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Research Article

Review of Risk Factors and Intervention of Myopia in Children and Adolescents

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Abstract: When the adjustment function of the eye is still, the external parallel light can not form a clear image on the retina after passing through the refractive effect of the eye, and the phenomenon of imaging in front or behind the retina is called ametropia. Common refractive errors include: Myopia, hyperopia, astigmatism, presbyopia, and myopia is the most common ametropia in children and adolescents. Myopia refers to the refractive state in which the external parallel light (distance greater than 5 meters) enters the eye and focuses on the retina after passing through the ocular refractive system when the eye is in the state of adjustment and rest. In general, myopia can be diagnosed when se is less than - 0.5d, and it can be divided into light, medium and high myopia according to the degree of myopia. Among them, mild myopia is 0d ≤ diopter < - 3D, moderate myopia is - 3D ≤ diopter < - 6D, high myopia is diopter ≥ - 6D. Nowadays, the myopia rate of children and adolescents is high in many countries, and it has become a global public health problem. Myopia not only affects the study and life of children and adolescents, but also causes a variety of serious ophthalmic complications (such as cataract, glaucoma, myopic macular degeneration and retinal detachment) with the growth of age. Studies have shown that as early as 2015, the global economic loss caused by uncorrected myopia was about 240 billion US dollars, of which the potential loss in East Asia, mainly China, was the largest. It is important to understand the prevalence, causes and intervention measures of myopia. Therefore, this paper summarizes the current situation of the research on the prevalence trend, influencing factors and intervention measures of myopia in children and adolescents.

Keywords: Youth myopia; Intervention; The research progress

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1 The trend of myopia at home and abroad

The incidence of myopia in the world is mainly concentrated in Asia, especially in East Asia (China, Singapore and Japan), showing obvious regional characteristics[1-4]. Meanwhile, the incidence rate of myopia has increased year by year, far higher than that of other countries and regions such as Europe, America and Africa.The reasons for the regional differences may be related to the genetic, race, life, study and work habits of the Asian population. At present, the global prevalence rate of myopia is 28.3%, and it is rising. Through data analysis, it is estimated that it will reach 39.9% in 2030 and 49.8% in 2050[5]. Through the literature review of foreign children and adolescents myopia, it is found that with the increase of grade or age, the myopia rate and detection rate of children and adolescents are increasing, and the myopia rate of foreign children and adolescents is lower than that of China. Studies have shown that , the range of foreign youth

myopia rate is about 4.47% ~ 49.7%, of which the myopia rate of American primary and secondary school students is only 10%[6,7][8]. According to the data of the National Health Commission, in 2018, the myopia rate of Chinese teenagers was 53.6%, higher than that of foreign teenagers, ranking first in the world. Domestic scholars have shown that the prevalence of juvenile myopia in China is very high. Through combing the relevant domestic literature, the prevalence of juvenile myopia is usually 38.37% - 88.78%. Kang Zefeng and others searched the database to obtain the epidemiological data of myopia in Chinese adolescents, and conducted a meta-analysis on the prevalence of myopia[9]. The results showed that the prevalence of myopia in Chinese adolescents was 38.37%. Chen Yan and others used a cross-sectional survey to study the prevalence and influencing factors of myopia among middle school students in Beijing[10]. The results showed that the total prevalence of myopia was 83.4%, including 77.8% of junior high school students and 88.78% of senior high school students. The prevalence of myopia increased with the increase of grade. Zhou Jia and others evaluated the prevalence and influencing factors of myopia among primary and secondary school students in China[11]. Using multi-stage cluster sampling method, one province or municipality directly under the central government was selected according to six administrative divisions in China, and 10 middle schools and 10 primary schools were selected from each city. It was found that the prevalence of myopia in 6-8 years old group, 10-12 years old group, 13-15 years old group and 16-18 years old group was 35.8%, 58.9%, 73.4% and 81.2% respectively, showing an obvious upward trend with the increase of age. The myopia rate of middle school students was significantly higher than that of primary school students. The incidence of myopia. In addition, Dayan's study showed that the prevalence of myopia in adolescents aged 16 to 22 increased from 20.3% in 1990 to 28.3% in 2002[12]. A study conducted in Hong Kong suggests that the age of myopia and refraction of students has been advanced from 10-11 years old in 1980 to 7-8 years old[13]. The above studies at home and abroad indicate that the incidence rate of myopia in children and adolescents has the following characteristics, that is, a certain geographical location, high prevalence rate, high growth trend and age of onset.

