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Ophthalmology Section

Impact of Electronic Gadgets Overuse on Myopia Progression among Young People: A Prospective Study

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ABSTRACT

Introduction: Myopia has a multifactorial aetiology, involving interplay between environmental, genetic and behavioural factors. In today's times of digitalisation, young people are now more exposed to digital devices, which is another possible risk factor for myopia.

Aim: To determine the effect of mobile and laptop overuse on progression of myopia in young people at three time points of six months interval.

Materials and Methods: This prospective observational study was conducted in the Department of Ophthalmology, Shyam Shah Medical College and associated Gandhi Memorial Hospital, Rewa, Madhya Pradesh, India, from of January 2019 to September 2020. A total of 400 eyes of 200 myopic patients were included. All the eyes were categorised into three groups based upon degree of myopia at the time of presentation. Cycloplegic autorefraction followed by subjective refinement of refraction was done and Spherical Equivalent (SE) was calculated in time 1, time 2 and time 3. Progression of myopia was calculated as increase in myopic refraction of subject's eye between time 1 and time 3. Questionnaire survey about amount of time spent on mobile and laptop and their working distance was done. Then task-specific-dioptre-hours per day were calculated. Multivariate analysis was done to estimate the adjusted odds ratio for mobile and laptop use associated with myopia progression.

Results: The present study was conducted on 200 patients having varying degree of myopia. Mean age of patients with low, moderate and high myopia was 18.62±3.18, 17.65±3.59 and 17.49±3.91 years, respectively. The male to female ratio was 1.04:1. This study documents task specific mobile and laptop dioptre hours per day was significantly higher in eyes with progression as compared to no progression in low, moderate as well as in high myopes (p-value <0.05).

Conclusion: In the present study, risk of progression of myopia was significantly higher in patients engaged for longer duration on mobile and laptop and at near distance. Thus, this study concludes that overuse of electronic gadgets has a significant adverse impact on myopia progression in young people.

Keywords: Cycloplegic autorefraction, Spherical equivalent, Task specific dioptre hour

INTRODUCTION

In children and young adults myopia is a common ocular disorder seen and a cause of concern worldwide [1]. Myopia is the condition in which parallel light rays from infinity refracted from cornea and lens converge at a focus in front of the retina. The image that projects itself into the retina thus corresponds to the sum of the blur circles, causing poor image quality [2]. Myopia is becoming a major epidemiological problem and its prevalence is growing worldwide. By the year 2050, 49.8% of the world's population is expected to be suffering from myopia and 9.8% from high myopia [3].

The onset of myopia has shifted to younger age, which is a concern, as younger age children exhibit more rapid progression of myopia and are more likely to reach higher degree of myopia [4,5]. High myopia can lead to increased risk of developing vision-threatening conditions including glaucoma, cataract, myopic maculopathy and retinal detachment in future life [6].

Myopia has multifactorial aetiology, involving interplay between environmental, genetic and behavioural factors, with increased time spent in education decreased time outdoors, urbanisation, and long periods of close work like reading, writing and mobile phone use all cited as possible influences [7-10].

Young people are now exposed to digital devices which are another possible environmental risk factor for myopia [11]. Smart phones, laptops and computers are used at a very early age in both school and home [12]. Young people are the fastest growing population of mobile phone users [13]. Smartphones are now the most widely used device for internet access on a daily basis by the children between age group of 9-16 years in Ireland [14]. Computer usage have identified as a risk factor for myopia by several studies [15-17]. In one study, myopia was found to be associated with a closer computer screen working distance [16]. Smartphone users typically adopted even more closer working distance than for computer screens [18]. Therefore, it is conceivable, that increased and continuous exposure to electronic gadgets might represent a reasonable risk factor for the development or progression of myopia, in young people.

Similar previous studies determined the effect of electronic gadgets over myopia development and compared electronic gadgets uses in myopic and non myopic patients [19-23]. Hence, the present study was conducted to determine the effect of mobile and laptop overuse on progression of myopia in young people at three time points of six months interval.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Ophthalmology, Shyam Shah Medical College and associated Gandhi Memorial Hospital, Rewa, Madhya Pradesh, India, from January 2019 to September 2020, study was approved by the Institutional Ethical Committee (IEC number 9454/SS/PG/MC/2019). Informed consent was taken from all participants.

