 D. Given that the refraction and biometry of both eyes are highly correlated, right eye data were primarily used in the analysis.[14]

The primary outcomes of the current study are incidence of myopia and changes in outdoor time, near work time and screen time during the COVID-19 pandemic. The secondary outcomes are changes in mean SER and mean AL over the follow-up period.

Statistical analysis

Both the χ^2 test and Fisher's exact test were used to test for group difference in categorical data, while the t-test was used for continuous data. Change in a parameter was defined as the difference between baseline and the corresponding follow-up values. Pairwise t-tests were used to test for differences in both outdoor and total near work time before and during the COVID-19 pandemic. Univariate and multiple logistic regression analyses were performed to determine demographic and lifestyle factors associated with myopia incidence. Results are reported with adjustments for confounders (age, sex, AL, parental myopia, outdoor time, total near work time, baseline SER or AL). Statistical values for reading and writing time, screen time and total near work time were generated from separate multiple regression models due to correlation between them. A similar approach was applied to examine SER progression and AL elongation. All statistical analyses were performed with SPSS Statistics (version 24.0, IBM Corp., Armonk, New York, USA). A p value <0.05 was considered statistically significant.

RESULTS

Study participants

The COVID-19 cohort consisted of 709 children with a mean (SD) age of 7.25 (0.92) years and a mean follow-up time of 7.89 (2.30) months; the response rate was 76.81% for an initial sample of 923 children. The pre-COVID-19 cohort included another 1084 children with a mean (SD) age 7.29 (0.75) years and a mean follow-up time of 37.54 (3.12) months; the response rate was 75.75% for an initial sample of 1431 children. No significant differences were observed between the two cohorts in age, sex, BMI, SER, AL, outdoor time, total near work time and reading time (online supplemental table 3). Similarly, no

Table 1 Cohort of children with COVID-19: changes of myopia prevalence, spherical equivalent and axial length over 8 months

	Baseline			At 8-month follow-up			Differences between baseline and 8-month follow-up					
	Myopia prevalence	SER (D) Mean (SD)	AL (mm) Mean (SD)	Myopia prevalence	SER (D) Mean (SD)	AL (mm) Mean (SD)	Changes in myopia prevalence	P value	Changes in SER (D) Mean (SD)	P value	Changes in AL (mm) Mean (SD)	P value
Age group (years)												
6 (n=224)	8.48%	0.62 (0.83)	22.70 (0.73)	25.45%	0.08 (1.03)	23.01 (0.74)	16.97%	<0.001**	−0.54 (0.54)	<0.001*	0.30 (0.39)	<0.001*
7 (n=236)	18.03%	0.33 (1.13)	22.95 (0.80)	36.80%	−0.22 (1.39)	23.25 (0.87)	18.77%	<0.001*	−0.53 (0.51)	<0.001*	0.31 (0.20)	<0.001*
8 (n=249)	29.51%	0.04 (1.36)	23.27 (0.85)	42.62%	−0.41 (1.47)	23.52 (0.92)	13.11%	<0.001*	−0.44 (0.47)	<0.001*	0.26 (0.41)	<0.001*
Total (n=709)	18.97%	0.32 (1.16)	22.98 (0.83)	35.25%	−0.19 (1.33)	23.27 (0.87)	16.28%	<0.001*	−0.50 (0.51)	<0.001*	0.29 (0.35)	<0.001*

X^2 was used to compare categorical variables between groups; a paired t-test was used to compare continuous variable between groups
*Significance was set at 0.05
AL, axial length; D, diopter; SER, spherical equivalent refraction.

significant differences were observed between study participants and subjects who declined to attend ophthalmological examinations, both in the COVID-19 (online supplemental table 4) and pre-COVID-19 cohorts (online supplemental table 5).

Myopia incidence in the COVID-19 and pre-COVID-19 cohorts

In the COVID-19 cohort, myopia incidence was 19.44% (112/576) in total, 18.05% (37/205), 22.16% (43/194) and 18.08% (32/177) in 6, 7- and 8-year old groups (p=0.58) over 8 months, respectively. In the pre-COVID-19 cohort, myopia incidence was 36.57% (324/886) in total, 41.54% (108/260), 34.47% (101/293) and 34.53% (115/333) in 6, 7- and 8-year old groups (p=*0.90*) after 3 years, respectively.