2 Influencing factors of myopia in children and adolescents

The influencing factors of myopia in children and adolescents have been a hot research topic of experts and scholars at home and abroad. The occurrence of myopia in children and adolescents is often not caused by a single factor, but is usually the result of multiple factors

2.1 Genetic factors

A large number of studies have shown that genetic factors are closely related to the occurrence of myopia, especially high myopia. High myopia, also known as pathological myopia, is usually caused by the change of ocular matrix and the extension of ocular axis. High myopia usually shows strong heredity, and also shows different differences in different races[14]. Studies have found that there is a strong correlation between parents and offspring in refractive power and other ocular biological parameters such as cornea, lens, anterior chamber depth[15]. When one of the parents was short-sighted, the incidence of myopia was 14.9%; When parents have no myopia, the incidence of myopia in their children is only 7.6%[16]. Foreign scholars Saur and others have studied the prevalence of hereditary myopia in Malaysian families, which shows that the prevalence of myopia in children and adolescents whose parents are both myopia is as high as 90%, while the prevalence of myopia in children and adolescents whose parents are myopia is only 25%[17]. In addition to the familial inheritance of myopia, Lam study suggests that the inheritance of myopia is also related to race[18]. The results suggest that the prevalence of myopia in Hong Kong students is higher than that in European (white) students. Although the pathogenesis of high myopia is not clear, it has been recognized that genetic factors play a decisive role in the occurrence of familial high myopia. However, school-age children and adolescents myopia is mainly caused by reading and writing environment, which is less affected by genetic factors.

2.2 Gender

A large number of studies at home and abroad have found that there are certain gender differences between myopia and gender in children and adolescents. In a three-year cohort study, foreign scholar Hyman found that the progress of myopia in

girls was faster than that in boys, with a difference of 0.16d in three years[19]. Guo and others conducted a vision survey on 20609 people in Taiwan and concluded that among the people under 40 years old, the myopia rate of women is significantly higher than that of men[20]. Domestic scholar Gao Qing and others conducted visual examination on primary school, junior high school and senior high school students in Liaoning Province[21]. The results showed that the myopia rate of girls (56.73%) was higher than that of boys (49.71%). This may be due to the fact that boys like sports activities and spend a relatively long-time outdoor activities, while most girls do not like sports activities and are quiet. They spend a relatively long time reading and studying and are tired of using their eyes. Du Tian and other studies also showed that the myopia detection rate of female students (58.52%) was higher than that of male students (54.31%)[22]. This may be related to the personality differences between boys and girls. During compulsory education, most girls have stronger self-discipline, longer learning time and less outdoor activities than boys. Outdoor activities are recognized as an important factor to protect students' eyesight. The longer outdoor activities for boys, the lower the risk of myopia. In addition, it is also possible that the development of eyeball is faster than that of adolescent girls, which is greatly affected by environmental factors. At the same time, sex hormones have a certain impact on the cornea of eyeball. The level of estrogen in girls is significantly higher than that of men, which may play a certain role in the development of myopia[23].

2.3 Eye habits

Bad eye use habits and excessive eye use are the important influencing factors of myopia in school-age children and adolescents. School age children and adolescents need to use their eyes for a long time because of their heavy learning tasks. If they don't pay attention to using their eyes when reading and writing, they should pay attention to using their eyes for a long time. Long time continuous use of eyes without rest, do not pay attention to eye hygiene, such as reading and writing posture is not correct, long time use of electronic products or reading and writing in poor light environment, will lead to long-term fatigue of eyes, and lead to the formation of myopia. Domestic research suggests that the myopia rate of students who continuously use their eyes for more than 1 hour (46.8%) is higher than that of students who continuously use their eyes for less than 0.5 hour (23.1%)[24]. The more likely they are to be myopic if they do homework for more than 30 minutes without rest. The incidence rate of myopia among students who read more than 30cm is only 16.7%, while the proportion of students with short distance reading is less than 15cm. The proportion of students with myopia is as high as 38.9%, suggests [25]. In addition to long eye distance, electronic products are also an important factor affecting myopia. Electronic products have both advantages and disadvantages. On the one hand, they bring benefits to children and adolescents, including expanding their knowledge and enhancing their interest in learning; On the other hand, it also brings adverse effects, including damage to vision and other aspects of health. With the development of economy, the global smartphone penetration rate increased from 21.6% in 2014 to 34.7% in 2018 [26]. Research shows that reading and reading small font text on smart phones can lead to eye fatigue, blurred vision, dizziness and dry eyes[27]. Since 2020, COVID-19 has significantly increased the number of students using electronic products at home. There are reports that are increasing[28-29]. Dong Xiaopeng research suggests that the detection rate of myopia in students who use mobile phones more than 1 hour a day (50.6%) is higher than that in students who use mobile phones less than 0.5 hour a day (37.9%)[30]. Moreover, using electronic products in dark environment (or = 1.281, 95% *CI*: 1.005-1.633) and using mobile phone more than one hour a day (or = 1.458, 95% *CI*: 1.036-2.051) were risk factors for poor vision.For the use of electronic products for school-age children and adolescents, if we want to maximize its favorable role, we should not only make good use of the favorable aspects, but also control the adverse effects. Only by choosing excellent quality electronic products and strictly controlling the use time, can we reduce the negative effects as much as possible, so that children and adolescents can really benefit from electronic products.

