Original Article

Myopia progression in children before and after the coronavirus disease lockdown

Prema K Chande [1] , Neepa Thacker Dave [1] , Mumtaz Qazi [1] and Priyanka Bapat Vora [1]

[1] *Lotus Eye Hospital, Mumbai, India*

ABSTRACT

Background: The worldwide spread of the coronavirus disease (COVID-19) pandemic in 2020, followed by lockdowns, forced children to be in home confinement with increased screen time, leading to rapid progression of myopia and an increase in the prevalence of myopia. This study was aimed at determining if myopia progression seen in evidence-based practice resulted from the COVID-19 lockdown or delayed follow-ups.

Methods: A retrospective review of case sheets of patients visiting the pediatric department of a tertiary care eye hospital in Mumbai, India, was conducted from 2017 onwards. We enrolled all children with myopia who had attended at least one follow-up visit before the COVID-19 lockdown and at least one follow-up visit post-lockdown. The spherical equivalent (SEQ) of refractive error values at baseline and pre- and post-COVID-19 lockdown follow-ups (hereinafter referred to as the "first" and "second" follow-ups, respectively) were recorded. The duration between baseline and the first follow-up visit and between the first and second follow-up visits were noted.

Results: We enrolled 112 eyes of 56 children, including 35 (62.5%) boys and 21 (37.5%) girls, with a mean (standard deviation [SD]) age of 9.54 (2.82) years. The mean (SD) SEQ values at baseline and first and second follow-ups were - 4.74 (3.83), - 5.46 (3.81), and - 6.42 (3.66) D, respectively. The mean change in SEQ, mean SEQ myopia progression, and rate of myopia progression per month differed significantly between the baseline and the first follow-up visit versus between the first and second follow-ups (all $P < 0.05$). However, the change in myopia degree did not differ significantly between these two periods in eyes with low, moderate, or high myopia (all $P > 0.05$). The mean (SD) duration between the baseline and the first follow-up visit was 14.57 (5.68) months, while that between the first and second follow-ups was 27.96 (9.18) months, showing a significant difference ($P < 0.05$).

Conclusions: Our findings suggest that a longer gap between follow-up visits and myopia progression per month should be factored into the management of myopia. Considering that young children are more vulnerable, preventive measures and school reforms should be urgently implemented in India. Further retrospective multicenter studies with a larger sample size of eyes, including various refractive errors over a longer period, are required to verify these findings.

KEYWORDS

myopia, clinical progression, health lockdown, COVID-19 pandemic, visual acuity, ocular refraction

Correspondence: Prema K Chande, Lotus College of Optometry, 13th, North-South Road, Vithalnagar, Juhu, Mumbai, Maharashtra - 400049, India. Email: prema@lcoo.edu.in. ORCID iD: https://orcid.org/0000-0002-1151-3667

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INTRODUCTION

A nationwide lockdown was announced in India on March 22, 2020, to curb the spread of coronavirus disease 2019 (COVID-19) [1]. Schools in India and abroad were closed earlier than nationwide lockdowns [2], and the United Nations International Children's Emergency Fund (UNICEF) press release on March 10, 2021, declared that 168 million children had been affected by the pandemic worldwide for over 1 year [3].

Even when cities were no longer under lockdown with the implementation of safety measures, schools remained closed in India, disrupting students' education [4]. In addition to education, both the physical and mental health of children were compromised [4-6].

Increased screen time and time spent indoors are risk factors for myopia [7, 8]. The prevalence of myopia has increased post-COVID-19 pandemic; however, few studies have reported quantitative changes in dioptric progression or follow-up durations [9-11]. A change in the axial length was documented during the COVID-19 pandemic after forced children into home confinement [12, 13].

The aim of the present study was to quantify myopia progression in Indian schoolchildren followed-up before and after the COVID-19 lockdown period and to compare the progression in the follow-up periods.