Inclusion criteria: All patients having any degree of myopia between the age group of 10-24 years (young people) were included in the study.

Exclusion criteria: Patients having any corneal dystrophy or degeneration, astigmatism more than 2 dioptres, keratoconus, any fundus abnormality other than myopic changes, any media opacity or history of any ocular surgery in the past were excluded from the study.

Sample size calculation: The sample size was calculated by taking prevalence of myopia in India as 13% [24].

$N=4pq/d^2$

Where, N=Sample size

p=13% (Prevalence)

q=100-p=100-13=87%

d=5% (Allowable error)

$N=4\times13\times87/5^2=181$ Round off=200 patients

Study Procedure

A total of 400 eyes of 200 patients (10-24 years age group) diagnosed with myopia of any degree attending the outdoor patient department of Ophthalmology Department of SS Medical College and associated Gandhi Memorial Hospital Rewa (MP) fulfilling the inclusion criteria were enrolled in the study

The purpose of study was explained to the subjects and their parents in cases of minors and confidentiality was assured. Data collected from all subjects included demographic characteristics like age, gender, residence, occupation and a detailed clinical history including the chief visual complaint, history of present illness, past history of ocular surgeries, any ocular trauma and wearing spectacles for vision correction and its changes.

Questionnaire

A proforma was given to all study subjects about electronic gadgets available at home, the amount of time spent on mobile phone and on the computer and subjects were also asked about their preferred working distance in centimetres for each task.

After that task-specific dioptre-hour per day was calculated by multiplying task specific duration in hours to inverse of working distance in metres [19].

All the study subjects underwent a comprehensive ophthalmic examination which included best corrected visual acuity assessment, anterior segment and posterior segment examination for the diagnosis of myopia.

Cycloplegic refraction with cyclopentolate 1% in both eyes was evaluated at the interval of five minutes for all patients at the time of enrollment, followed by autorefration with Shin Nippon Autorefractometer after 30 minutes. SE was calculated by adding the sum of the sphere power with half of the cylinder power [20]. All the eyes were categorised depending upon the degree of myopia as [25]:

1. Group A: myopia <-3.00 dioptres (low myopia)
2. Group B: myopia between -3.00 and -6.00 dioptres (moderate myopia)
3. Group C: myopia >-6.00 dioptres (high myopia)

Patients were examined for Spherical Equivalent (SE) of each eye separately at the time of enrolment (time 1) and thereafter at 6 month and 12 month (time 2 and time 3 respectively). Progression of myopia was calculated as increase in myopic refraction of subject's eye between time 1 and time 3.

STATISTICAL ANALYSIS

The collected data was compiled using Microsoft (MS) excel and analysed using IBM Statistical Package for the Social Sciences (SPSS) software version 20.0. Categorical data like sex, residence, distance and duration of various electronic gadget use was expressed as frequency and percentage whereas, numerical data like age and task specific dioptre hours per day was expressed as mean and standard deviation. Multivariate analysis was done to estimate the adjusted Odds Ratio (OR) for electronic gadgets use associated with myopia progression and t-test was used for association. The p-value less than 0.05 were considered statistically significant.

RESULTS

The present study was conducted on 200 patients having varying degree of myopia. The age of the study subjects varied from a minimum of 10 years to a maximum of 24 years, with mean age of patients with low, moderate and high myopia was 18.62±3.18, 17.65±3.59 and 17.49±3.91 years, respectively. There were 102 males and females were 98 and, the male to female ratio was 1.04:1. Depending on the severity of myopia, 203 (50.75%) eyes were categorised as low myopia, 148 (37%) as moderate and 49 (12.25%) as high myopia.

