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A Summary of the Effect of Physical Exercise on Myopia in Children and Adolescents

Yaohui Ye

Taizhou University, Taizhou, China
Email: 602812652@qq.com

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Abstract

Myopia is a highly prevalent refractive error, which develops rapidly in children and adolescents. Children's myopia is not a common problem and has gradually evolved into a global problem. It is particularly prominent in China. According to the statistics of the Ministry of health, China's youth myopia rate ranks first in the world. The wide spread of myopia has become a medical problem, but it has also become one of the problems that seriously endanger Chinese public health. In the past decade, studies on myopia in children and adolescents have shown that increasing homework and reducing physical activity are the main risk factors for myopia in children and adolescents. A large number of experiments show that children and adolescents can effectively reduce the incidence rate of myopia through certain exercises. The main reason is that reducing close work and sunlight exposure will increase the synthesis of dopamine, which can prevent the occurrence of myopia. It is an important guarantee for young people to keep their eyesight healthy in their daily study and life. However, the age of young people's myopia is getting younger and more common, which seriously affects the development of young people and society. This paper starts with the correlation between the concepts of physical exercise and myopia and teenagers' approximation, discusses the influence of physical exercise on improving teenagers' approximation, and puts forward some specific causes of myopia harm and induction, analyzes the situation of myopia and exercise of teenagers in China at the present stage, and finally explains the correlation between exercise and myopia and summarizes it. It is hoped that society can pay attention to the importance of exercise and exercise can effectively alleviate the process of teenagers' approximation, Promote the healthy growth of teenagers.

Subject Areas

Physical Education

Keywords

Physical Exercise, Myopia in Children and Adolescents, Influence

1. Introduction

Myopia treatment is an important health problem that affects the health, eyesight, physical condition and national security of children and adolescents. Put the physical and mental health of children and adolescents in a more prominent position, and serve the construction of a strong country in education, sports and health. In accordance with the requirements of the implementation plan for comprehensive prevention and control of myopia among children and adolescents (hereinafter referred to as the implementation plan), firmly establish the educational concept of "health first", adhere to comprehensive prevention and control, scientific prevention and control, accurate prevention and control, and effective prevention and control, and implement a number of special actions. We will improve the prevention and control of myopia among children and adolescents. We will strengthen the party's overall leadership, and the government, schools, medical and health institutions, students, families, and society will work together to guide the whole society to establish a correct outlook on health, education, and success, to form a life and learning style, education and management mechanism, and a good social environment conducive to the vision health of children and adolescents, and to effectively improve the vision health level of children and adolescents. At present, the research on myopia mainly focuses on the incidence of myopia and the factors affecting myopia. On the basis of the investigation on the vision of teenagers, this topic includes the myopia rate of teenagers, and further analyzes the main factors affecting the myopia of teenagers, especially sports.

2. Definition of Relevant Concepts

2.1. Physical Exercise

Physical exercise refers to the physical activities that people choose themselves according to their physical needs, use various physical means, and combine natural forces and health measures to develop their bodies, improve their health, strengthen their physiques, regulate their spirits, enrich their cultural life and dominate their leisure time [1]. To achieve this goal, it is necessary to use various sports means and methods in this process, and combine natural forces and necessary health measures [2].

2.2. Myopia

When the eye adjustment is relaxed, the external direct light enters the eye, and its focus only falls on the retina, forming a clear image called emmetropia; if the focus cannot fall on the retina, it is called non emmetropia therapy, that is, ame-

tropia. Myopia is a kind of refractive error. When the external parallel light enters the eye, its focus falls in front of the retina and cannot form a clear image, it is called myopia [3] (**Picture 1**).

3. The Harm and Inducement of Myopia

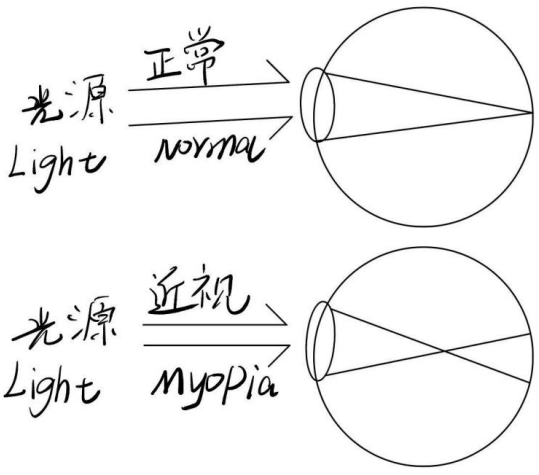
3.1. Hazards of Myopia

3.1.1. Social Hazards

The prevalence of myopia has a great impact on the prosperity and development of the country and society. According to the report of the research team of Peking University, the social and economic cost caused by various types of vision defects in 2012 reached about 560 billion yuan, accounting for about 1.1% of GDP [4]. At present, the rate of poor eyesight is aging, and the problem of conscription is prominent. When the army recruits, the requirements for eyesight have to be lowered many times.