METHODS

In this retrospective longitudinal cohort study, we reviewed case sheets of 7000 children who had visited the pediatric department of a tertiary care Lotus Eye Hospital in Mumbai, India from 2017 up to a follow-up of at least 3 years. We enrolled all children with myopia or myopic astigmatism who had attended at least one follow-up visit from baseline before the COVID-19 lockdown and at least one follow-up visit post-COVID-19 lockdown. Children with ocular comorbidities, such as congenital cataracts, congenital cornea diseases, pterygium, keratoconus, uveitis, glaucoma, pseudophakia, neurological, or retinal disorders, were excluded. Moreover, we excluded children enrolled in the myopia clinic who had been undertaking myopia control measures such as low-dose atropine therapy, orthokeratology, and myopic defocus spectacles.

As this was a retrospective study using case sheets, the Ethics Committee waived the requirement for prior approval. The study procedures followed the tenets of the Declaration of Helsinki. When patients, both adults and children, arrived at the Lotus Eye Hospital, comprehensive written consent was obtained from them or their parents/legal guardians for all tests and access to medical records.

Visual acuity was recorded using a Snellen chart (illuminated Snellen chart; Baliwalla and Homi, Pvt. Ltd., Mumbai, India). Streak retinoscopy was performed in dry and cycloplegic states (Keeler; Halma UK, Windsor, UK). Cycloplegic refraction was conducted using 1% cyclopentolate (Cyclogel eye drop; Intas Pharmaceuticals Ltd., Gujarat, India). The anterior segment was evaluated in both dilated and undilated states using a slit-lamp biomicroscope (SL 220; Carl Zeiss Meditec AG, Jena, Germany). The posterior segment was evaluated in the undilated state with a direct ophthalmoscope (Keeler; Windsor, UK) and in the dilated state with a binocular indirect ophthalmoscope (Vantage Plus Digital Indirect Ophthalmoscope, Keeler Ltd., Windsor, UK) and +20-D lens (Volk Optical Inc., Mentor, OH, USA).

The case sheets contained data from the standard outpatient department examination protocol, including demographic data, full history (i.e., general medical history, ocular history, medications list, and surgical history), and results of cycloplegic refraction, visual acuity test, eye movement assessment, and detailed assessments of the anterior and posterior segments. Data points extracted from the case sheets included the age at baseline and spherical equivalent (SEQ) of refractive errors at baseline and pre- and post-COVID-19 lockdown follow-ups (hereinafter referred to as the "first" and "second" follow-ups, respectively). The duration between baseline and the first follow-up and between the first and second follow-ups was recorded in months.

Myopia progression was calculated as the difference in SEQ scores from baseline to the first follow-up and from the first to second follow-ups. Dioptric progression per month was calculated between these two periods by dividing myopia progression by the gap from baseline to the first follow-up and from the first to second follow-up in months. Low, moderate, and high myopia were defined as SEQs ranging from - 0.25 to ≤ - 3.00, ranging from > - 3.00 to < - 5.00, and ≥ - 5.00 D, respectively [14].

Data were entered into spreadsheets and analyzed using IBM SPSS Statistics for Windows, version 29.0 (IBM Inc., Armonk, NY, USA). The Kolmogorov – Smirnov test was performed to check for normality of data distribution. Subgroup analyses of changes in myopia between these two periods were performed by sex, severity of myopia, rate of myopia progression per month, and age (≤ 9 and > 9 years at baseline). For normally distributed data, such as changes in SEQ myopia progression, the paired *t*-test was performed to compare the two periods. For non-normally distributed data, the Wilcoxon signed-rank, Mann – Whitney U, and Kruskal – Wallis tests were performed to compare myopia changes by age, sex, and severity of myopia between the two periods. A *P*-value < 0.05 was considered to indicate statistical significance.

RESULTS

We enrolled 112 eyes of 56 children, including 35 (62.5%) boys and 21 (37.5%) girls, with a mean (SD) age of 9.54 (2.82) years. The mean (SD) SEQs at baseline and first and second follow-ups were - 4.74 (3.83), - 5.46 (3.81), and - 6.42 (3.66) D, respectively.

