

Lifestyle modification in school-going children before and after COVID-19 lockdown

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Purpose: To evaluate the impact of COVID-19 lockdown restrictions on lifestyle of school-going children. **Methods:** This was a questionnaire-based prospective study of 1237 school children aged 9-14 years enrolled from various private and government schools across Delhi in October-December 2020. These children were being followed-up over the previous 2 years (before pandemic) with details of their lifestyle like near/outdoor/reading activities using a questionnaire as a part of another study. The data during the COVID-19 lockdown was collected by telephonic interview. This was compared to similar information collected from this cohort in the pre-Covid period in 2019 when the students had a regular physical school curriculum. **Results:** 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; $P < 0.001$) and doing homework offline (from 15.3 hour/week to 14 hours/week; $P < 0.001$). A significant increase was noted in screen time spent on digital devices (from 6.2 hours/week to 19.8 hours/week; $P < 0.001$), and watching television (from 12.2 hours/week to 13.4 hours/week; $P < 0.001$). The rise in the digital on-screen time was significantly more in boys ($P < 0.001$) and in students from private schools ($P < 0.001$). The rise in the duration of watching television was significantly more in girls than boys ($P < 0.05$). **Conclusion:** COVID-19 lockdown has markedly impacted the lifestyle of school children by significantly decreasing the outdoor activity and increasing the screen time, thereby pre-disposing them to ocular ill-health and myopia. This necessitates the adoption of guidelines for promoting healthy digital habits in children.

Key words: COVID-19 pandemic, digital screen time, behavioural risk factors, refractive errors

The COVID-19 pandemic has resulted in travel bans and restrictions by numerous governments across the globe to contain the spread of the disease. Schools and other educational institutions have been shut causing a significant impact on the academic training of the students. To compensate for the academic loss, there has been an advent of a digitalized education system and e-classrooms. The classes are held online with the students spending around 2-5 h, depending on the age, connected to the teachers digitally through tablets, laptops, and smartphones. While there have been guidelines about the optimal hours that a child should be given access to these devices,^[1,2] they are often ignored in the interest of teaching. Moreover, restrictions imposed on outdoor movement have increased the recreational time spent on these devices such as playing video games and social media use.

Many studies have highlighted the increased incidence of computer vision syndrome and associated ocular symptoms due to increased digital dependency in the last decade.^[3-6] Moreover, there is large evidence suggesting the role of environmental factors such as extended near work and on-screen time on the progression of refractive errors in children.^[7-10] Also, the beneficial effect of outdoor activities on arresting myopic axial elongation and progression of refractive error has been

intricately studied and described.^[11-18] Although there is ample evidence to believe that extended digital device use and near work can impact the ocular health of individuals across all age groups, school-going children in their formative years are the worst hit of all strata. This evolving trend may lead to long-term behavioral changes with both psychological and physiological impacts and can aggravate the ongoing myopia epidemic.

The purpose of the current study was to evaluate the impact of lockdown restrictions on routine activities and the lifestyle of school-going children owing to the digital shift in the academic curriculum and factors affecting the same.

Methods

We conducted a questionnaire-based assessment in August-September 2020 among a cohort of 1237 students aged 9-14 years studying in standards V-VII of various private and government-aided schools across Delhi. The children were being followed-up over the previous 2 years with details of their near, outdoor, and reading activities as a part of ongoing study using a questionnaire to elicit the details of various

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outdoor and indoor activities. The baseline data collection had been performed through in-person interviews in schools during the previous rounds between April and August 2019 during pre-COVID-19 time. Due to the COVID-19 imposed school closure, the current data was collected by telephonic interviews with the children and subsequently confirmed by one/both of the parents from July till October 2020. In case of any discrepancy, parents' response was recorded. A single telephonic interview was sufficient in most children. Repeat calls were required only in certain cases with doubts. The following questions were asked:

1. Duration of outdoor activities on weekdays and weekends,
2. Duration of digital devices use on weekdays and weekends.
3. Duration of watching television (TV) on weekdays and weekends.