3.1.2. Personal Hazards

Myopia causes serious harm to the visual health of teenagers. Once it is confirmed as myopia, the shape of the eyeball has changed, and this change is irreversible. If we do not pay attention to protection, the degree of myopia will be further deepened [5]. Moderate and low myopia will increase the probability of complications, while high myopia is often accompanied by serious complications such as visual macular degeneration, retinal detachment, cataract and open-angle glaucoma [6]. Compared with those with normal vision, the quality of life of patients with high myopia will be impaired to a certain extent [7]. Myopia is hereditary, and the influence of contemporary children and adolescents will be transmitted to the next generation, which seriously threatens the future population quality of our country and the long-term prosperity and development of our country and society. Therefore, the prevention and control of myopia have become one of the many challenges in the field of public health in China.



Picture 1. Principle diagram of myopia.

3.2. Incentives for Myopia

Myopia refers to when the eyeball is relaxed and adjusted; the directional light enters the eye, concentrates in front of the retina, and observes indefinitely. The main performance is that the far vision is decreased, but the near vision is normal, which is prone to visual fatigue. Although there is no clinical description of the top ten causes of myopia, the causes of myopia are mainly related to genetic factors, environmental factors, personal factors, eating habits, and so on.

3.2.1. Genetic Factors

Myopia may be inherited in a certain family. If parents have high myopia in a family, the incidence rate of myopia in the next generation of the family will be very high. The heredity of myopia mainly depends on the degree of myopia of both parents. If both parents are highly myopic, the heritability is greater than 50%. If one of the parents is high myopia, the heritability is also close to 30%. If both parents have no myopia, the genetic rate of myopia will reach about 5% to 10%.

3.2.2. Environmental Factors

If you read or work in a place where the light is too strong or too weak, your eyes may not be able to see the fonts or things clearly, which may lead to eye fatigue and myopia.

3.2.3. Personal Factors

Long-term daily use of the eyes, especially when carefully observing or reading electronic products, may cause spasm of the fundus muscles, which may lead to myopia. In addition, reading can also set the distance between the eyes and the books on the moving or walking vehicle. If the current light conditions are not good, it will also increase the eyeball load, leading to myopia. Moreover, reading lying in bed and various other wrong writing postures and reading styles can lead to myopia. It is necessary to pay attention to the correctness of using eyes in daily life, read books at a proper distance and under light, and control the time of using electronic products to reduce the damage to eyes.

3.2.4. Dietary Factors

During the development of children's vision, an unbalanced diet may lead to a lack of vitamins, proteins and trace elements in the body, which may also affect the development of children's vision, and may further cause the occurrence of myopia. In terms of diet, you can eat as many fruits and vegetables rich in various vitamins as possible. Foods rich in vitamin A and vitamin C have certain resistance to the induction of myopia.

4. Research Status of Vision of Children and Adolescents in China

4.1. Current Situation of Vision Level of Children and Adolescents

The myopia of children and adolescents in China has been particularly serious in

recent years. In 2018, the Ministry of education and the National Health Commission carried out a survey on the myopia of children and adolescents in China. The survey data showed that the overall myopia prevalence rate of children and adolescents in China was 53.6%, including 14.5% of 6-year-old children, 36% of primary school students, 71.6% of junior high school students, and 81% of high school students. The incidence of myopia is severe [8]. Since then, on August 30, 2018, the Ministry of education and other eight departments jointly issued the implementation plan for comprehensive prevention and control of myopia in children and adolescents. Fortunately, through eight special intervention measures, the myopia rate of children and adolescents has decreased year by year and has been improved to a certain extent. In 2020, due to the outbreak of the epidemic, the prevalence of myopia in children and adolescents increased slightly. The team of Professor Li Ling of Peking University released the report on prevention and control of myopia in children and adolescents in the information age. The report clearly pointed out that the overall prevalence of myopia in children and adolescents in China has exceeded 60%, and the number of myopia patients in China will reach at least 960 million in the future [9].