The mean (SD) duration between baseline and the first follow-up visit was 14.57 (5.68) months and between the first and second follow-up visits was 27.96 (9.18) months. The mean myopia progression between the two periods was significant (*P* < 0.05). When the mean change in myopia was compared between these two periods, the difference was significant (*P* < 0.05; Table 1).

The mean (SD) rates of myopia progression per month between baseline and the first follow-up and between the first and second follow-ups were - 0.06 (0.07) and - 0.03 (0.03) D, respectively. The mean rates of myopia progression per month between the two periods was significant (*P* < 0.05) (Table 1). Figure 1 shows changes in myopia during the two periods. The monthly myopia progression differed between the two periods (*P* < 0.05) (Table 1), indicating a slower rate of myopia progression between the first and second follow-ups (Table 1 and Figure 1).

The mean (SD) myopia progression in children ≤ 9 and > 9 years was - 0.92 (0.97) and - 0.57 (0.71) D between baseline and the first follow-up, respectively, and - 0.82 (0.74) and - 1.07 (0.97) D between the first and second follow-ups, respectively, with no statistically significant difference (both *P* > 0.05). The rates of myopia progression per month in children ≤ 9 and > 9 years were - 0.08 and - 0.04 D from baseline to the first follow-up, respectively, and - 0.03 and - 0.04 D from the first to second follow-ups, respectively. Children aged ≤ 9 years showed significantly slow myopia progression from the first to second follow-ups (*P* < 0.05). While the older age group showed a stable myopia progression of - 0.04 D.

Table 1. Mean change in spherical equivalent, myopia progression, and rate of monthly myopia progression during the two periods

Parameters compared	Between baseline and the first follow-up	Between the first and second follow-ups	*P*- value
Mean change in SEQ (D), Mean ± SD	- 5.46 ± 3.81	- 6.42 ± 3.66	**< 0.001**
Follow-up durations (m), Mean ± SD	14.57 ± 5.68	27.96 ± 9.18	**< 0.001**
SEQ myopia progression (D), Mean ± SD	- 0.72 ± 0.84	- 0.96 ± 0.88	**0.010**
Rate of myopia progression per month (D), Mean ± SD	- 0.06 ± 0.07	- 0.03 ± 0.03	**0.019**

Abbreviations: SEQ, spherical equivalent of refractive error; COVID-19, coronavirus disease; D, diopters; SD, standard deviation; m, months. Note: *P*-values < 0.05 are shown in bold (Wilcoxon signed-ranked test). The difference between parameters was compared between the two periods; The durations are between baseline and the first follow-up before the coronavirus disease lockdown and between the first and second post-coronavirus disease lockdowns.

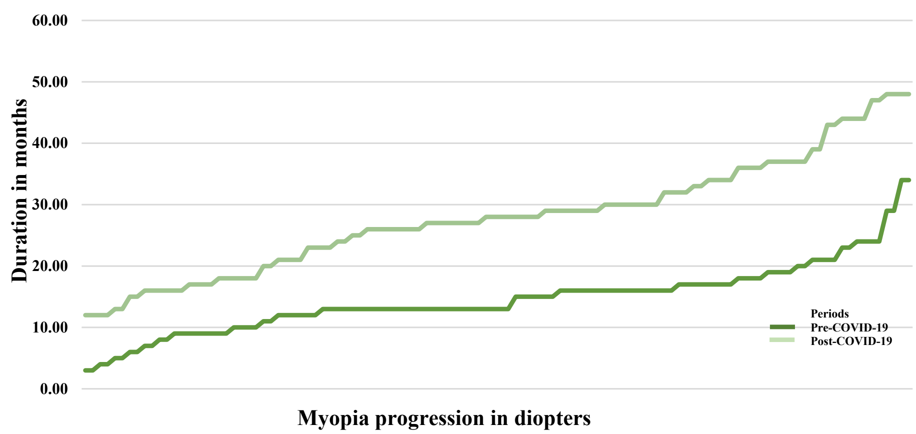

Figure 1. Monthly progression at pre- and post-coronavirus disease (COVID-19) follow-ups. Note: "Pre-COVID-19" indicates the period between baseline and the first follow-up before the COVID-19 lockdown. "Post-COVID-19" indicates the period between the first (before COVID-19 lockdown) and second (post- COVID-19 lockdown) follow-ups.

