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MYOPIA – RISK FACTORS, PREVALENCE IN BULGARIAN SCHOOLS, AND PREVENTION

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Abstract. *Myopia is a type of clinical refraction, a form of spherical refractive anomaly in which the eye has a relatively stronger refractive power for the corresponding length of the anteroposterior axis. The focus of this optical system is far in front of the retina. Myopia can be congenital or manifest later, most often at school age. It can be stationary or progressive. Progresive myopia is sight-threatening. The article discusses results from a screening program for myopia progression in Bulgarian schools between 2018-2023. The risk factors for myopia development have been outlined, and the ways of prophylaxis have been pointed out.*

Key words: *myopia, progression, prophylaxis*

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INTRODUCTION

Myopia is a clinical refraction, a form of spherical refractive error in which the eye refractive power does not correspond to the length of the anterior-posterior axis. The focus of this optical system is located in front of the retina [1]. Therefore, the image of a dot is not a dot but a big spot on the retina. Only divergent rays from nearby objects give a clear image of the retina. The term short-sightedness is related to this. It is an optical system that can focus clearly only divergent rays on the retina. The main characteristics of the myopic eye can be summarized as follows:

- parallel rays intersect in the vitreous in front of the retina.
- the image of a dot is a spot on the retina [1, 2].
- divergent rays are refracted in such a way as to form a clear image on the retina.
- PR is located at a closer distance of 5 m.

Myopia can be axial when the anterior-posterior axis of the eye is larger; refractive, when the refractive power is stronger; combinational, when the length of the eye and the refraction are within the norm, but are combined so that the images do not fall on the retina, and mixed when both the axis of the eye is longer, and the refractive power is stronger. The far point of clear vision is located at a distance of less than 5 m [15]. Thus, with myopia of 1 diopter, it is located at 1 m in front of the eye.

According to the severity of the refractive anomaly, myopia is classified as weak, medium and strong. It is weak up to -3.0 diopters, medium from -3.0 to -6.0 and strong (high) myopia above -6.0 diopters [7].

Myopia can be congenital or appear later in life, most often at school age. It can be stationary or progres-

sive. 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 and thinning of the retina and sclera, resulting in degenerative diseases.

Epidemiology

Myopia, which years ago was considered to be a simple variation of clinical refraction, is currently becoming a worldwide epidemic, with numerous serious complications for vision [1, 2, 10]. In recent years, the number of people with myopia has been constantly increasing (Fig. 1).

Myopia is on the rise worldwide. It is expected that by 2050, half of the world's population – 5 billion people - will be myopic, and about 1 billion of them will develop myopia-related complications. If myopia is currently 27% worldwide, it is expected that in the next decade, its frequency in Asian countries will reach 87% [11, 14]. It is believed in the near future, excessive myopia will be the leading cause of irreversible blindness worldwide. This makes it a problem of great social 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 3 times higher than usual. With 2 myopic parents, the risk is 6 times higher than normal (3.8). It turns out that the children of myopic parents are more prone to the progression of myopia. Environmental factors are also of particular importance. Among them, ethnicity is important.

Ethnic origin

It turns out that the greatest frequency of myopia is observed in Asia and Southeast Asia. Myopia prevails in countries where education and academic achievement are particularly important. Moreover, the overloaded curricula, requiring many hours of close work, lead to a rapid progression of myopia [4, 12, 13].

Of particular importance as a risk factor is the ratio of time spent in front of the computer screen and time outside [5].

Education

Education plays an important role in the onset and progression of myopia. A recent international study reported that each additional year of schooling was associated with -0.50 D higher myopia [5].

The protective effect of time spent outside is due to many factors, the most important of which are:

- prolonged exposure to sunlight;
- exposure to light from the short wavelength spectrum (360-400 nm);
- ultraviolet light;
- the increase in the levels of vitamin D in the body.

