

## COMPETITIVE ENVIRONMENT AND MYOPIA PROGRESSION IN YOUNG PEOPLE: A PROSPECTIVE STUDY

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### ABSTRACT

**Objective:** The aim of the study was to determine the effect of duration and distance of reading and writing over myopia progression in young people.

**Methods:** This prospective, observational, and single-centered study was conducted on 400 eyes of 200 myopic patients. Eyes were categorized into three groups based on degree of myopia (low, moderate, and high) at the time of presentation. Cycloplegic autorefractometry followed by subjective refinement of refraction was done and spherical equivalent (SE) was calculated at baseline (Time 1), and then after 6 months (Time 2), and at 1 year (Time 3). Progression of myopia was calculated as increase in SE of subject's eye between Time 1 and Time 3. Questionnaire survey about the amount of time spent on reading and writing and their preferred working distance in centimeters for each task was filled. Task specific diopter hours per day was calculated. Multivariate analysis was done to estimate the adjusted odds ratio for time spent on reading and writing and their preferred working distance in centimeters for each task and task specific diopter hours per day for reading and writing associated with myopia progression was calculated.

**Results:** Mean task specific reading and writing diopter hours per day in eyes with progression was  $40 \pm 12$  whereas that in eyes with no progression was  $30 \pm 10$ . The observed difference was statistically highly significant ( $p < 0.01$ ). Task specific reading and writing diopter hours per day was significantly higher in eyes with progression as compared to no progression in low and moderate as well as in high myopes ( $p < 0.01$ ).

**Conclusion:** Risk of progression of myopia was significantly ( $< 0.05$ ) higher in patients engaged in longer duration of reading and writing ( $> 6$  h) and at near distance ( $< 25$  cm).

**Keywords:** Young people, Myopia progression, Competitive environment, Task specific diopter hour, Spherical equivalent.

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### INTRODUCTION

Myopia onset in younger age leads to high myopia in adult life [1-3]. The prevalence of myopia around the world has increased dramatically in recent years and, it now exceeds 80% in some highly educated groups such as medical and law students [4,5]. This has consequently led to an increase in the prevalence of high myopia also. High myopia is associated with increased risk of severe and irreversible loss of vision because it is associated with an increased risk of several ocular diseases including myopic retinal degeneration, retinal detachment, glaucoma, and cataract [6-8]. Therefore, it is important to identify the preventive and possible risk factors in the development and progression of myopia.

In general, myopia is believed to have a multifactorial etiology [9] but in certain areas of the world, the rapid increase in the prevalence of myopia suggests that increasing educational pressures, school environment, and urbanization like environmental factors might be significant determinants for the current patterns of school myopia [9,10].

Thus, it becomes important to determine the impact of competitive environment over myopia progression in young people. Hence, the present study was conducted with an aim to assess the magnitude of the association between time spent on near work, working distance of reading and writing and task specific diopter hours for near work and myopia progression.

### METHODS

This prospective, observational, single-centered, and hospital-based study was conducted in the Department of Ophthalmology of

S. S. Medical College and associated GM Hospital, Rewa, (MP), between January 2019 and September 2020. All patients having any degree of myopia between the ages of 10 and 24 years (young people) [11] were included in the study, while those having any corneal dystrophy or degeneration, astigmatism more than two diopters, 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.

Subjects who satisfied all inclusion criteria and met no exclusion criteria were enrolled in the study. Informed consent was taken. 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 such as 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.

A questionnaire survey was done about the amount of time spent on reading and/or writing and their preferred working distance in centimeters for each task. After that task specific diopter hours per day was calculated by multiplying task specific duration in hours to inverse of working distance in meters.

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

Cycloplegic refraction with cyclopentolate 1% in each eye 5 min apart was done for all patients followed by autorefractometry with Shin

Nippon Autorefractometer after 30 min. Spherical equivalent (SE) was calculated for each eye separately by adding the sum of the sphere power with half of the cylinder power.

Depending on the degree of myopia, eyes were categorized as-

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

Patients were examined at the time of initial enrollment (Time 1) and twice thereafter, at 6-month intervals (Time 2 and Time 3). Progression of myopia was calculated as increase in myopic refraction of subject's eye between Time 1, Time 2, and Time 3. The collected data were compiled using MS Excel and analyzed using IBM SPSS software version 20. Categorical data were expressed as frequency and percentage whereas numerical data were expressed as mean and standard deviation. Multivariate analysis was done to estimate the adjusted odds ratio for time spent on reading and writing and their preferred working distance in centimeters for each task and task specific diopter hours per day for reading and writing associated with myopia progression was calculated and  $p < 0.05$  was 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  $18.62 \pm 3.18$ ,  $17.65 \pm 3.59$ , and  $17.49 \pm 3.91$  years, respectively. There were 102 males and the male: female ratio was 1.04:1. Depending on the severity of myopia, 101 (50.5%) eyes were categorized as low myopia, 74 (37%) as moderate, and 25 (12.5%) as high myopia.