Table 2. Myopia progression based on the severity of myopia

Severity of myopia	n	Mean myopia at baseline, D	Mean myopia, at the first follow-up, D	Mean myopia at the second follow-up, D	Change in mean myopia between baseline and the first follow-up, D	Change in mean myopia between the first and second follow-ups, D	*P*- value *
Low Myopia (SEQ ≤ - 3.00 D)	41	- 1.21	- 2.16	- 3.42	- 0.95	- 1.26	0.480
Moderate myopia (SEQ > - 3.00 D to < - 5.00)	29	- 3.66	- 4.18	- 5.31	- 0.52	- 1.13	0.157
High myopia (SEQ ≥ 5.00 D)	42	- 8.94	- 9.24	- 10.13	- 0.30	- 0.89	0.480

Abbreviations: n, number of eyes; D, diopters; COVID-19, coronavirus disease; SEQ, spherical equivalent of refractive error. Note: * *P*-value for comparison of the spherical equivalent change by severity of myopia between the two periods; The durations were between baseline and the first follow-up (before coronavirus disease lockdown) and between the first and second (after coronavirus disease lockdown) follow-ups (Kruskal – Wallis test).

The mean (SD) rates of myopia progression in boys and girls were - 0.65 (0.70) and - 0.83 (1.04) D between baseline and the first follow-up, respectively, and - 0.96 (0.93) and - 0.96 (0.80) D between the first and second follow-ups, respectively. The myopia progression did not differ between the two sexes in either period (both *P* > 0.05).

The eyes with low myopia showed a maximum progression of - 1.26 D (Table 2). The myopia change did not differ significantly between the two periods for myopia of any severity (all *P* > 0.05; Table 2).

DISCUSSION

The present study showed that a longer gap between follow-ups and monthly myopia progression should be factored into the management of myopia in children. The monthly myopia progression differed significantly from baseline to the first follow-up and from the first to second follow-ups. Yang et al. investigated changes in refractive error during COVID-19 over a 3-year follow-up and reported a significant change from 2018 to 2019 and from 2019 to 2020 [15]. In the present study, the change in myopia differed significantly between the two periods.

In the present study, the eyes with low and moderate myopia showed significantly faster progression in the post-COVID-19 lockdown period than in the pre-COVID-19 lockdown period, yet it was not statistically significant. In Yang et al.'s study with a similar 3-year longitudinal period, the eyes with low myopia were more susceptible to myopia progression [15]. However, they also reported that myopia in girls progressed significantly faster than in boys, contrary to the findings of the present study. A study on the impact of the COVID-19 lockdown and sex revealed that girls were more vulnerable during the pandemic as it widened the gap in education [16, 17]. A global report by UNICEF in 2016 showed that the burden of household work was greater on girls, who spent almost 40% more time on household work than boys worldwide [17]. A study involving out-of-school girls and the negative impact on girls' education reported before the COVID-19 pandemic revealed gender discrimination, which became wider during the COVID-19 lockdown [18, 19]. Less online schooling could explain the slower myopia progression in girls in the present study, which should be verified in future studies.

Chang et al. [20] investigated myopia progression before, during, and after the COVID-19 lockdown and changes in SEQ of myopia progression per month and reported that the rate of progression in diopters was faster during the COVID-19 lockdown and that it slowed down during the post COVID-19 lockdown period. Consistently, the present study showed that the rate of myopia progression per month between baseline and the first follow-up differed significantly from the period between the first and second follow-ups and was - 0.06 (0.07) and - 0.03 (0.03) D, respectively. Chang et al. attributed this change to accommodative spasms during the COVID-19 lockdown, which were released in the post-COVID-19 lockdown period [20].