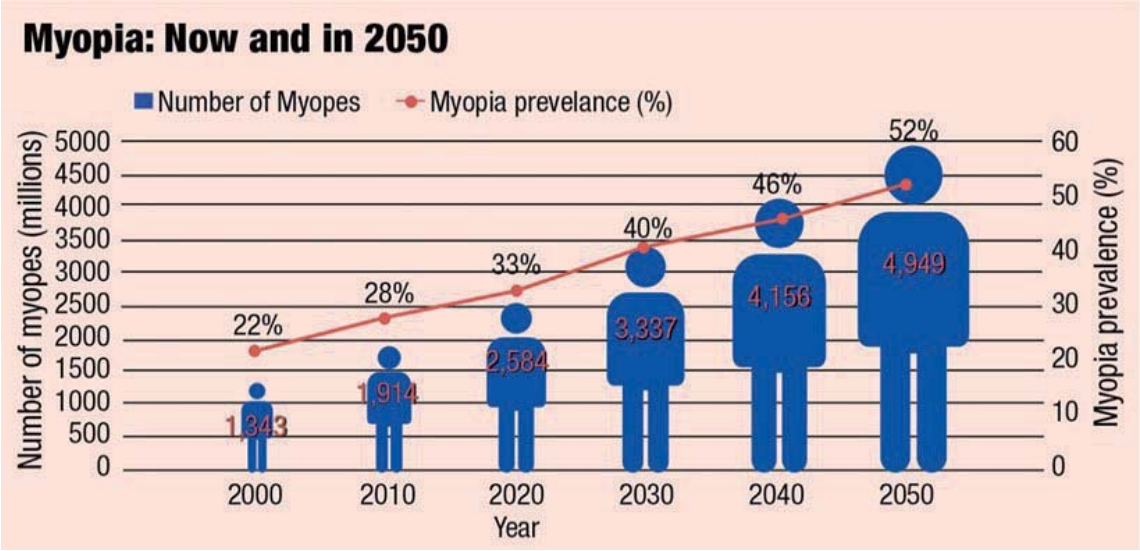

Fig. 1. The number of myopes in the world is constantly increasing, and their number is expected to reach 50% of all refractive anomalies by 2050

All this reduces the stimuli for the growth of the length of the eyeball and the progression of myopia.

Work nearby

It turns out that a longer time spent in close work than outside leads to a faster progression of myopia. The main risk factor is prolonged close work at a distance of less than f < 20 cm. There is a significant association between computer screen time and myopia progression [3].

The aim of the present screening study is to investigate the influence of different risk factors on the occurrence and progression of myopia in Bulgarian schools (2018-2022).

MATERIALS AND METHODS

From 2018 to 2022, 1401 children were screened, of which 236 with myopia (SE ≤ -0.75 and decimal VA ≤ 0.8). They were divided into three types of schools – those living in a small town, language schools in Sofia and sports schools. The potential risk for myopia development has been evaluated with special question charts with information about sport activities, time outdoors, time in front of the screen etc.

The percentage distribution of myopia in the 3 types of schools can be shown as follows (Table 1).

Table 1. Distribution of myops in different type of schools.

Small town schools	8.36% myopes
Language schools in the capital	31.38% myopes
Sport schools	8.84 % myopes

Quite expected, the schools with the highest educational requirements for children are also those with the highest percentage of myopic children.

There was no big difference in the percentage of myopes in the different age groups: 6-10 (19.93%) and 11-15 (14.22% myopes). Myopia was slightly more common in girls compared to boys – 20.21% to 13.86%, respectively.

The conducted polls showed that nearly 68% of the children had already been examined by an ophthalmologist, but despite this, only 27.5% wore the prescribed glasses. This is an alarming statistic and a serious risk factor for the progression of myopia. Survey data also show an alarming increase in time spent in front of electronic devices.

It turns out that this particular risk factor has undergone the greatest negative change in recent years and under the influence of the COVID-19 pandemic. This is also clearly visible in the following graphs (Fig. 2).

Unfortunately, in the last 5 years, the percentage of Bulgarian school-aged children who play sports every day has decreased, and the number of those who spend more than 4 hours a day on the computer screen has increased (Fig. 2). This certainly affects the number of myopes in Bulgarian schools. It is no coincidence that statistically speaking, until 2020, we have a plateau in terms of the increase in the number of myopes, while from 2020 and the following years, the number of myopes begins, albeit smoothly, to increase (Fig. 3).