The study showed that longer use of mobile was significantly associated with higher odds of progression of myopia, only in eyes with moderate myopia (p-value <0.05). For the entire study cohort as well as for those with low and high myopia, no such increase in risk was observed [Table/Fig-1]. Analysing myopia progression with respect to distance, authors observed a significantly higher odds of progression in patients using mobiles at distances of 10 cm and 15 cm (p-value <0.05) in all three grades of myopia [Table/Fig-2].

Myopia	Mobile duration	Progression		OR (95% CI)	p-value
		No n (%)	Yes n (%)		
Low	<2	77 (64.7)	61 (72.6)	Ref	-
	2-4	38 (31.9)	19 (22.6)	1.11 (0.45-2.89)	0.07
	5-6	4 (3.4)	4 (4.8)	1.05 (0.57-2.15)	0.09
	>6	0 (0)	0 (0)	-	-
	Mean±SD	2.2±1.1	2.1±1.3	-	-
Moderate	<2	30 (93.8)	73 (62.9)	Ref	-
	2-4	2 (6.2)	39 (33.6)	2.17 (1.32-4.19)	0.001
	5-6	0 (0)	4 (3.4)	1.24 (0.91-3.11)	0.03
	>6	0 (0)	0 (0)	-	-
	Mean±SD	1.8±0.6	2.3±1.0	-	-
High	<2	8 (100)	33 (80.5)	Ref	-
	2-4	0 (0)	4 (9.8)	1.12 (0.46-1.98)	0.078
	5-6	0 (0)	0 (0)	-	-
	>6	0 (0)	4 (9.8)	1.12 (0.46-1.98)	0.078
	Mean±SD	1.4±0.7	2.5±2.7	-	-
Total	<2	115 (72.3)	167 (69.3)	Ref	-
	2-4	40 (25.2)	62 (25.7)	1.0 (0.41-1.9)	0.27
	5-6	4 (2.5)	8 (3.3)	1.2 (0.5-2)	0.47
	>6	0 (0.0)	4 (1.7)	1.1 (0.6-1.9)	0.39
	Mean±SD	2.1±1	2.2±1.5	-	-

[Table/Fig-1]: Association of progression of myopia with duration of mobile use.
OR: Odds ratio; CI: Confidence interval; SD: Standard deviation
*p-value <0.05 was considered statistically significant

The mean task specific mobile dioptre hours per day in eyes with progression, was 20±10 whereas for eyes with no progression, it was 10±10. The observed difference was statistically highly significant (p-value <0.01). For all the three groups of myopia also, the task specific mobile dioptre hours per day was significantly higher in eyes with progression as compared to no progression (p-value <0.05) [Table/Fig-3].

As regards laptop use, authors found that the odds of myopia progression were 1.23 times higher in patients engaged in longer duration of laptop use especially more than six hours (p-value <0.05). The odds of progression were 1.82 times higher in patients with high myopia engaged in longer duration of laptop use (p-value <0.05), but similar observations were not noted in patients with low or moderate myopia [Table/Fig-4].

On calculating odds of myopia progression for distance of laptop use, they were significantly higher among patients using laptop at 60 cm distance with low and high myopia patients as well as for the entire study population (p-value <0.05). However, in eyes with moderate

Myopia	Mobile distance	Progression No n (%)	Progression Yes n (%)	OR (95% CI)	p-value
Low	10	11 (9.2)	21 (25)	2.2 (0.9-3.8)	0.03
	15	17 (14.3)	46 (54.8)	2.3 (1.1-4.2)	0.004
	20	27 (22.7)	17 (20.2)	0.78 (0.05-1.2)	0.45
	25	44 (37)	0 (0)	0.23 (0.01-0.46)	0.03
	30	20 (16.8)	0 (0)	Ref	-
	Mean±SD	21.89±5.9	14.7±3.4	-	-
Moderate	10	0 (0)	9 (7.8)	1.43 (0.39-2.34)	0.04
	15	4 (12.5)	91 (78.4)	2.2 (1.1-3.3)	0.04
	20	0 (0)	16 (13.8)	1.6 (1.0-2.7)	0.03
	25	12 (37.5)	0 (0)	0.75 (0.5-1.5)	0.23
	30	16 (50)	0 (0)	Ref	-
	Mean±SD	26.3±4.9	15.3±2.3	-	-
High	10	0 (0)	23 (56.1)	2.3 (1.02-4.4)	0.001
	15	0 (0)	18 (43.9)	2.1 (1.3-4.9)	0.001
	20	8 (100)	0 (0)	Ref	-
	Mean±SD	20±0	12.2±2.5	-	-
Total	10	11 (6.9)	53 (22)	1.67 (0.44-2.89)	0.03
	15	21 (13.2)	155 (64.3)	1.98 (0.98-3.87)	0.02
	20	35 (22)	33 (13.7)	0.86 (0.06-1.15)	0.35
	25	56 (35.2)	0 (0)	0.23 (0.03-0.54)	0.03
	30	36 (22.6)	0 (0)	Ref	-
	Mean±SD	22.7±5.9	14.6±2.9	-	-