For the entire study cohort, it was observed that those subjects who had a reading and writing duration of more than 10 h, showed a significant ( $p < 0.001$ ) increase in myopia progression. Analyzing this progression with respect to varying grades of myopia, it was seen that significant increase was present for reading and writing of both 6–10 h duration and 11–15 h duration for those having low as well as moderate myopia. For patients having high myopia, this increase was not significant.

Calculating the odds of progression in patients of low myopia, it was found to be 1.2 time and 2.26 times higher in patients engaged in reading and writing for 6–10 and >10 h, respectively. Similarly, odds of progression were significantly higher with longer duration of reading and writing in overall patients as well as moderate myopia ( $p < 0.01$ ) (Table 1 and Fig. 1).

The distance for doing near work also affected myopia progression for the entire study population as well as for the three grades of myopia severity. However, this was seen to reach statistical significance only for near distance of 30 cm or less in all the three groups.

On analyzing the association of myopia progression with preferred average working distance for reading and writing by subjects, we found that odds of progression was significantly higher in patients with low and moderate as well as high myopia engaged in reading and writing at a distance of 25 cm as well as 30 cm ( $p < 0.05$ ). This implies that patients engaged in closer distance for reading and writing had higher odds of myopia progression (Table 2 and Fig. 2).

Analyzing mean task specific reading and writing diopter hours per day for the various grades of myopia, it was significantly ( $p < 0.01$ ) higher in eyes with progression as compared to no progression for all three groups, namely, low and moderate as well as high myopes. For the entire study cohort, in eyes with progression, it was  $40 \pm 12$  whereas for eyes with no progression, it was  $30 \pm 10$ . The observed difference was statistically significant ( $p < 0.01$ ) (Table 3 and Fig. 3).

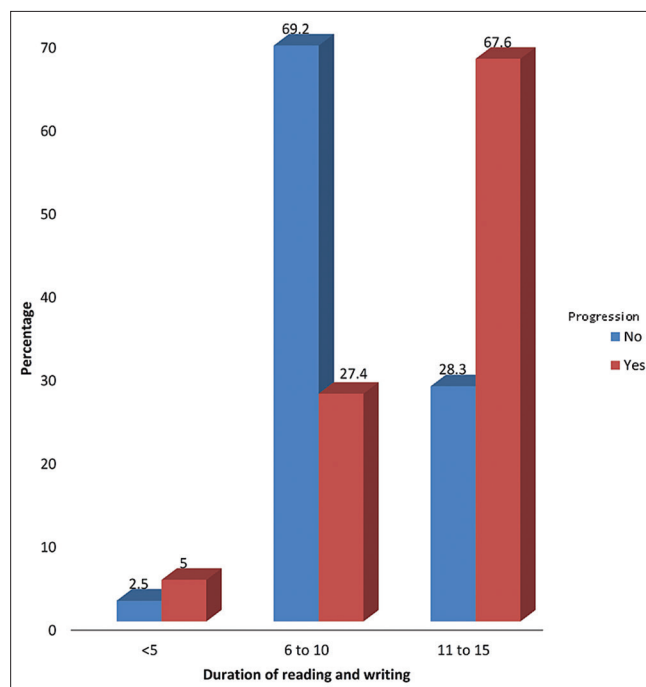


Fig. 1: Association of progression of myopia with duration of reading and writing