Table 1: Sociodemographic profile of school children in the study

	Baseline assessment
Age at enrollment: Mean (SD)	11.88 (1.01)
Age Group <i>n</i> (%)	
9-11 years	424 (34.3)
12-14 years	813 (65.7)
Gender <i>n</i> (%)	
Male	732 (59.2)
Female	505 (40.8)
Type of School <i>n</i> (%)	
Government funded/aided	441 (35.7)
Private funded	796 (64.3)
Father's education <i>n</i> (%)	
Illiterate	64 (5.2)
Primary, middle school	264 (21.3)
High school	636 (51.4)
Graduate and above	211 (17.1)
N/A	62 (5.0)
Mother's education: <i>n</i> (%)	
Illiterate	148 (12.0)
Primary, middle school	359 (29.0)
High school	557 (45.0)
Graduate and above	134 (10.8)
N/A	39 (3.2)
Vision Status (Better eye) <i>n</i> (%)	
Vision category Normal (6/6-6/9.5)	993 (80.3)
Mild visual impairment (6/12-6/19)	117 (9.5)
Moderate visual impairment (<6/19-6/60)	118 (9.5)
Severe visual impairment (<6/60-3/60)	5 (0.4)
Blind (<6/60-3/60)	2 (0.2)
Vision Status (Worse eye) <i>n</i> (%)	
Vision category Normal (6/6-6/9.5)	891 (72.0)
Mild visual impairment (6/12-6/19)	164 (13.3)
Moderate visual impairment (<6/19-6/60)	160 (12.9)
Severe visual impairment (<6/60-3/60)	12 (1.0)
Blind (<6/60-3/60)	8 (0.7)
Use of spectacles <i>n</i> (%)	223 (18.0)
Myopia <i>n</i> (%)	368 (29.8)

4. Duration of homework (offline) on weekdays and weekends.

This was compared to similar information collected from this cohort in the pre-COVID-19 period in the year 2019 when the students had a regular physical school curriculum. Before recruitment in the current study, informed consent was obtained from the parents. The study was conducted in adherence to the Declaration of Helsinki and was approved by the Institutional Ethics Committee.

Statistical analysis was performed using software Stata 15. The demographic parameters like age, gender, types of schools, parent education, and occupational skills were expressed as mean and standard deviation. The behavioral risk factors – numbers of hours per week spent on various indoor and outdoor activities – were recorded and factors affecting them were analyzed using the paired *t*-test and analysis of variance test. The results were expressed as mean \pm SD. A *P* value < 0.05 was deemed significant.

Results

The cohort comprised of students in the age group 9–14 years with 732 boys (59.1%) and 505 girls (40.9%). The number of students enrolled from private schools was 796 (64.3%) and from government-aided schools was 441 (35.7%). Table 1 provides the sociodemographic details of the cohort.

There was a significant decrease in the duration of outdoor activities, from an average of 8.5 h/week in the pre-COVID-19

Table 2: Time spent in outdoor and indoor activities over weekends and weekdays, and overall by school children during pre-COVID-19 and during COVID-19 lockdown periods in New Delhi

	Pre-COVID-19	COVID-19	<i>P</i>
Time spent (minutes per day)			
Outdoor activities			
Weekdays	62 (38.9)	14 (38.6)	<0.001
Weekends	101 (55.7)	15 (42.8)	<0.001
Homework (offline)			
Weekdays	138 (53.4)	129 (54.7)	<0.001
Weekends	113 (66.4)	96 (52.8)	<0.001
Watching TV			
Weekdays	90 (49.7)	108 (65.4)	<0.001
Weekends	142 (71.6)	130 (77.6)	<0.001
Computer/Laptop			
Weekdays	4 (16.2)	13 (41.9)	<0.001
Weekends	7 (20.9)	9 (29.3)	0.059
Mobile phone/Tabs			
Weekdays	41 (31.5)	178 (79.2)	<0.001
Weekends	60 (48.1)	102 (68.2)	<0.001
Overall time spent (hours per week)			
Outdoor activities	8.5	1.6	<0.0001
Homework (offline)	15.3	14	<0.0001
Watching TV	12.2	13.4	<0.0001
Digital device use	6.2	19.8	<0.0001

time to 1.6 h/week during the COVID-19 lockdown ($P < 0.001$). A significant drop was also noted in the time spent on doing homework offline from an average of 15.3 h/week to 14 h/week during the pandemic ($P < 0.001$). On the contrary, the average screen time spent on digital activities (computers/laptop, video games, mobiles/tablets) and watching TV increased significantly ($P < 0.001$ for both). A 69% jump was seen in the digital screen time from a pre-COVID-19 duration of 6.2 h/week to 19.8 h/week after the lockdown. The average time spent on watching TV increased from 12.2 h/week to 13.4 h/week. [Table 2]