2.4 Outdoor activities

Outdoor activities have always been a hot spot in the research on the influencing factors of myopia in children and adolescents. A large number of investigations have confirmed that outdoor activities

are one of the important measures for myopia prevention and control[31-35]. Increasing the duration of outdoor activities can effectively reduce the occurrence of myopia. In western countries, school-age children have about 2 hours of spare time for outdoor activities every day, and the myopia rate is far lower than that in China [36]. A meta-analysis of 2912 articles suggests that in nearly 10000 children and adolescents, there is a significant protective relationship between the increase of outdoor activity time and the prevalence of myopia[37]. The incidence of myopia decreased by 2% (or = 0.98) when the time spent outdoors increased by one hour per week, and the increase of 7 hours per week (1 hour / day) was the protective factor of myopia in children and adolescents. Lia cohort study in Anyang suggests that in non myopic children and adolescents, the increase of outdoor activity time can slow down the lengthening of eye axis[38]. In addition, the results of animal experiments show that relatively high outdoor light intensity and spectral composition of natural light may be the real protective factors for vision. Foreign studies suggest that chicks' eyes are exposed to the environment with slow change of brightness contrast, and the light source rich in blue light can slow down the growth of eye axis[39]. Jiang and other studies found that blue light can slow down the progress of optical defocus myopia in guinea pigs[40]. Foulds et al also found that chickens raised in blue light can develop hyperopia, and blue light irradiation can reverse the myopia caused by red light[41].

2.5 Eating habits

With the change of modern diet structure, food is more and more single and fine, children and adolescents prefer high sugar diet. At the same time, China's staple food is mainly cereals. Due to the high content of phytic acid in cereals, which affects the metabolism and absorption of zinc, and the high content of starch, the secretion of glucagon will be inhibited when the body's blood sugar is high due to long-term high glucose intake, which reduces the key growth factors coordinating the development of eyeballs, leading to the occurrence of myopia[42, 43]. A large number of studies[44-46] have shown that bad eating habits can lead to myopia, such as high sugar diet, preference for refined food, preference for picky food, eating too little hard food, eating a large number of fried barbecue food can lead to an increase in the prevalence of myopia. Zeng Yechun et al[47]. Showed that the average daily intake of calcium and iron in non myopia group was higher than that in myopia group, and the average daily intake of carbohydrate and sugar in myopia group was higher than that in non myopia group, and the differences were statistically significant ($P < 0.05$); At the same time, compared with the non myopia group, the myopia group did not like eating animal viscera, carrots, green vegetables and beans, which was significantly correlated with not eating animal viscera, green vegetables and carrots ($P < 0.05$).

3 Intervention measures for myopia in children and adolescents

The formation of myopia is a gradual and irreversible process[48]. Most newborn babies are hyperopia. With the growth and development, the refractive power of the eyeball increases, and gradually develops to emmetropia. In this process, it is easy to be affected by visual environment factors[49]. After excluding the uncontrollable factors such as genetic factors, in order to effectively reduce the prevalence of myopia and reduce the occurrence of myopia complications (cataract, glaucoma, myopic macular degeneration and retinal detachment, etc.), we should strengthen the health publicity and education of children and adolescents in the aspects of eye protection and prevention of myopia, and take the measures of prevention first and combination of prevention and control, so as to prevent and develop myopia early Early diagnosis and treatment can delay the occurrence and development of myopia.In recent years, scholars at home and abroad have done a lot of research on the intervention of myopia in children and adolescents.Through literature review, the current interventions for myopia in children and adolescents mainly focus on optical glasses, clinical intervention (drugs and surgery), behavioral intervention and health education, but there is still a lack of accurate and effective prevention and control methods that can be popularized.At present, the specific prevention and control measures are as follows.

