



10.2478/AMB-2026-0037

ORIGINAL ARTICLE

CURRENT CONCEPTS FOR MYOPIA DEVELOPMENT IN BULGARIAN SCHOOLS

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Abstract. *The current concepts for the risk factors for myopia state nowadays factors can be analyzed from the perspective of their modification and the prevention of the eye disorder. The main question is not only what the risk factors are, but also how to reduce them in order to delay the myopia onset and progression. In that regard, some more important risk factors are identified than others. The risk factors closely linked to the concept of prevention of myopia are: timing, brightness and UV light exposure in outdoor activities; duration and distance of near work (more than 2 hours per day, less than 20 cm), the type of electronic devices used, and breaks from near work; indoor illumination (over 250 lux, which is protective for myopia); age – pre-myops aged 6-8 years are at extreme risk of myopic complications. The complications of excessive myopia can be sight-threatening. With the aim of preventing them, a screening program was implemented in Bulgarian schools for a 7-year-period (2018-2025). The results, as well as the new methods of myopia prevention, are discussed and outlined.*

Key words: *myopia, progression, prevention*

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Received: 25 August 2025; **Accepted:** 28 August 2025

INTRODUCTION

Myopia, which in the past has been considered a benign form of the refraction, is nowadays considered a pandemic affecting more than half of the world population. Myopia is a clinical refraction, known mostly as short-sightedness, as the affected people can see clearly at short distances and blurry in the distance. The punctum remotum (PR) of such an eye is in the near objects, and only divergent light rays give a clear image on the retina. Normally, the disorder develops during teenage years, and very few people, less than 2%, are born myopic.

According to the severity of the refractive anomaly, myopia is classified as low – up to -3.0 diopters, medium – up to -6.0 diopters, and high – over -6.0 diopters [7]. In stationary myopia, diopters usually do not change significantly after puberty [9]. In progressive myopia, the refraction rapidly increases and reaches -10, -20 diopters. It is combined with an increased anterior-posterior diameter of the eye, thinning of the retina and sclera, as a result of which degenerative diseases occur.

Epidemiology

Myopia is currently becoming a worldwide epidemic, affecting more and more people worldwide [1, 2, 10]. The disorder is expected to affect almost

5 billion people by 2050. It is estimated that over 1 billion of them will develop myopia-related complications. Although the current statistics show the rate of 27% of myopia globally, in the next decade, the proportion in Asian countries will rise to 87% [11, 14]. Excessive myopia is supposed to be the most common cause of severe vision loss worldwide, which gives the topic of myopia great social impact and importance.

Risk factors for the development and progression of myopia

Myopia is caused by the complex interaction between genetic and environmental factors.

Genetic factors, although repeatedly discussed and contested, remain to this day a major risk factor for the development of myopia. It has been proven that if one of the parents is short-sighted, the risk of the child being short-sighted is 2 times higher than usual. With two myopic parents, the risk is 6 times higher than normal [3, 8].

Ethnic origin and education

Ethnic origin is of importance, and children in Asia are more prone to myopia development. The disorder is extremely common in Asia and Southeast Asia. Education also plays a role, especially in countries where education is very important, long-term, and labor-intensive. In such regions, myopia is more common. It is clear that schools with numerous study hours and intensive close work speed up myopia development.

Work at a near distance

It is assumed that a longer time spent in close work than outdoors leads to a faster progression of myopia. The main risk factor is prolonged close work at a distance of less than 20 cm. There is a significant association between computer screen time and the progression of myopia [3, 16].

The current concepts for myopia risk factors state that nowadays, the risk factors can be viewed from the perspective of their modification and the prevention of myopia. The question is not only what the risk factors are, but also to find ways to reduce them in order to delay myopia onset and progression. In view of this perspective, some risk factors, such as the time spent in near work and computer devices, time spent outdoors, and illumination, are more important than others are, as they can be assessed and modified. The new risk factors coming from the notion to prevent myopia are:

- Timing, brightness, and UV light exposure in outdoor activities;

- Distance and duration of near work (less than 20 cm, more than 2 hours per day), type of electronic devices used, and breaks from near work;
- Indoor illumination – over 250 lux – is protective for myopia;
- Age – pre-myops at 6-8 years are at extreme risk of myopic complications.

AIM

The aim of the study is to outline the current concepts of myopia risk factors in Bulgarian schools and analyze the importance of the risk factors for myopia progression.

MATERIALS AND METHODS

In the period from 2020 to 2024, 990 children were screened (280 boys and 710 girls). Three types of refraction groups were found: emmetropes, hypermetropes and myopes. We performed our screening in three different types of schools: schools in rural towns, language schools, and sports schools in Sofia.