The duration of these activities was evaluated separately on weekdays and weekends and noted as minutes/day. On comparing data between the two, a significant rise in the screen time for digital activities as well as for watching TV was noted in both weekends and weekdays during the lockdown [Table 2]. The outdoor activity showed a significant decline both during the weekdays (62–14 min/day) and weekends (101–15 min/day) [Table 2]. The increase in outdoor activity during the weekends compared to weekdays was around 40% in the prelockdown period (62–101 min/day). However, during lockdown this increase was only 10% (14–15 min/day), highlighting the markedly reduced exposure to outdoors despite having an off day at school.

Univariate analysis was done between the duration of these activities or behavioral risk factors (for development of

digital eye strain and myopia) and factors like gender, age, type of school (government or private), and education of the parents (illiterate, primary or middle school, high school, and graduate or above). For the purpose of univariate analysis, the age was divided into two groups: 9–11 and 12–14 years.

Outdoor activity

No significant difference was observed in the outdoor activity duration in relation to the age group (P value: 0.147), and both the age groups showed a significant decrease in the duration of outdoor activity during the COVID-19 period. The cumulative duration of the outdoor activity was more in the boys (pre-COVID-19: 9.9 h/week; COVID-19: 1.9 h/week) than in the age-matched population of girls (pre-COVID-19: 6.5 h/week; COVID-19: 1.2 h/week) during prelockdown (P value: <0.001) and remained so even during the lockdown (P value 0.013). Greater duration of outdoor activity was also noted in children from government-aided schools as compared to those in private schools during both COVID-19 and pre-COVID-19 periods (P value: 0.001 for both). Although there was a significant decrease in the duration of outdoor activity across various levels of education of parents, an inverse relationship was noted between the educational qualification of parents and the duration of the outdoor activity during both pre-COVID-19 and COVID-19 periods [Table 3].

Digital device use/on-screen time

This included the cumulative duration of time spent using electronic gadgets such as computers/laptops to attend online

Table 3: Risk factors associated with outdoor activity (hours per week) during pre-COVID-19 and COVID-19 lockdown periods among school children in New Delhi

Parameters	Mean (SD)		Difference (P)
	Pre-COVID-19	COVID-19	
Gender			
Males	9.9 (4.5)	1.9 (4.8)	-8 (<0.0001)
Females	6.5 (4.0)	1.2 (4.2)	-5.3 (<0.0001)
Difference (P)	3.4 (<0.0001)	0.7 (0.0138)	<0.0001
Age group (Years)			
9-11	8.4 (4.5)	1.9 (5.1)	-6.5 (<0.0001)
12-14	8.6 (4.7)	1.5 (4.3)	-7.1 (<0.0001)
Difference (P)	0.2 (0.521)	0.4 (0.170)	0.147
Type of school			
Govt-aided	9.5 (5.1)	2.2 (4.9)	-7.3 (<0.0001)
Private	8.0 (4.3)	1.3 (4.4)	-6.6 (<0.0001)
Difference (P)	1.5 (<0.0001)	0.9 (0.001)	0.071
Fathers' education			
Illiterate	10.3 (5.8)	2.5 (5.0)	-7.7 (<0.0001)
Primary, middle school	9.1 (4.6)	1.8 (4.5)	-7.3 (<0.0001)
High school	8.2 (4.5)	1.5 (4.6)	-6.6 (<0.0001)
Graduate and above	8.2 (4.3)	1.3 (4.1)	-6.9 (<0.0001)
P	0.0003	0.201	0.358
Mothers' education			
Illiterate	9.2 (5.0)	1.8 (4.5)	-7.4 (<0.0001)
Primary, middle	8.9 (4.6)	1.9 (4.6)	-7 (<0.0001)
High school	8.3 (4.6)	1.5 (4.6)	-6.7 (<0.0001)
Graduate and above	8.0 (4.4)	0.9 (3.9)	-6.9 (<0.0001)
P	0.001	0.015	0.663