3.1 Optical glasses

For children and adolescents who have myopia, the first step of myopia prevention and control is to fit a pair of appropriate glasses.Common optical glasses are mainly frame glasses and orthokeratology

glasses.Frame glasses are the most common optical intervention tool to control the development of myopia.When wearing glasses, eye position and adjustment force should be taken into account, and the principle of minimum degree of best corrected visual acuity should be followed.If the myopia is not corrected or not completely corrected, the peripheral retina will be in a state of relative hyperopia. Fuzzy imaging on the retina, that is, hyperopia defocusing state[50], Chen and other studies have confirmed that hyperopia defocusing state is an important mechanism of the occurrence and development of myopia, which can induce the growth of ocular axis[51]. Orthokeratology lens, commonly known as OK lens, is a good optical tool to control the progress of myopia.It is a special geometric inversion rigid permeable contact lens. It can flatten the cornea to make the central epithelium thin, reduce the central curvature of the cornea, thicken the central epithelium and corneal stroma. After wearing it at night, the naked eye vision is clear during the day, and the hyperopia and defocus can be controlled to control the development of myopia. A large number of studies have shown that wearing orthokeratology lenses regularly can greatly improve the daytime naked eye vision, and long-term wearing can effectively control the progress of myopia in adolescents[52-56].With the continuous improvement of the technical level, the safety of wearing orthokeratology has also been confirmed by a large number of domestic and foreign scholars[57]. Orthokeratology is highly concerned by ophthalmologists and myopic patients because of its good control effect and high safety.

3.2 Clinical intervention

As an intervention method for myopia, drugs mainly include atropine, pirenzepine and 7-methylxanthine, among which atropine has been recognized to prevent and control myopia. Ren Qiujin et al Analyzed the effect of low concentration atropine on the development and control of myopia in adolescents, and found that low concentration atropine can help to improve diopter and axial length, especially the effect is significant, but the disadvantage is that there may be some problems Now the adverse reactions, such as glare, blur, allergy and other symptoms.In addition to drugs, surgery is a more common and thorough method in the treatment of myopia.Myopia corneal refractive surgery is also widely used in the treatment of myopia, commonly used are excimer laser in situ keratomileusis and whole femtosecond laser refractive surgery, but the principle of laser surgery is to thin the central cornea, so laser surgery can not be done more.In addition, there are strict age requirements for myopia surgery. Because the diopter of minors is unstable, laser surgery is not suitable for the treatment of myopia in children and adolescents.

4 Conclusion

In conclusion, through combing the literature at home and abroad in recent ten years, it is found that the relevant research on the influencing factors of children and adolescents myopia at home and abroad is basically consistent, mainly focusing on genetic factors, eye habits, outdoor activities. In contrast, foreign studies focus on the prevalence of myopia in children and adolescents, while domestic studies not only describe the prevalence trend, but also focus on the intervention measures of myopia in children and adolescents, suggesting that the current situation of myopia in children and adolescents in China is worrying, and effective prevention and intervention are urgently needed. Based on the literature review of myopia intervention in children and adolescents, it is found that myopia intervention in the world mainly focuses on optics, clinic, behavior and health education. The large-scale prevalence of myopia in children and adolescents has become a global public health problem, and how to effectively prevent and control myopia has also become an important research topic. It is suggested that the government, schools, hospitals and families should cooperate to carry out comprehensive intervention, focusing on prevention and paying equal attention to treatment. The government should establish and improve the rules and regulations for the prevention and control of myopia, and strictly control the growth of the incidence of myopia in children and adolescents; The school should optimize the curriculum arrangement, pay attention to the all-round development of "morality, intelligence, sports, beauty and labor", and carry out health education at the same time, so that children and adolescents can understand the knowledge of myopia prevention and control; The hospital standardized the treatment of myopia, and carried out clinical intervention on myopia children and adolescents to slow down the growth of myopia

degree; In the family, parents should set an example, guide students to take active outdoor activities and physical exercise, use electronic products correctly, and form a good habit of using eyes.

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