A major focus in our screening studies in Bulgarian schools was the lighting of the classrooms. A number of Chinese studies prove that increasing the illumina-

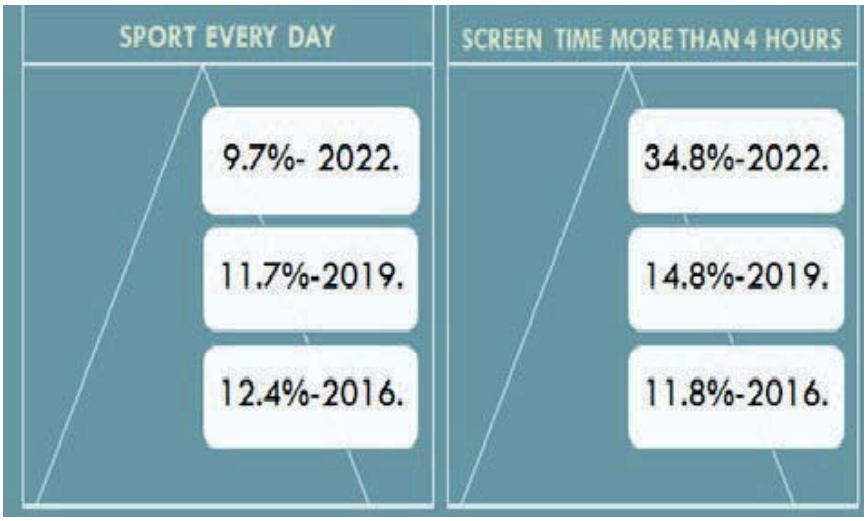

Fig. 2. Change in the percentage of school children having sport activities every day versus the percentage of those having screen activities more than 4 hours

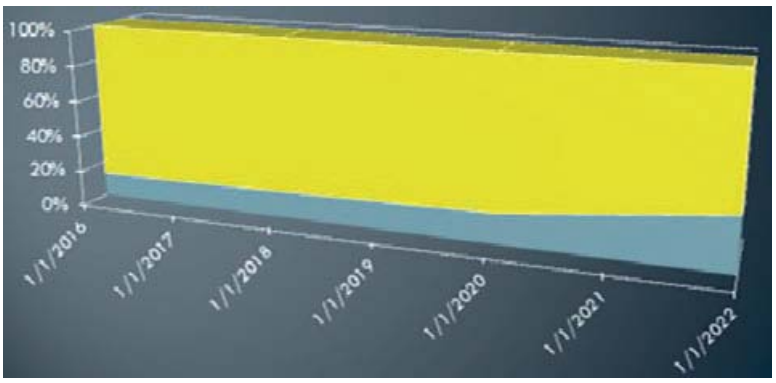

Fig. 3. Increase of the number of myops through out the years

tion from 100 to 500 lux has a protective effect on the axial elongation of the eyeball. Examining the illuminance of the classrooms with a lux meter, we found the following illuminance distribution (Table 2).

Table 2. Illumination in the classrooms of Bulgarian schools

Illumination from 100 to 110 lux	40% of the classrooms
Illumination from 200 to220 lux	40% of classrooms
Illumination from 300- 350 lux	20% of classrooms

A very small percentage of classrooms in Bulgarian schools have a level of lighting that has a protective effect on myopia development.

Ambient lighting and the progression of myopia are inversely related. The less lux illumination the classroom lighting is, the greater the number of myopic children and vice versa.

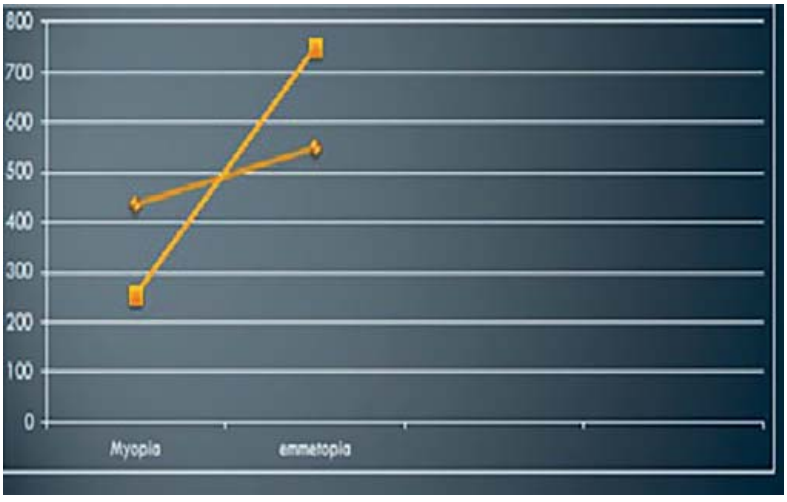

Fig. 4. Number of myops according to illumination in the Bulgarian schools

DISSCUSION

Our studies show that out of the 1401 school-aged children studied

- 40% of myopes progressed by ~0.50 D.
- > 6 hours daily reading/writing increases the risk of progression. The number of myopes increased after the COVID pandemic – 10%.
- > 2 hours a day spent outside (sports) has a protective effect,
- 7 hours/week of screen time = 2 x myopia risk
- Reduced ambient light below 220 lux is a serious risk factor for myopia development.