The present study revealed that children arrived at the hospital for follow-up after almost 2 years compared to the annual period before the COVID-19 lockdown. The mean (SD) duration between the first and second follow-ups was significantly longer than that between baseline and the first follow-up (27.96 [9.18] versus 14.57 [5.68] months, respectively). Fear of infection, absence of safety guidelines for school health programs, and lack of access to primary eye care during the COVID-19 pandemic increase the risk of myopia progression [21, 22] and could justify longer follow-up intervals.

Williams et al. reported that early schooling is a risk factor for myopia [23]. In the present study, when myopia progression was analyzed in primary school children ≤ 9 years and older school children > 9 years of age, those ≤ 9 years showed faster progression between baseline and the first follow-up (pre-COVID-19 lockdown) compared to between the first and second follow-ups (post-COVID-19 lockdown). The association of education and early-age schooling also propelled countries such as China to introduce school reforms to control myopia [24, 25]. In India, studies investigating school stress, private supplementary tutorials, and their impact on the social and mental health of children have been reported [26, 27]. A study from Turkey on the effect of home schooling on myopia progression reported that approximately 42% of the children who spent more time outdoors had a slower rate of myopia progression during the COVID-19 pandemic than those who had regular school time [28]. The absence of rigorous schooling during the COVID-19 lockdown period with reduced hours of online schooling for primary school children in government primary schools [29] could be attributed to slowed down myopia progression in the present study.

When the rate of progression per month was compared between the two age groups in the present study, the ≤ 9-year age group showed reduced myopia progression from - 0.08 D at baseline to the first follow-up visit to - 0.03 D from the first to second follow-up while the older age group showed a stable myopia progression of - 0.04 D. Wang et al. reported that older children aged ≥ 9 years showed no significant increase in myopia prevalence after home confinement, which they attributed to the fact that younger children were more susceptible to environmental changes [30]. A review of the environmental and social impacts of myopia in 2022 cited similar results and causes of myopia progression among schoolchildren worldwide [31]. Although we did not assess the details of environmental or social factors, the pandemic as a global challenge significantly delayed the time interval between follow-ups.

Our findings suggest that a longer gap between follow-ups and myopia progression per month should be factored into myopia management. However, we included a limited number of students from a single ophthalmic center; therefore, the results of this study may not be generalizable to other populations or settings. Further retrospective multicenter studies with a larger sample of included eyes and various refractive errors over a longer period are required to verify these findings. We failed to assess the environmental and social factors and their effects on myopia progression. Future studies are required to address the limitations for verifying the study outcomes.

CONCLUSIONS

The findings of this study suggest that a gap between follow-up periods and dioptric myopia progression per month should be factored into managing myopia in school-age children with myopia. Considering that younger children are more vulnerable, school reform is urgently required in India.

ETHICAL DECLARATIONS

Ethical approval: As this was a retrospective study using case sheets, the Ethics Committee waived the requirement for prior approval. The study procedures followed the tenets of the Declaration of Helsinki. When patients, both adults and children, arrived at the Lotus Eye Hospital, comprehensive written consent was obtained from them or their parents/legal guardians for all tests and access to medical records.
Conflict of interest: None.