[Table/Fig-2]: Association of progression of myopia with distance of mobile use.
OR: Odds ratio; CI: Confidence interval; SD: Standard deviation
*p-value <0.05 was considered statistically significant

Myopia	Mean task specific mobile dioptre hours per day Myopia progression (Mean±SD) No	Yes	t-test	p-value
Low	12±10	20±10	2.5	0.01*
Moderate	7±10	20±10	5.7	0.001*
High	10±0	20±20	2.1	0.04*
Total	10±10	20±10	5.4	0.001*

[Table/Fig-3]: Association of progression of myopia with task specific mobile dioptre hours per day.
*p-value <0.05 was considered statistically significant

Myopia	Laptop duration	Progression No n (%)	Progression Yes n (%)	OR (95% CI)	p-value
Low	<2	31 (93.9)	27 (100)	Ref	-
	3-4	0 (0)	0 (0)	-	-
	5-6	2 (6.1)	0 (0)	0.35 (0.02-0.78)	0.15
	>6	0 (0)	0 (0)	-	-
	Mean±SD	1.364±1.2	1.1±0.3	-	-
Moderate	<2	10 (83.3)	24 (85.7)	Ref	-
	3-4	0 (0)	0 (0)	-	-
	5-6	2 (16.7)	2 (7.1)	0.75 (0.5-1.5)	0.23
	>6	0 (0)	2 (7.1)	1.32 (0.9-3.3)	0.078
	Mean±SD	1.8±1.9	1.9±2.2	-	-
High	<2	4 (100)	10 (55.6)	Ref	-
	3-4	0 (0)	0 (0)	-	-
	5-6	0 (0)	0 (0)	-	-
	>6	0 (0)	8 (44.4)	1.82 (1.1-2.3)	0.03
	Mean±SD	0.7±0.3	4±3.7	-	-
Total	<2	45 (91.8)	61 (83.6)	Ref	-
	3-4	0 (0)	0 (0)	-	-
	5-6	4 (8.2)	2 (2.7)	0.29 (0.06-0.89)	0.89
	>6	0 (0)	10 (13.7)	1.23 (1.1-1.7)	0.048
	Mean±SD	1.4±1.4	2.1±2.5	-	-

[Table/Fig-4]: Association of progression of myopia with duration of laptop use.
OR: Odds ratio; CI: Confidence interval; SD: Standard deviation
*p-value <0.05 was considered statistically significant

myopia, use of laptop was significantly associated with higher risk of progression (OR- 2.08; p-value <0.01) only at a distance of 70 cm [Table/Fig-5].