RESULTS

Risk factors for myopia in Bulgarian schools in the period 2020-2024.

The distribution of the studied children by sex and age is shown in Table 1.

Table 1. Distribution of the children according to sex and age

Characteristics	Sex	N	Mean age	SD	Min. age	Max. age
	Boys	280	7.32	0.48	7.00	8.00
	Girls	710	7.25	0.47	6.00	8.00
	All	990	7.27	0.47	6.00	8.00

It was found that in the language schools, the number of myopes was the largest, while in the rural town schools and sports schools, the corresponding numbers were identical.

The average age of the examined children was 7.24 years (range 6-8 years). In this age group, almost an equal number of children have emmetropia or hypermetropia (Table 2), which are the most common refractive anomalies for this age. Myopia is less common, and those who are detected are at risk of developing pathological myopia. Myopia prevailed in

girls in comparison to boys (20.21% vs 13.86%, respectively).

Although the majority of children had been examined by ophthalmologists before and had prescriptions for glasses, they did not wear them. Almost 68% did not follow the prescription of wearing glasses, and this is a hazardous tendency, which also leads to myopia development and progression. We also found a large increase in the time spent in front of electronic devices in recent years.

In light of the current concepts of myopia, it turns out that hours spent outdoors daily are most important for preventing the development of myopia. Our results show a statistical relationship between the indicator – time spent outdoors per day – and myopia. The relationship is inversely proportional. The more time spent outdoors per day, the lower the number of myopic children is ($p = 0.013$) (Table 3). Time spent

outdoors has a protective effect on the development of myopia.

The same is valid for weekend sports. The time spent playing sports on the weekend has a statistically significant effect on the development of myopia, and more time spent playing such activities reduces the development and progression of the disease.

The alarming tendency of having more time in front of the computer instead of sports activities outdoors is a phenomenon seen in the post-COVID-19 pandemic period. The number of children spending time outdoors with sports every day has decreased, and those spending eight or more hours in front of computers has increased (Table 4).

There is a general negative trend toward a decrease in outdoor activities in the weekend and everyday in the Bulgarian schools. More and more our children

Table 2. Distribution of myopia among the children between 6 and 8 years of age

Indicator	Group	N	Mean	SD	Min	Max
Age	Emmetropes	300	7.27	0.45	7.00	8.00
	Hypermetropes	320	7.31	0.47	7.00	8.00
	Myopes	220	7.24	0.49	6.00	8.00

Table 3. Statistical evaluation of the influence of time outdoors in minutes on the development and progression of myopia – Kruskal–Wallis test

Indicator	Group	N	Mean	Median	SD	Min	Max	p
Time spent outdoors per day (minutes)	Emmetropes	300	117.00	120.00	69.04	30.00	320.00	0.013
	Hypermetropes	320	75.00	60.00	41.27	30.00	220.00	
	Myopes	370	84.46	60.00	67.25	0.00	300.00	

Table 4. The time spent in front of the computer screens and computer games increases while that of sports activities in the weekend decreases

Indicator	Group	N	Mean	Median	SD	Min	Max	p
Minutes of sport on the weekend	Emmetropes	300	178.83	180.00	85.82	45.00	330.00	0.022
	Hypermetropes	320	205.00	210.00	82.66	90.00	360.00	
	Myopes	370	143.78	120.00	82.54	0.00	300.00	
Minutes in front of the computer	Emmetropes	300	91.50	90.00	35.26	30.00	220.00	0.141
	Hypermetropes	320	79.38	75.00	37.84	0.00	180.00	
	Myopes	370	100.95	60.00	42.65	30.00	200.00	
Time of reading and writing	Emmetropes	300	64.50	60.00	30.18	30.00	120.00	0.168
	Hypermetropes	320	50.63	55.00	26.90	0.00	120.00	
	Myopes	370	66.62	90.00	40.26	20.00	180.00	
Time of playing computer games (minutes)	Emmetropes	300	68.17	60.00	30.86	0.00	120.00	0.001
	Hypermetropes	320	48.13	40.00	31.67	0.00	120.00	
	Myopes	370	82.03	90.00	49.95	15.00	300.00	

sit in front of the computers, play games or read and write at a near distance. All that leads to a general increase in the line of myopia level in our schools. It is becoming not a plateau curve but a steep one in the last 5 years after the COVID-19 pandemic. There is a major trend of rise of myopic refraction in our schools, which is now more evident than it was before. It is alarming and has to be addressed quickly.