SER progression and AL elongation in COVID-19 cohort and pre-COVID-19 cohort

The mean (SD) SER progression in the COVID-19 cohort was –0.50 (0.51) D, decreasing from 0.32 (1.16) D at baseline to –0.19 (1.33) D at 8 months (p<0.001). The mean (SD) AL elongation was 0.29 (0.35) mm, increasing from 22.98 (0.83) mm to 23.27 (0.87) mm over 8 months (p<0.001) (table 1). The mean (SD) SER progression in the pre-COVID-19 cohort was –1.27 (1.34) D. The mean (SD) AL elongation was 0.88 (0.49) mm (p<0.001) over 3 years (table 2).

Changes in outdoor time, reading and writing time, screen time, and total near work time in the COVID-19 and pre-COVID-19 cohorts

In the COVID-19 cohort, the mean (SD) total time spent on outdoor activities decreased from 1.27 (1.12) hours/day at baseline recruitment to 0.41 (0.90) hours/day (p<0.001) at the 8-month follow-up. 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), of which screen time increased to 6.89 (4.42) hours/day (table 3). Total near work and screen time in the pre-COVID-19 cohort are summarised in online supplemental table 6.

Associations of lifestyle factors with myopia incidence, SER progression and AL elongation

In the multiple logistic models, lifestyle factors—including reading and writing time, screen time, total near work time and outdoor time—were not significantly associated with myopia incidence during the 8-month follow-up period (table 4). Notably, changes in SER and AL were both associated with reading time (p=0.01; table 4).

DISCUSSION

There are growing concerns about a potential myopia boom during the current COVID-19 pandemic as a result of changes in lifestyle and behaviour due to school closures and restrictions on social activities.[8] Our study is one of the first to report myopia progression during this pandemic, showing a myopia incidence of 19.44% over 8-months' follow-up in COVID-19. During the pandemic, there was −0.50 D SER progression, and 0.29 mm axial elongation over the 8 months. Most alarmingly, children's outdoor time decreased by two-thirds from 1.27 to 0.41 hours/day, while their screen time more than doubled from 2.45 hours/day to 6.89 hours/day during the current pandemic.

Comparison of myopia incidence of the COVID-19 cohort with pre-COVID-19 and previous cohorts in Hong Kong

The COVID-19 and pre-COVID-19 cohorts are two separate population-based samples. Although age, gender, ocular parameters and outdoor and reading times at baseline are comparable in the two cohorts, direct comparison of myopia incidence between them needs to be done cautiously. Based on the observation that myopia incidences were similar across different age groups in

Table 2 Cohort of children pre-COVID-19 : changes of myopia prevalence, spherical equivalent and axial length (AL) over 3 years

	Baseline			At 3 year follow-up			Differences between baseline and 3-year year follow-up					
	Myopia prevalence	SER (D) Mean (SD)	AL (mm) Mean (SD)	Myopia prevalence	SER (D) Mean (SD)	AL (mm) Mean (SD)	Changes in myopia prevalence	P value	Changes in SER (D) Mean (SD)	P value	Changes in AL (mm) Mean (SD)	P value
Age group (years)												
6 (n=286)	9.09%	0.60 (1.64)	22.82 (0.93)	51.94%	−0.77 (2.36)	23.85 (1.17)	42.85%	<0.001*	–1.38 (1.46)	<0.001*	1.02 (0.51)	<0.001*
7 (n=363)	19.28%	0.41 (1.46)	22.95 (0.89)	51.82%	−0.98 (2.18)	23.82 (1.14)	-32.54%	<0.001*	–1.39 (1.26)	<0.001*	0.89 (0.47)	<0.001*
8 (n=435)	23.45%	0.10 (1.38)	23.20 (0.88)	54.66%	−1.00 (1.95)	23.96 (1.04)	31.21%	<0.001*	–1.10 (1.31)	<0.001*	0.77 (0.47)	<0.001*
Total (n=1084)	19.02%	0.34 (1.49)	23.02 (0.91)	52.99%	−0.93 (2.14)	23.89 (1.11)	33.97%	<0.001*	–1.27 (1.34)	<0.001*	0.88 (0.49)	<0.001*

X^2 was used to compare categorical variables between groups; a paired t-test was used to compare continuous variable between groups
*Significance was set at 0.05
AL, axial length; D, diopter; SER, spherical equivalent refraction.