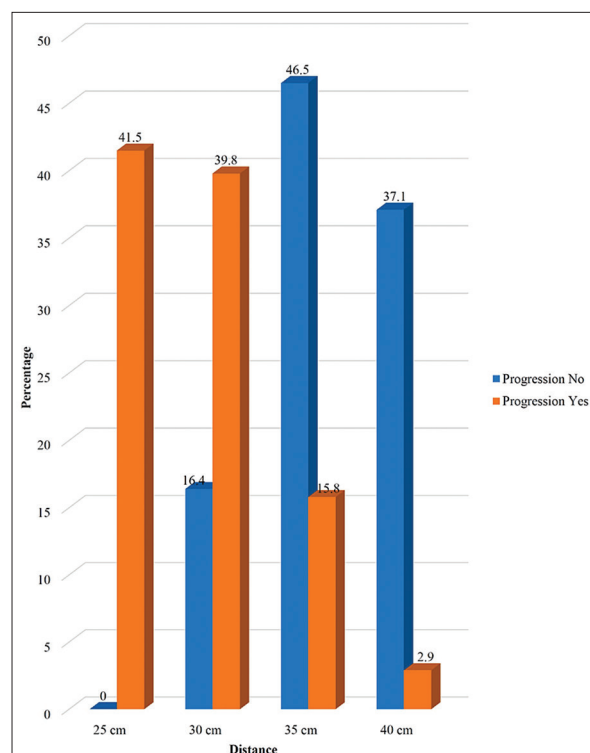


Fig. 2: Association of progression of myopia with distance of reading and writing

## DISCUSSION

The present study aimed to determine the effect of competitive environment, that is, duration and distance of reading and writing over myopia progression in young people.

For the entire study cohort, the mean duration of reading and writing in patients with myopia progression was  $11.1 \pm 2.7$  h whereas mean

Table 1: Association of progression of myopia with duration of reading and writing

Myopia	Duration (hours)	Progression		OR (95% CI)	p-value
		No	Yes		
Low	<5	4 (3.4)	2 (2.4)	-	
	6-10	84 (70.6)	34 (40.5)	1.2 (0.38-3.9)	0.04
	11-15	31 (26.1)	48 (57.1)	2.26 (1.31-5.45)	0.001
Moderate	Mean	9.38±1.83	10.30±1.93		
	<5	0 (0)	2 (1.7)	-	
	6-10	24 (75)	28 (24.1)	1.32 (0.59-3.11)	0.02
High	11-15	8 (25)	86 (74.1)	3.1 (1.2-7.5)	0.001
	Mean	9.81±1.03	11.75±2.17		
	<5	0 (0)	8 (19.5)	-	
Total	6-10	2 (25)	4 (9.8)	0.65 (0.06-2.90)	0.38
	11-15	6 (75)	29 (70.7)	1.20 (0.98-2.91)	0.18
	Mean	11.00±0.76	11.07±4.28		
Total	<5	4 (2.5)	12 (5)	-	
	6-10	110 (69.2)	66 (27.4)	1.39 (0.58-3.30)	0.023
	11-15	45 (28.3)	163 (67.6)	2.98 (1.2-5.78)	0.001
	Mean	9.6±1.7	11.1±2.7		

Table 2: Association of progression of myopia with distance of reading and writing

Myopia	Average distance (cm)	Progression		OR (95% CI)	p-value
		No	Yes		
Low	25	0 (0)	7 (8.3)	2.89 (1.32-5.19)	0.001
	30	24 (20.2)	36 (42.9)	2.24 (0.91-4.11)	0.003
	35	50 (42)	34 (40.5)	1.33 (0.59-3.2)	0.08
	40	45 (37.8)	7 (8.3)	-	
	Mean	35.88±3.7	32.4±3.8		
Moderate	25	0 (0)	64 (55.2)	3.89 (1.32-7.79)	0.001
	30	2 (6.2)	48 (41.4)	2.16 (0.98-3.39)	0.03
	35	18 (56.2)	4 (3.4)	0.65 (0.04-1.45)	0.45
	40	12 (37.5)	0 (0)	-	
	Mean	36.56±2.96	27.41±2.84		
High	25	0 (0)	29 (0.7)	1.12 (0.02-3.32)	0.045
	30	0 (0)	12 (29.3)	2.22 (0.78-4.98)	0.02
	35	6 (75)	0 (0)	0.59 (0.17-1.59)	0.57
	40	2 (25)	0 (0)	-	
	Mean	36.25±2.32	26.5±2.3		
Total	25	0 (0)	100 (41.5)	3.9 (1.2-6.9)	0.002
	30	26 (16.4)	96 (39.8)	1.8 (0.1-2.9)	0.04
	35	74 (46.5)	38 (15.8)	1.1 (0.9-2.0)	0.44
	40	59 (37.1)	7 (2.9)	-	
	Mean	36.04±3.5	29±4.1		

Table 3: Association of progression of myopia with task specific reading and writing dioptr hours per day