A major part of our screening in Bulgarian schools considered classrooms illumination. Numerous authors, especially in China, point out that by increasing the illumination from 100 to 500 lux the axial elongation of the eyeball is stopped and thus it is protective against the development of myopia. In our screening, we measured the indoor illumination with the help of a lux meter. The following results have been found: illumination from 100 to 110 lux is available in 40% of the classrooms; illumination from 200 to 220 lux – in 40% of classrooms; and illumination from 300 to 350 lux – in 20% of classrooms.

Although it is obligatory to provide illumination of 220 lux in our classrooms, about 40% have illumination lower than that, exposing the children to the risk of developing myopia. Moreover, some of these classrooms were the classrooms of children in the first year of school – about 6 years of age, which is absolutely forbidden. Only a very small proportion of classrooms in the Bulgarian schools (20%) have a level of lighting, which has a protective effect on the development of myopia, with illumination of 300-350 lux.

In three of the studied schools, screening was conducted in the same classes in two consecutive years. It turns out that during the follow-up, 96.7% of the children who were hemitropic remained so, 78% of the hyperopic children also retained their hyperopia diopters, and in 21% there was an increase in hyperopia (Table 5).

Table 5. The change of the refraction in one-year period in the same classes in two consecutive years

Refraction on the first year of screening	Progression	N	%
Emmetropes	No	290	96.7
	Yes	10	3.3
Hypermetropes	No	250	78.1
	Yes	70	21.9
Myopes	No	130	35.1
	Yes	240	64.9

In myopic children, however, the trend is the opposite; in 64% myopia progressed and in only 35%, it

remained unchanged. This can be explained by the poor working habits of myopic children – more work on computers and less time outdoors, as well as poor lighting in classrooms.

In one of the studied schools, after our screening program, the lighting was changed, increasing the illumination in the classrooms to 300 lux. After the change, the screening showed a reduced number of myopic children (Figure 1). The Mann–Whitney test for statistical dependence shows that the improvement in lighting statistically reduces the progression of myopia.

There is an inverse relationship between classroom illumination and myopic shift in children. The better the illumination is, the lower the number of myopic children. The lower the classroom lighting you have, the greater the number of myopic children, and vice versa.

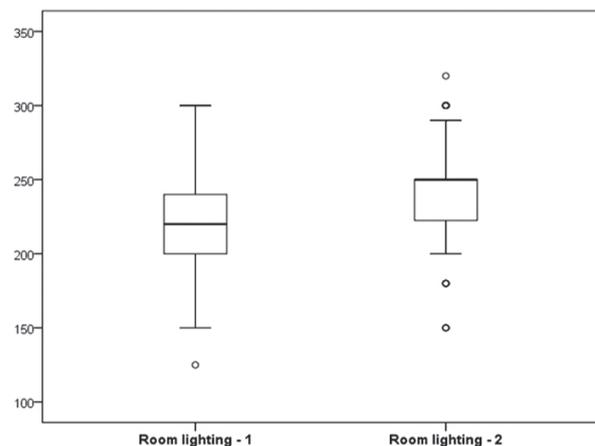


Fig. 1. The figure shows a decrease in the number of myopes when classroom lighting is improved in the same school

Other risk factors, suspected for myopia progression, are the time spent in reading and writing after school, distance for near work, way of going to school – with a car or on foot, additional sport exercises during the weekend, good compliance to myopia treatment, and not wearing prescribed glasses, which are all serious risk factors. Also, the adequate and early healthcare is important, a late first visit to an ophthalmologist, is a risk factor for myopia progression and development.

Although all of the above-mentioned risk factors seem to be related to myopia development, we could not find a statistically significant relationship in our study.

CONCLUSION

Current concepts of myopia risk factors bring us more questions than before: What are the factors that influence treatment decisions and treatment outcomes

– the age of myopia onset, rate of previous myopic progression, family history, sex, ethnicity, lifestyle conditions, social-economic status, education and school habits, environmental light and illumination?

We look at them as factors to be modified and factors for prevention. We know now that everything in myopia is individual and complex. Risk factors for myopia development, according to current concepts, are individual for each child. We have to examine the whole complex to find the risk profile of myopia and modify it. We all agree that the highly risky profile includes:

- A 6-8-year-old pre-myope,
- Family history of myopic parents,
- Female sex,
- Asian race,
- Inclination for more near work and less outdoor activity.

Our general aim is to find those children from our screening and turn their high-risk profile into the low risk one by modifying the factors of the environment to more protective ones for myopia. It is now the time to act, as in myopia as in many other severe diseases, prevention is better than the cure.

Conflict of Interest Statement: *The authors declare no conflicts of interest related to this work.*

Funding: *The authors did not receive any financial support from any organization for this research work.*

Ethical statement: *This study has been performed in accordance with the ethical standards as laid down in the Declaration of Helsinki.*

Informed Consent from Participants: *Informed consent was obtained from all participants included in the study.*

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