LED l lights are harmful to children's eyes because they increase the progression of myopia and can cause photo trauma to the photoreceptors [9].

Myopia prevention

The reduction of the progression of myopia, as well as the number of myopes in the world is a very important cause contributing to the reduction of patients with glaucoma and myopic maculopathy in the world. The prevention of myopia is a complex process involving many different components. Prevention of excessive myopia involves many factors, from lifestyle changes through various multifocal lenses and glasses to refractive surgery, orthokeratology, and the use of low-dose atropine.

The main recommendations for the prevention of myopia are:

1. At least 90 minutes outdoors daily, active sports 60 minutes.
2. 20:20 rule – every 20 minutes, rest for 20 seconds.
3. When reading and writing, always at elbow distance from the book.
4. No more than 2 hours in front of electronic devices per day after school.

A lifestyle change has a positive effect on the development of myopia. Each additional hour of outdoor activity has been shown to reduce the risk of myopia by 2% [8, 12]. The protective effect of outdoor activities is related to the sunlight-mediated release of dopamine in the body, which is thought to reduce eyeball growth.

CONCLUSION

Until a few years ago, myopes were 27% of people on earth, but by 2050, in some countries of the world, they will become 85% [12]. That's why we need to act

now because, with myopia, prevention is much more important than treating late complications.

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REFERENCES

1. Holden BA, Fricke TR, Wilson DA, et al. Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. Ophthalmology 2016; 123: 1036-1042.
2. Morgan IG, Ohno-Matsui K, Saw S-M. Myopia. Lancet 2012; 379: 1739-1748.
3. Resnikoff S, Jonas JB, Friedman D, et al. Myopia- a 21st century public health issue. Invest Ophthalmol Vis Sci 2019; 60: Mi-Mii.
4. Fricke T, Holden B, Wilson D, et al. Global cost of correcting vision impairment from uncorrected refractive error. Bull World Health Org 2012; 90: 728-738.
5. Wu L, Sun X, Zhou X, et al. Causes and 3-year-incidence of blindness in Jing-An District, Shanghai, China 2001-2009. BMC Ophthalmol 2011; 11: 10.
6. Flitcroft DI. The complex interactions of retinal, optical and environmental factors in myopia aetiology. Prog Retin Eye Res 2012; 31: 622-660.
7. Haarman AEG, Enthoven CA, Tideman JWL, et al. The complications of myopia: a review and meta-analysis. Invest Ophthalmol Vis Sci 2020; 61: 49.
8. Grzybowski A, Kanclerz P, Tsubota K, et al. A review on the epidemiology of myopia in school children worldwide. BMC Ophthalmol 2020; 20: 27.
9. Troilo D, Smith EL III, Nickla DL, et al. IMI-experimental models of emmetropization and myopia. Invest Ophthalmol Vis Sci 2019; 60: M31-M88.
10. Tedja MS, Haarman AEG, Meester-Smoor MA, et al. IMI-myopia genetics report. Invest Ophthalmol Vis Sci 2019; 60: 89-105.
11. Wolffsohn JS, Flitcroft DI, Gifford KL, et al. IMI-myopia control reports overview and introduction. Invest Ophthalmol Vis Sci 2019; 60: M1-M17.
12. Flitcroft DI, He M, Jonas JB, et al. IMI-defining and classifying myopia: a proposed set of standards for clinical and epidemiologic studies. Invest Ophthalmol Vis Sci 2019; 60: M20-M30.
13. Sorsby A. Refraction and its components in twins. Privy council, Medical research council, Special report series, no. 303. London: HM Stationery Office, 1962, 136-137.
14. Kepler J. Dioptrice, Agsburg (1611): Cited by Duke-Elder S and Abrams D. Ophthalmic optics and refraction. In: Duke-Elder S (ed.) System of ophthalmology. Vol V. London: Henry Kimpton, 1970, 341.
15. Cohn H. Untersuchungen der Augen von 10060 Schoolkindern nebst Vorschlägen 3 fur Verbesserung der Augen nachtheiligen Schul-Einrichtungen, Leipzig 1867. Cited by Rehm DS. The myopia myth. Ligonier, IN: IMPA, 1981, 57.