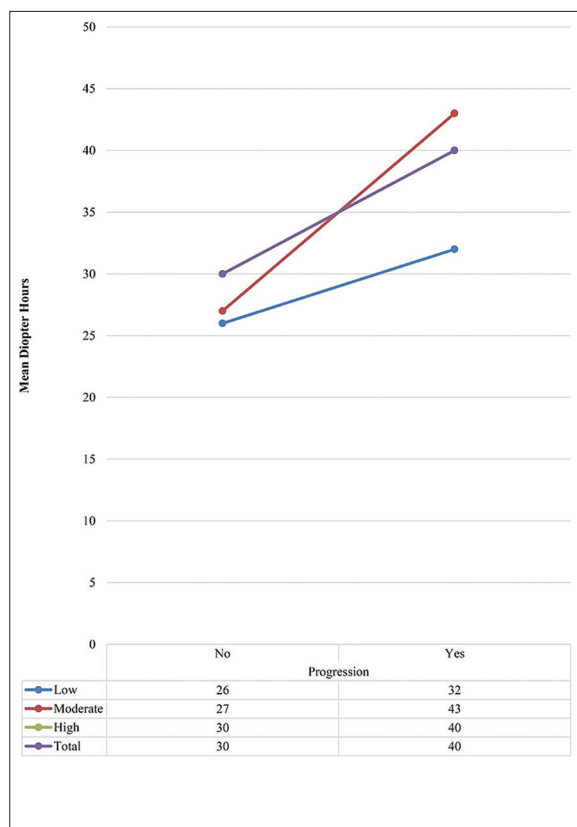
Myopia	Progression		T test	p-value
	No	Yes		
Low	26±6	32±7	5.9	0.001
Moderate	27±3	43±9	10.1	0.001
High	30±3	40±20	3.9	0.001
Total	30±10	40±12	12.5	0.001

duration in patients with no progression was 9.6±1.7 h. The odds of myopia progression increased significantly with duration of reading and writing, that is, risk of progression was 2.98 times higher in patients engaged in reading and writing for more than 10 h whereas it was 1.39 times higher in patients engaged in reading and writing for 6-10 h ( $p \leq 0.001$ ) and on practical near-work ( $p \leq 0.05$ ). Mutti *et al.* [12] also observed long duration of study hours and more time in reading to be significantly associated with risk of developing myopia as well

as its progression ( $p < 0.05$ ). The findings of present study were also consistent with the findings of French *et al.* [13] who documented that myopic children performed significantly more near work (19.4 vs. 17.6 h;  $p = 0.02$ ).

Our study also observed that as the distance of reading and writing decreased, risk of myopia progression increased significantly. It was 3.9 times higher in patients reading at 25 cm compared to 1.8 times and 1.1 times higher in patients reading/writing at 30 cm and 35 cm distance, respectively. Similarly, Ip *et al.* [14] documented statistically significant risk of myopia progression in those engaged in close reading distance ( $< 30$  cm) for longer duration ( $p < 0.01$ ). Huang *et al.* [15] in their meta-analysis concluded that distance of near work is significantly associated with risk of myopia progression.

The mean task specific reading and writing dioptr hours per day in eyes with progression was 40±12 whereas for eyes with no progression, it was 30±10 in our study. Task specific reading and writing dioptr hours per day was significantly higher in eyes with progression as compared



**Fig. 3: Association of progression of myopia with task specific reading and writing diopeter hours per day**

to no progression in low and moderate as well as high myopes ( $p < 0.01$ ). Similar findings were observed by previous studies [16-18] indicating near work distance and duration to be significantly associated with progression of myopia in young patients ( $p < 0.05$ ).

#### Limitations

1. Duration of study was shorter which leads low odds ratio
2. As recruitment of subjects was outdoor patient department based and sample size was smaller, generalization of results may not represent the population as a whole.

#### CONCLUSIONS

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. In our study, myopia progression risk was significantly higher in eyes with longer task specific reading and writing diopeter hours per day ( $p < 0.01$ ), that is, risk of progression of myopia was significantly higher in patients engaged longer duration of reading and writing ( $> 6$  h) and at near distance ( $p < 0.05$ ). Thus, this study concludes that competitive environment has a significant adverse impact on myopia progression in young people.

With the current impetus on online teaching and multiple coaching schedules being undertaken concurrently by children, both children and their parents need to be made aware of the negative impact of this kind of competitive environment on progression of myopia. Furthermore,

designing those programs which reduce excess near work and promote more outdoor activity should be among the priorities of administrators, health care policy makers, ophthalmologists, and pediatricians.

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