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REFERENCES

1. Kumar S, Sonkar SK, Atam I, Gupta H, Parmar KS, Verma SK, et al. Socio-economic impact of first 21 days nationwide lockdown- 1 on the spread of SARS-COV-2 in India in relation to health. J Family Med Prim Care. 2020;9(9):4557-4562. doi: 10.4103/jfmpc.jfmpc_662_20 pmid: 33209763
2. Varalakshmi R, Arunachalam K. COVID 2019 - Role of Faculty Members to Keep Mental Activeness of Students. Asian J Psychiatr. 2020;51:102091. doi: 10.1016/j.ajp.2020.102091 pmid: 32289726
3. Kidman R, Breton E, Behrman J, Kohler HP. Returning to school after COVID-19 closures: Who is missing in Malawi? Int J Educ Dev. 2022;93:102645. doi: 10.1016/j.ijedudev.2022.102645 pmid: 35814168
4. Panneer S, Kantamaneni K, Akkayasamy VS, Susairaj AX, Panda PK, Acharya SS, et al. The Great Lockdown in the Wake of

COVID-19 and Its Implications: Lessons for Low and Middle-Income Countries. Int J Environ Res Public Health. 2022;19(1):610. doi: 10.3390/ijerph19010610 pmid: 35010863

5. Majumdar P, Biswas A, Sahu S. COVID-19 pandemic and lockdown: cause of sleep disruption, depression, somatic pain, and increased screen exposure of office workers and students of India. Chronobiol Int. 2020;37(8):1191-1200. doi: 10.1080/07420528.2020.1786107 pmid: 32660352
6. Sama BK, Kaur P, Thind PS, Verma MK, Kaur M, Singh DD. Implications of COVID-19-induced nationwide lockdown on children's behaviour in Punjab, India. Child Care Health Dev. 2021;47(1):128-135. doi: 10.1111/cch.12816 pmid: 33047842
7. Sherwin JC, Reacher MH, Keogh RH, Khawaja AP, Mackey DA, Foster PJ. The association between time spent outdoors and myopia in children and adolescents: a systematic review and meta-analysis. Ophthalmology. 2012;119(10):2141-51. doi: 10.1016/j.ophtha.2012.04.020 pmid: 22809757
8. Saxena R, Vashist P, Tandon R, Pandey RM, Bhardawaj A, Gupta V, et al. Incidence and progression of myopia and associated factors in urban school children in Delhi: The North India Myopia Study (NIM Study). PLoS One. 2017;12(12):e0189774. doi: 10.1371/journal.pone.0189774 pmid: 29253002
9. Xie J, Lu C, Zhu J. Screen time and myopia: A serial multiple mediator SEM analysis. Front Public Health. 2022;10:860098. doi: 10.3389/fpubh.2022.860098 pmid: 36299744
10. 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(12):3623-3629. doi: 10.4103/ijo.IJO_2096_21 pmid: 34827007
11. Saara K, Swetha S, Subhiksha R, Amirthaa M, Anuradha N. Steep increase in myopia among public school-going children in South India after COVID-19 home confinement. Indian J Ophthalmol. 2022;70(8):3040-3044. doi: 10.4103/ijo.IJO_40_22 pmid: 35918969
12. Lv H, Wang Y, Sun S, Wei S, Guo Y, Wu T, et al. The impact of COVID-19 home confinement on axial length in myopic children undergoing orthokeratology. Clin Exp Optom. 2023;106(1):15-19. doi: 10.1080/08164622.2021.2016352 pmid: 34982947
13. Yum HR, Park SH, Shin SY. Influence of coronavirus disease 2019 on myopic progression in children treated with low-concentration atropine. PLoS One. 2021;16(9):e0257480. doi: 10.1371/journal.pone.0257480 pmid: 34520481
14. 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. doi: 10.1111/opo.12305 pmid: 27350183
15. Yang X, Fan Q, Zhang Y, Chen X, Jiang Y, Zou H, et al. Changes in Refractive Error Under COVID-19: A 3-Year Follow-up Study. Adv Ther. 2022;39(6):2999-3010. doi: 10.1007/s12325-022-02150-0 pmid: 35508845