Table 3 Outdoor time and near work time before and during the COVID-19 pandemic in the COVID-19 cohort

	Before COVID-19	During COVID-19	Differences	
	Mean (SD)	Mean (SD)	Mean (SD)	P value
Outdoor time (hours/day)	1.27 (1.12)	0.41 (0.90)	−0.86 (1.20)	<0.001*
Outdoor for sports	0.64 (0.70)	0.13 (0.32)	−0.51 (0.69)	<0.001*
Outdoor for leisure	0.63 (0.72)	0.28 (0.81)	−0.35 (0.84)	<0.001*
Diopter*hour	10.18 (6.78)	19.51 (10.23)	9.24 (7.72)	<0.001*
Total near work time(hours/day)	3.42 (2.50)	8.05 (4.49)	4.58 (3.62)	<0.001*
Reading and writing time	2.03 (1.32)	2.18 (1.52)	0.15 (1.26)	<0.006*
Doing paper homework	1.03 (0.70)	0.81 (0.71)	−0.23 (0.77)	<0.001*
Reading	0.44 (0.51)	0.69 (0.73)	0.25 (0.58)	<0.001*
Drawing and writing	0.55 (0.66)	0.69 (0.78)	0.14 (0.64)	<0.001*
Screen time hours/day)	2.45 (2.32)	6.89 (4.42)	4.47 (3.60)	<0.001*
Watching TV	1.04 (0.89)	2.07 (1.65)	1.03 (1.34)	<0.001*
Using computer	0.29 (0.50)	1.26 (1.22)	0.97 (1.18)	<0.001*
Electronic game/ using smartphone or tablet PC for leisure	0.87 (1.38)	2.28 (2.52)	1.41 (1.93)	<0.001*
Using smartphone or tablet PC for learning	0.27 (0.49)	1.29 (1.15)	1.01 (1.16)	<0.001*

Pairwise t tests were used to test the differences of outdoor time and near work time before and during the COVID-19 pandemic
Significant level was set at 0.05; Diopter hours were defined as: (study hours+leisure reading hours)×3 + (video game or home computer work hours)×2 + (television hours)×1.

both the COVID-19 and pre-COVID-19 cohorts, we estimated the risk ratio of incidence of myopia between the two groups using a relative risk regression model (log-binomial model)[15] to account for age and cohort time. The details of the statistics are described in the appendix. In this model, myopia incidence in the COVID-19 cohort was higher than in the pre-COVID-19 cohort (p=0.03) after adjusting for age, gender, follow-up duration, parental myopia, time of outdoor activity and near work (online supplemental table 7). Estimated 1-year incidence is 27.64%, 26.47% and 25.81% for 6, 7 and 8-year-olds in the COVID-19 cohort, and 16.76%, 15.42% and 14.66%for 6, 7 and 8-year-olds in the pre-COVID-19 cohort, suggesting a higher myopia incidence in the COVID-19 cohort than in the pre-COVID-19 cohort. Of note, the estimated 1-year incidence of the pre-COVID-19 cohort is similar to that of the published annual incidence in 2004 in Hong Kong,[16] lending further support to our models.

We also compared the COVID-19 cohort with the previous age-matched cohort in Hong Kong.[16] The myopia incidence (13.15% over 1 year) in the previous cohort was lower than that of our COVID-19 cohort (19.44% over 8 months, p<0.001) despite having a longer follow-up of 1 year compared with 8 months in the COVID-19 cohort, indicating that the incidence of myopia increased during the COVID-19 pandemic (online supplemental table 8).