Table 4: Risk factors associated with digital device use/on-screen time (hours per week) during pre-COVID-19 and COVID-19 lockdown periods among school children in New Delhi

Parameters	Mean (SD)		Difference (<i>P</i>)
	Pre-COVID-19	COVID-19	
Gender			
Males	6.5 (4.5)	20.6 (8.7)	14.1 (<0.0001)
Females	5.7 (4.6)	18.6 (7.5)	12.9 (<0.0001)
Difference (<i>P</i>)	0.8 (0.001)	2 (<0.0001)	0.029
Age group (Years)			
9-11	6.0 (4.2)	19.7 (7.6)	13.7 (<0.0001)
12-14	6.3 (4.8)	19.9 (8.6)	13.6 (<0.0001)
Difference (<i>P</i>)	0.3 (0.358)	0.2 (0.788)	0.829
Type of school			
Govt-aided	6.5 (5.2)	18.8 (7.9)	12.3 (<0.0001)
Private	6.0 (4.2)	20.4 (8.4)	14.6 (<0.0001)
Difference (<i>P</i>)	0.5 (0.109)	1.2 (0.001)	0.0002
Fathers' education			
Illiterate	6.2 (4.7)	19.5 (9.6)	13.3 (<0.0001)
Primary, middle school	6.1 (4.9)	18.8 (8.1)	12.7 (<0.0001)
High school	6.3 (4.3)	20 (7.9)	13.7 (<0.0001)
Graduate and above	6.1 (4.5)	20.7 (8.5)	14.5 (<0.0001)
<i>P</i>	0.940	0.090	0.192
Mothers' education			
Illiterate	6.5 (5.4)	6.2 (4.3)	6.2 (<0.0001)
Primary, middle school	6.2 (4.5)	19.6 (7.8)	13.4 (<0.0001)
High school	6.2 (4.3)	20 (8.3)	13.8 (<0.0001)
Graduate and above	5.9 (4.7)	20.4 (7.6)	14.5 (<0.0001)
<i>P</i>	0.685	0.554	0.321

e-classes, playing video games, and operating mobiles/tablets. During COVID-19, a significant increase in the duration of the digital activities/on-screen time was noted. However, the rise was more in boys (*P* value < 0.001) and in students from private schools (*P* value: 0.001). It is interesting to note that on-screen time was significantly higher in boys (*P* value: 0.001) even in the pre-COVID-19 time and this trend was maintained during the COVID-19. There were no significant differences in the on-screen time in relation to the age group or the educational qualifications of the parents [Table 4].

Television

A greater increase in the duration of watching TV was observed in girls than boys (*P* value 0.05). This trend was also noted in the pre-COVID-19 time (*P* value < 0.004). The age group of 12–14 years showed more rise in the duration of watching TV than their younger counterparts (*P* value 0.005) during the COVID-19 lockdown. No significant difference was observed based on other factors like the type of school or parent's educational qualifications [Table 5].

Offline COVID-19 homework

This included the cumulative duration of time spent on performing offline near activities such as reading, writing, and doing homework. The duration of time spent on offline homework was significantly higher in girls than boys (Pre-COVID-19-*P* value < 0.001; COVID-19-*P* value 0.009) and in students enrolled in private school than

in government schools (Pre-COVID-19-*P* value < 0.001; COVID-19-*P* value < 0.001) during the COVID-19 as well as pre-COVID-19 duration [Table 6].

Discussion

This study also noted behavioral differences between the two genders. While girls spent more time on near work and watching TV, they devoted less time on outdoor activities and using digital device compared to boys. Similar behavioral differences were observed in the North India Myopia study,^[20] where girls were found to spend more time indoors and hence show a higher prevalence of myopia. A recent study by Xu *et al.*^[21] from China also noted low frequency of weekend outdoor activity and outdoor time in females aged 10–15 years, which were risk factors for myopia. On the contrary, boys have a greater tendency to engage in digital devices for academic as well as recreational purposes such as playing video games and operating smartphones.