16. Flor LS, Friedman J, Spencer CN, Cagney J, Arrieta A, Herbert ME, et al. Quantifying the effects of the COVID-19 pandemic on gender equality on health, social, and economic indicators: a comprehensive review of data from March, 2020, to September, 2021. Lancet. 2022;399(10344):2381-2397. doi: 10.1016/S0140-6736(22)00008-3 pmid: 35247311
17. Burzynska K, Contreras G. Gendered effects of school closures during the COVID-19 pandemic. Lancet. 2020;395(10242):1968. doi: 10.1016/S0140-6736(20)31377-5 pmid: 32539938
18. Mitra S, Mishra SK, Abhay RK. Out-of-school girls in India: a study of socioeconomic-spatial disparities. GeoJournal. 2022:1-17. doi: 10.1007/s10708-022-10579-7 pmid: 35261431
19. Agarwal B. Imperatives of recognising the complexities: gendered impacts and responses to COVID-19 in India. Econ Polit (Bologna). 2022;39(1):31-53. doi: 10.1007/s40888-021-00242-8 pmid: 35422596
20. Chang P, Zhang B, Lin L, Chen R, Chen S, Zhao Y, et al. Comparison of Myopic Progression before, during, and after COVID-19 Lockdown. Ophthalmology. 2021;128(11):1655-1657. doi: 10.1016/j.ophtha.2021.03.029 pmid: 33771516
21. Muralikrishnan J, Christy JS, Srinivasan K, Subburaman GB, Shukla AG, Venkatesh R, et al. Access to eye care during the COVID-19 pandemic, India. Bull World Health Organ. 2022;100(2):135-143. doi: 10.2471/BLT.21.286368 pmid: 35125538
22. Prakash WD, Khanna RC. COVID-19 safety guidelines for school eye health screening programs. Indian J Ophthalmol. 2021;69(9):2511-2515. doi: 10.4103/ijo.IJO_1282_21 pmid: 34427255
23. Williams KM, Kraphol E, Yonova-Doing E, Hysi PG, Plomin R, Hammond CJ. Early life factors for myopia in the British Twins Early Development Study. Br J Ophthalmol. 2019;103(8):1078-1084. doi: 10.1136/bjophthalmol-2018-312439 pmid: 30401676
24. Morgan IG, Jan CL. China Turns to School Reform to Control the Myopia Epidemic: A Narrative Review. Asia Pac J Ophthalmol (Phila). 2022;11(1):27-35. doi: 10.1097/APO.0000000000000489 pmid: 35044336
25. Mountjoy E, Davies NM, Plotnikov D, Smith GD, Rodriguez S, Williams CE, et al. Education and myopia: assessing the direction of causality by mendelian randomisation. BMJ. 2018;361:k2022. doi: 10.1136/bmj.k2022. Erratum in: BMJ. 2018;362:k2932. pmid: 29875094
26. Verma S, Sharma D, Larson RW. School stress in India: Effects on time and daily emotions. International Journal of Behavioral Development. 2002;26(6):500-8. doi: 10.1080/01650250143000454
27. Bhorkar S, Bray M. The expansion and roles of private tutoring in India: From supplementation to supplantation. International Journal of Educational Development. 2018;62:148-56. doi: 10.1016/j.ijedudev.2018.03.003
28. Aslan F, Sahinoglu-Keskek N. The effect of home education on myopia progression in children during the COVID-19 pandemic. Eye (Lond). 2022;36(7):1427-1432. doi: 10.1038/s41433-021-01655-2 pmid: 34193982
29. Sarkar B, Islam N, Das P, Miraj A, Dakua M, Debnath M, et al. Digital learning and the lopsidedness of the education in government and private primary schools during the COVID-19 pandemic in West Bengal, India. E-Learning and Digital Media. 2022:20427530221117327. doi: 10.1177/20427530221117327 pmcid: pmc9364067
30. Wang J, Li Y, Musch DC, Wei N, Qi X, Ding G, 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 pmid: 33443542
31. Limwattanayingyong J, Amornpetchsathaporn A, Chainakul M, Grzybowski A, Ruamviboonsuk P. The Association Between Environmental and Social Factors and Myopia: A Review of Evidence From COVID-19 Pandemic. Front Public Health. 2022;10:918182. doi: 10.3389/fpubh.2022.918182 pmid: 35844861