Comparison of myopia progression with other Chinese cohorts in Asia

We list the estimates of annual incidence, annual change in SER and AL in online supplemental table 9. The estimated annual incidence of myopia is 29.68% in the COVID-19 cohort compared with 11.63% in the pre-COVID-19 cohort, suggesting a 2.5-fold increase in myopia incidence during the COVID-19

Table 4 Association of reading and writing, screen time, total near work and outdoor time with myopia incidence, changes of spherical equivalent and axial length

	Myopia incidence*		Changes of spherical equivalent (D)		Changes of axial length (mm)	
	Univariate	Multiple regression	Univariate	Multiple regression	Univariate	Multiple regression
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
	P values	P values	P values	P values	P values	P values
Reading and writing time	1.06 (0.90 to 1.25)	1.09 (0.92 to 1.29)	−0.03 (−0.06 to 0.00)	−0.04 (−0.07 to 0.01)	0.03 (0.01 to 0.05)	0.03 (0.01 to 0.05)
	0.51	0.35	0.03*	0.02*	0.01*	0.01*
Screen time	0.98 (0.93 to 1.04)	0.98 (0.93 to 1.04)	0 (−0.01 to 0.01)	−0.01 (−0.02 to 0.01)	0 (−0.01 to 0.01)	0 (−0.01 to 0.01)
	0.59	0.57	0.59	0.40	0.73	0.85
Total near work time	0.99 (0.94 to 1.05)	1.00 (0.94 to 1.06)	−0.01 (−0.02 to 0.01)	−0.01 (−0.02 to 0.00)	0 (−0.01 to 0.01)	0 (−0.01 to 0.01)
	0.79	0.87	0.29	0.15	0.53	0.5
Outdoor time	0.98 (0.74 to 1.31)	1.06 (0.79 to 1.41)	0.02 (−0.03 to 0.07)	0.02 (−0.03 to 0.07)	0.01 (−0.03 to 0.04)	0.01 (−0.03 to 0.05)
	0.90	0.71	0.54	0.50	0.66	0.64

Statistical values for reading and writing time, screen time and total near work time were generated from separate multiple regression models due to correlation between them, which adjusted for age, gender, baseline SER (for myopia incidence and changes of SER), baseline AL (only for changes of AL), height (only for change of AL), parental myopia and outdoor time. For outdoor time, the model was adjusted for age, gender, baseline SER (only for changes of SER), baseline AL (only for changes of AL), height (only for changes of AL), parental myopia and total near work time.
*To determine the association of lifestyle with myopia incidence, only participants without myopia at baseline were included in the models.
AL, axial length; SER, spherical equivalent refraction.

pandemic. In addition, the estimated annual change in SER was –0.80 D among subjects in the former compared with –0.41 D in the latter, and the estimated annual change in AL was 0.45 mm compared with 0.28 mm in the latter. Both changes indicate a faster myopia progression during the COVID-19 pandemic.

Since direct comparisons of SER and AL progression between our COVID-19 and pre-COVID-19 cohorts were unsuitable due to different follow-up duration, we therefore compared the results from our COVID-19 cohort with other demographically similar studies in which annual SER and AL progression were available. Our 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),[17] Guangzhou (−0.31)[18] and Taipei of Taiwan (−0.42D)[19] over a 1-year follow-up (online supplemental table 10).

Change in lifestyle habits during COVID-19 pandemic

Another alarming finding from our report is the significant changes in children's lifestyle during the COVID-19 pandemic, with 68% decreased outdoor time and 2.8-fold increased screen time. Evidence suggests that when children are out of school, they are physically less active and have much longer screen time,[9 20] and of all the environmental risk factors that have been studied, increased outdoor time has been consistently shown to have a protective role against the development of myopia.[21] In this study, we found that baseline outdoor time was low to begin with compared with that for Western communities,[22] and decreased further during the COVID-19 pandemic. In Hong Kong, not only have schoolsclosed, but most recreation facilities such as sports grounds, swimming pools, country parks, campsites and even indoor recreation areas such as gyms and gaming arcades were also shut down during the pandemic, which further confined school children indoors.

In addition, school closures and home confinement due to COVID-19 have led to schools employing digital teaching methods, thereby increasing their near work time. Notably, our data show that total near work and screen time during the pandemic was more than double their pre-COVID-19 levels. The results of the present study also showed associations of reading time with SER progression and AL elongation respectively. Although no clear association was found between screen time and myopia progression, screen time itself is a form of near work; increased screen time therefore might have contributed to myopia progression during the current period of quarantine.