Myopia	Laptop distance (cm)	Progression No n (%)	Progression Yes n (%)	OR (95% CI)	p-value
Low	60	2 (6.1)	18 (66.7)	2.3 (0.9-3.2)	0.004*
	70	9 (27.3)	9 (33.3)	1.08 (0.05-1.42)	0.49
	80	18 (54.5)	0	0.51 (0.01-0.96)	0.03*
	90	4 (12.1)	0	-	-
	Mean±SD	77.3±7.6	63.3±4.8	-	-
Moderate	60	0	4 (14.3)	1.36 (0.87-1.89)	0.67
	70	0	16 (57.1)	2.08 (1.1-3.6)	0.034*
	75	0	2 (7.1)	1.04 (0.7-2.01)	0.69
	80	4 (33.3)	4 (14.3)	0.67 (0.34-1.3)	0.89
	90	8 (66.7)	2 (7.1)	-	-
	Mean±SD	86.7±4.9	71.8±7.6	-	-
High	60	0	14 (77.8)	2.64 (1.5-4.5)	0.0023*
	70	2 (50)	4 (22.2)	0.33 (0.04-0.77)	0.78
	80	2 (50)	0	-	-
	Mean±SD	75±5.8	62.2±4.3	-	-
Total	60	2 (4.1)	36 (49.3)	1.9 (0.7-2.9)	0.032*
	70	11 (22.4)	29 (39.7)	1.06 (0.8-1.3)	0.42
	75	0	2 (2.7)	0.9 (0.6-1.2)	0.36
	80	24 (49)	4 (5.5)	0.5 (0.04-0.89)	0.43
	90	12 (24.5)	2 (2.7)	-	-
	Mean±SD	79.4±8.0	66.3±7.3	-	-

[Table/Fig-5]: Association of progression of myopia with distance of laptop use.
OR: Odds ratio; CI: Confidence interval; SD: Standard deviation
*p-value <0.05 was considered statistically significant

On analysing mean task specific laptop dioptre hours per day in eyes with progression was 2±0 whereas that in eyes with no progression it was 1±0. The observed difference was statistically highly significant (p-value <0.01). Task specific laptop dioptre hours per day was significantly higher in eyes with progression as compared to no progression in low, moderate as well as in high myopes (p-value <0.05) [Table/Fig-6].

Myopia	Progression (Mean±SD) No	Yes	t-test	p-value
Low	1±0	2±0	8.5	0.001*
Moderate	1±0	1±0	5.7	0.001*
High	1±0	2±0	4.9	0.001*
Total	1±0	2±0	9.2	0.001*

[Table/Fig-6]: Association of progression of myopia with task specific laptop dioptre hours per day.
*p-value <0.05 was considered statistically significant

DISCUSSION

The present study aimed to determine the effect of mobile and laptop overuse on progression of myopia in young people. In the present study, mean age of patients with and without myopia progression was 17.9±3.6 and 18.5±3.3 years, respectively. The use of smart

Parameters	Present study (India) 2020-21	Saxena R et al., (North India) 2015 [21]	McCrann S et al., (Ireland) 2020 [23]	Rusnak S et al., (Czech Republic) 2018 [22]	Sheppard AL and Wolffsohn JS, (UK) 2018 [26]	Tori H et al., (Japan) 2017 [27
Mean age (years)	Low myopia: 18.62±3.18 Moderate myopia: 17.65±3.59 High myopia: 17.49±3.91	11.6+2.2	16.77	12	-	-
Male-female ratio	1.04:1	2.01:1	0.38:1	0.76:1	-	-
Study group	Varying degree of myopia	Children with myopia <-0.5 D	Myopic and non myopic	Myopic and non myopic	All age group above 16 Myopic and non myopic	Myopic children ≤-1.00 D myopia patients who wore non-violet light transmitting eyeglasses, partially violet light blocking Contact Lenses (CL) and violet light transmitting CL.
Results	In the present study, longer duration of use of mobile was significantly associated with higher odds of progression in eyes with moderate myopia (p-value <0.05) However, no such increase in risk was observed in eyes with low myopia, high myopia as well as all the eyes (p-value >0.05). Similarly, odds of progression was significantly higher in patients with myopia using mobile especially at a distance of 10 cm and 15 cm (p-value <0.01). Overall, mean task specific mobile dioptre hours per day were observed to be significantly higher in eyes with progression (20±10) as compared to eyes with no progression (10±10) (p-value <0.01). In present study, laptop/computer use was observed in small proportions of patients. Our study documented significantly higher odds of progression in patients engaged in longer duration of laptop use especially more than six hours (p-value <0.05). Though, the progression risk was significantly associated with long duration of laptop use in high myopes (p-value 0.05). With respect to distance of laptop use, odds of progression was significantly higher among patients using laptop at 60 cm distance with myopia (p-value <0.01). Mean task specific laptop dioptre hours per day in eyes with progression was significantly higher (0.2±0.0) as compared to eyes with no progression (0.1±0.0) (p-value <0.01).	Myopia was significantly associated with playing computer/ video/mobile games (p-value <0.001).	Significantly longer duration and near distance of mobile phone use in myopic students as compared to non myopes (1,130.71±1,748.14 MB vs 613.63±902.15 MB; p-value=0.001).	Significantly higher (p-value <0.0001) axial length growth in children not engaged in outdoor activity or engaged in near work including use of mobile and laptop (p-value <0.01).	Excessive use and access to computer devices and smart phones have been associated with computer vision syndrome which is associated with visual fatigue and digital eye strain. These factors might help in progression of myopia.	Violet light exposure from computer might have beneficial effect on progression of myopia, but such association have not been established.