The behavioral risk factors were affected by the type of school in which the child was enrolled. While students from government schools spent more time outdoors during pre-COVID-19 as well as COVID-19 duration, their counterparts from private school dedicated more time in near work. This can be attributed to a rather stringent academic curriculum seen in private schools that existed even in the pre-COVID-19 time. The students from private school were also observed to have greater

Table 5: Risk factors associated with watching TV (hours per week) during Pre-COVID-19 and COVID-19 lockdown periods among school children in New Delhi

Parameters	Mean (SD)		Difference (P)
	Pre-COVID-19	COVID-19	
Gender			
Males	11.7 (5.7)	13 (7.8)	1.3 (<0.0001)
Females	12.9 (6.2)	13.9 (7.6)	1 (0.025)
Difference (P)	1.2 (0.0004)	0.9 (0.053)	0.504
Age group (Years)			
9-11	12.3 (6.1)	12.5 (7.6)	0.2 (0.585)
12-14	12.2 (5.8)	13.8 (7.8)	1.6 (<0.0001)
Difference (P)	0.1 (0.765)	1.3 (0.005)	0.011
Type of school			
Govt-aided	14.3 (6.3)	13.6 (8.3)	-0.7 (0.118)
Private	11.0 (5.4)	13.2 (7.4)	2.2 (<0.0001)
Difference (P)	3.3 (<0.0001)	0.4 (0.476)	<0.0001
Fathers' education			
Illiterate	14.4 (6.6)	12.4 (6.8)	-1.9 (0.091)
Primary, middle school	12.3 (6.0)	13.6 (8.6)	1.3 (0.029)
High school	12.1 (6.0)	13.4 (7.7)	1.3 (0.0007)
Graduate and above	11.6 (5.2)	13.4 (7.0)	1.9 (0.0005)
(P)	0.458	0.542	0.033
Mothers' education			
Illiterate	13.5 (6.5)	13.0 (7.6)	-0.5 (0.515)
Primary, middle school	12.6 (6.2)	13.4 (8.3)	0.8 (0.111)
High school	11.8 (5.7)	13.4 (7.6)	1.6 (<0.0001)
Graduate and above	11.3 (5.5)	13.5 (7.4)	2.2 (0.002)
P	0.003	0.923	0.038

on-screen time than those from government school during the lockdown. This can be due to more extensive digital learning approach seen in private schools and greater accessibility of private school children to digital devices highlighting the obvious difference in the socio-economic backgrounds of children attending these schools.^[20]

Interestingly, we noted an inverse relationship between the duration of outdoor activities and the educational qualifications of parents. Higher was the education and skill level of the parents, lesser was the time spent outdoors by children. Many epidemiological studies conducted in past have emphasized that higher educational qualifications in parents may lead to promoting myopic habits in off-springs like increased reading, writing, and decreased outdoor time and therefore a higher prevalence of myopia in their children.^[17,22]

The assessment of these behavioral factors is important as there is ample evidence highlighting the deleterious effect of strenuous near work, decreased outdoor activities, and digital device misuse/abuse on the progression of refractive errors. Increased outdoor activity has been associated with reduced myopia onset and to a lesser extent with progression.^[23,24] Level II evidence has been noted between near work and myopia.^[7] Recently, concerns have been raised about the risk of future myopia boom linked to the increased digital screen time during the pandemic. This study reports a significant increase in these myopigenic behavioral risk factors post lockdown, which

may very well be a predictor of an upcoming myopia spike in Indian school-going children unless preventive measures are implemented. Many recent studies have also reported a surge in the cases of digital eye strain or Computer Vision Syndrome following an increase in on-screen time during the COVID-19 lockdown.^[25-28] The increased screen time is also expected to have drastic effects on the behavior of children such as irregular sleeping and eating habits, general feeling of tiredness, and lack of motivation. This has been shown to negatively impact mental and physical health by causing several ailments like depression and obesity.^[29-31]