We found that in the pre-COVID-19 cohort at the 3-year follow-up, there was a statistically significant decrease in outdoor time, TV-watching time, and computer-using time, with an accompanying increase in time spent on a smart phone or tablet PC for learning. We postulate that this could be due to a number of factors. First, as the subjects progress in school, children spend more time on coping with the increasing workload from school, thus increasing time spent on smart phone or tablet PC for learning and decreasing whatever little time was left spent outdoors. Second, the culture of after-school tutorials is very popular in Hong Kong, where school children have additional tutorial sessions after school, which could have replaced sports as an extracurricular activity, explaining the statistically significant decrease in outdoor time for sports but no change in outdoor time for leisure. Finally, the decrease in TV watching and computer-using time could be inversely related to smart phone or tablet PC time, as there is a trend towards delivering education TV programmes, school lectures and homework via tablet PCs or smart phones.

Perspectives

Our results serve as a warning to eye care professionals, policy makers, educators, and parents on the effect of restricted outdoor activities and intensive near work during this quarantine period on myopia progression in school children. Collective efforts should be taken to prevent the worsening of such myopigenic behaviour and to counteract the jeopardisation of existing myopia control policies. First, government agencies should make recommendations for schools to increase outdoor curricular activities; for example, mandatory outdoor time has already been implemented as part of myopia prevention programmes in cities of mainland China[23] and Taiwan.[24] It is also a top priority among international recommendations for myopia control strategies.[25] On the premise of adequate social distancing, outdoor time should be incorporated into the daily schedule for schoolchildren to encourage a more holistic lifestyle during the pandemic. Second, the increasing reliance on digital devices needs to be addressed. As more educational activities are being moved to online platforms, electronic devices are used more frequently for reading and writing. Since screen time itself is often a form of near work, it plays an indirect role in myopia development. Educators and parents therefore need to help students and children develop healthy relationships with digital devices. Considering the broader lifestyle shifts resulting from the rapid development of electronic devices, effective myopia control interventions could be implemented to inhibit myopia progression in high-risk groups through pharmacological[26 27] or optical approaches.[28]

Strengths and limitations

The strengths of this study include its population-based study design, making it representative of children across the whole territory of Hong Kong. We had also collected baseline data shortly before the onset of the COVID-19 pandemic; we were thus able to directly compare these baseline data with longitudinal follow-up data taken 8 months later. Furthermore, a strict cycloplegia protocol was used to ensure the accuracy of refraction. Axial length measurements were also available to document axial elongation.

Nevertheless, our study has a few limitations. First, one of the main limitations is the difference in duration of follow-ups of the two cohorts. In an ideal situation, it would be better to compare myopia incidence and progression in the COVID-19 cohort with a control group of similar demographics that had been followed up for the sameduration. However, it is difficult to include such an ideal control group given the circumstances of this global pandemic. In addition, owing to unforeseen additional COVID-19 outbreaks in Hong Kong, we were only able to conduct the follow-up in the post-8 month mark, during the short period between 1 July and 31 August 2020 when the COVID-19 outbreak was well-controlled in Hong Kong.

Considering that both cohorts are derived from the ongoing population-based HKCES and share similar demographics, we made comparisons using a relative risk regression model to account for age and cohort time. However, direct comparisons between the two cohorts are not appropriate, as the progression rates in a 3-year longitudinal study cannot be directly compared with those from a cohort that was followed up after only 8 months. As for myopia progression, comparison with other published cohorts is limited by other possible confounders (such as parental myopia and lifestyle) that could not be adjusted, although we had set a strict inclusion criterion. Despite all these unsurmountable study limitations, our initial results still show an alarming myopia progression that warrants appropriate remedial action.

Second, lifestyle in our study was documented by validated questionnaires, which are prone to recall bias. Furthermore, we have only collected the data at the beginning and end of the cohort study. Additional data during follow-up period are required to better represent the change of lifestyle throughout the whole period. Third, our results may not represent the impact of COVID-19 in other parts of the world, where social distancing, home quarantine, and school closure policies may be different. Finally, the results for the children participating in this study, who were aged 6–8 years, should not be extrapolated to account for myopia incidence and progression rates among older children and adolescents during the COVID-19 pandemic.

CONCLUSION

We showed a potential increase in myopia incidence among schoolchildren in Hong Kong during the COVID-19 pandemic. There was also a significant decrease in outdoor time and increase in near work time in 6–8-year-old school children. Our results serve to warn eye care professionals, and also policy makers, educators and parents, that collective efforts are needed to prevent childhood myopia, a potential public health crisis as a result of COVID-19.

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