[Table/Fig-7]: Comparison of similar studies with the findings of present study [21-23,26,27].

phones as well as laptop especially by children and teenagers has increased which has been attributed high risk of myopia development and progression [11]. However, in the present study, longer duration of use of mobile was significantly associated with higher odds of progression in eyes with moderate myopia (p-value <0.05). However, no such increase in risk was observed in eyes with low myopia, high myopia as well as all the eyes (p-value >0.05). Similarly, odds of progression was significantly higher in patients with myopia using mobile especially at a distance of 10 cm and 15 cm (p-value <0.01). Overall, mean task specific mobile dioptre hours per day were observed to be significantly higher in eyes with progression (20±10) as compared to eyes with no progression (10±10) (p-value <0.01).

These findings were concordant with the findings of Saxena R et al., in which myopia was significantly associated with playing computer/ video/mobile games (p-value <0.001) [21]. Similarly, Rusnak S et al., also observed significantly higher (p-value <0.0001) axial length growth in children not engaged in outdoor activity or engaged in near work including use of mobile and laptop (p-value <0.01) [22]. McCrann S et al., also observed that significantly longer duration and near distance of mobile phone use in myopic students as compared to non myopes (1,130.71±1,748.14 MB vs 613.63±902.15 MB; p-value=0.001) [23].

In present study, laptop/computer use was observed in small proportions of patients. The present study documented significantly higher odds of progression in patients engaged in longer duration of laptop use especially more than six hours (p-value <0.05). Though, the progression risk was significantly associated with long duration of laptop use in high myopes (p-value <0.05). With respect to distance of laptop use, odds of progression was significantly higher among patients using laptop at 60 cm distance with myopia (p-value <0.01). Mean task specific laptop dioptre hours per day in eyes with progression was significantly higher (0.2±0) as compared to eyes with no progression (0.1±0) (p-value <0.01). Sheppard AL and Wolffsohn JS concluded that excessive use and access to computer devices and smart phones have been associated with computer vision syndrome which is associated with visual fatigue and digital eye strain [26]. These factors might help in progression of myopia. However, Torri H et al., documented that violet light exposure might have beneficial effect on progression of myopia, but such association has not been established [28]. Comparison of the findings of present study with similar previous studies is shown in [Table/Fig-7] [21-23,26,27].

Limitation(s)

Electronic gadget use with myopia progression may show significant association, if the follow-up duration of the study was longer than one year. As recruitment of subjects was Outpatient Department based and sample size was smaller, generalisation of results may not represent the population as a whole.

CONCLUSION(S)

In the present study, myopia progression risk was significantly higher in eyes with longer task specific mobile and laptop dioptre hours per day i.e., risk of progression of myopia was significantly higher in patients engaged for longer duration on mobile and laptop and at near distance. Myopia onset in younger age leads to high myopia in adult life and high myopia is associated with increased risk of severe and irreversible loss of vision. Thus, this study concludes that overuse of electronic gadgets has a significant adverse impact on myopia progression in young people. The current findings suggest that by educating and instructing healthcare providers, children and their parents on reducing screen time and taking frequent breaks while using electronic gadgets will help to prevent further myopia progression.

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