Although these lockdown measures are temporary, it may inculcate long-term lifestyle change in children by ready acceptance of digital platform for learning and recreation. Though India has recently emerged from the second wave of pandemic, the traditional classroom learning is far from being restored. Integrated digital learning has become the need of the hour. However, with this digital boom percolating every stratum of society, certain guidelines need to be designed to contain the impact on ocular health and lifestyles of children. Though norms to restrict digital device use are enforced in some countries like China, India is yet to define a policy for the same. Therefore, there is a need to promote healthy digital device habits among students and create awareness among parents and teachers about the same. Proper placement of digital devices, taking regular breaks between screen time (20/20/20 rule),^[6] optimal room lighting, and limiting the

Table 6: Risk factors associated with near work/home work (hours per week) during pre-COVID-19 and COVID-19 lockdown periods among school children in New Delhi

Parameters	Mean (SD)		Difference (P)
	Pre-COVID-19	COVID-19	
Gender			
Males	14.6 (5.7)	13.6 (5.6)	-1.0 (0.0006)
Females	16.2 (6.4)	14.5 (6.2)	1 (0.025)
Difference (P)	1.6 (<0.0001)	0.9 (0.009)	0.113
Age group (Years)			
9-11	15.7 (5.8)	13.9 (5.6)	-1.8 (<0.0001)
12-14	15.1 (6.1)	14.0 (6.0)	-1.0 (0.0003)
Difference (P)	0.6 (0.082)	0.1 (0.754)	0.123
Type of school			
Govt-aided	14.1 (6.3)	13.1 (5.3)	-1.0 (0.008)
Private	15.9 (5.8)	14.5 (6.1)	-1.4 (<0.0001)
Difference (P)	1.8 (<0.0001)	1.4 (<0.0001)	0.353
Fathers' education			
Illiterate	14.1 (7.0)	13.1 (5.2)	-1.1 (0.287)
Primary, middle school	14.3 (6.0)	13.6 (5.8)	-0.7 (0.141)
High school	15.7 (5.9)	14.1 (5.7)	-1.6 (<0.0001)
Graduate and above	15.6 (5.9)	14.7 (6.7)	-0.9 (0.176)
P	0.005	0.107	0.418
Mothers' education			
Illiterate	14.4 (6.6)	12.8 (6.5)	-1.6 (0.015)
Primary, middle school	14.9 (6.2)	13.6 (5.7)	-1.2 (0.006)
High school	15.7 (5.8)	14.5 (5.6)	-1.2 (0.0002)
Graduate and above	15.6 (5.7)	14.6 (6.9)	-1.0 (0.176)
P	0.042	0.004	0.936

recreational screen time are some of the measures that can be easily implemented without hampering the academics. Wong *et al.*^[24] have described the term “digital detox” that comprises of measures like parent supervision of screen time and digital content, and encouraging child’s engagement in offline indoor activities during the pandemic.

Owing to our background knowledge regarding the role of certain behavioral risk factors and their impact on ocular health, this study was designed to elaborate the setbacks and changes in routine activities of school-going children during the pandemic. However, our study is not free from limitations. As it is a one-point cross-sectional study, conclusions on long-term trends cannot be drawn. Being a questionnaire-based study, the data may not be free of response bias. Also, further longitudinal studies need to be undertaken in the same cohort when possible, to assess the impact of these changing behavioral factors on various parameters of ocular health such as incidence and progression of refractive errors and digital eye strain. Finally, the methodology of the study was based on the guidelines of school vision screening program where refraction was done for children with a vision of 6/9 or less. So, it is likely that only high hyperopes and myopes were selected filtering out other refractive errors.

Conclusion

To conclude, a significant transition from conventional classroom teaching and regular outdoor lifestyle to a digitalized lifestyle was observed during the pandemic. The restriction of outdoor activity has led to an excessive use of digital devices in children across all age groups of both private and government-aided schools, thereby predisposing them to ocular ill-health and future risk of myopia. This highlights the need for specific guidelines for promoting healthy digital behavior in children and preventing these lifestyle changes from becoming permanent once the “new normal” is achieved.

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Conflicts of interest

There are no conflicts of interest.

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