4.2. Demographic Differences in Visual Acuity of Children and Adolescents

4.2.1. Gender

In the study of gender differences in vision of children and adolescents, there are differences in the rate of poor vision between male and female students, and the rate of poor vision of girls is higher than that of boys. Long Peipei and others randomly selected six middle schools and six primary schools in Chongqing, and conducted visual examination, questionnaire survey and statistical analysis on 11878 students. The study found that the poor visual acuity rate was 56.4% for girls and 50.6% for boys, and the poor visual acuity rate of girls was higher than that of boys [10]. The survey in Anhui Province shows that the poor vision rate of male and female students is 45.50% and 50.90% respectively, with statistical difference [11]. The poor vision rate of male and female students in Sichuan Province is 48.8% and 55.8% respectively. The poor vision rate of female students is also higher than that of male students, and the average vision is lower than that of male students [12].

4.2.2. Age

In the study of age differences in children's and adolescents' vision, the rate of poor vision in children and adolescents continues to increase with age. According to the survey report on vision of children and adolescents carried out in China in 2018, the overall prevalence of myopia among children and adolescents in China is 53.6%, including 14.5% for 6-year-old children, 36% for primary school students, 71.6% for junior high school students and 81% for high school students [8]. The research group of students' vision in different regions also found that the poor vision rate of children and adolescents is proportional to

their age, and the older they are, the higher the poor vision rate is. Wen Yuechun and others investigated and analyzed the situation of 5055 students in four counties of Anhui Province. The results showed that the poor vision rate of primary school students, junior high school students and senior high school students were 25.47%, 60.00% and 79.90% respectively [11].

4.2.3. Urban and Rural Areas

In the study of the urban-rural differences in the vision of children and adolescents, there are differences in the poor vision rate between urban and rural students. The poor vision rate of urban students is higher than that of rural students, and the average vision is lower than that of rural students. Liang Jing and others analyzed the physical examination data of 9991 students in 8 high schools in Yixing City, Jiangsu Province, and found that the poor vision rate of 9991 high school students was as high as 95.24%. The poor eyesight rate of urban students is higher than that of rural students [13]. The poor vision rate of primary and secondary school students in urban and rural areas in Xi'an is 68.8% and 42.3% respectively, and the poor vision rate of urban students is significantly higher than that of rural students [14]. The poor vision rate of urban and rural students in Sichuan Province is 59.6% and 44.5% respectively, and the average vision of urban students is lower than that of rural students [12].

5. Current Situation of Research on Physical Exercise of Children and Adolescents in China

5.1. Current Situation of Physical Exercise Level of Children and Adolescents

With the gradual improvement of the attention of all social parties to the physical health of children and adolescents, and the inclusion of physical education in the secondary school entrance examination, and the gradual improvement of the scores of physical education subjects in the secondary school entrance examination, the level of physical exercise of Chinese adolescents has also significantly increased. In 2007, the CPC Central Committee and the State Council issued the opinions on strengthening physical training for teenagers, requiring schools to strictly implement the national curriculum standards to ensure the high quality of physical education. If physical education classes are not held on the same day, after-school classes should be arranged so that each student can exercise for 1 hour every day. The physical activity guide for Chinese adolescents published in 2017 also recommends that moderate and high-intensity physical activities greater than 60min per day will bring more health benefits [15]. However, due to academic and other reasons, children and adolescents in China do not have enough time for physical exercise every day. A survey across different regions and ages shows that only 21.8% of children and adolescents exercise more than one hour a day, and the proportions of children and adolescents in Beijing, Wuhan and Shenyang exercise more than one hour a day are 31.2%, 14.5% and 24.1% respectively [16]. Yang Yang *et al.* conducted a survey on the physical ex-

ercise of 12,646 primary and middle school students aged 9 to 18 in Shanghai through a questionnaire. The results showed that the proportion of primary and middle school students exercising more than one hour per day was 40.2%, and the proportion of primary school, junior high school and high school students exercising more than one hour per day was 60.9%, 39.0% and 19.1% respectively [17].

5.2. Demographic Differences in Physical Exercise Levels of Children and Adolescents

5.2.1. Gender

The research on the gender difference of physical exercise levels of children and adolescents shows that the proportion of boys' physical exercise duration greater than 1 hour is higher than that of girls. According to the research data of Yang Yang and others, the proportion of girls' physical exercise longer than 1 hour per day in primary schools, junior middle schools and senior high schools in Shanghai is 59.6%, 36.6% and 15.6% respectively, and that of boys is 62.2%, 41.3% and 22.7%. The proportion of boys' physical exercise longer than 1 hour per day in the three school stages is higher than that of girls [17]. Song Yinan conducted a questionnaire survey on 10,972 students in the second grade of primary school, the first grade of junior middle school and the first grade of senior high school in the urban area of Guangzhou. The results showed that the proportion of male and female students exercising more than 1 hour a day was 19.36% and 9.49% respectively [18].

5.2.2. Age

The research on the age difference of physical exercise level of children and adolescents shows that the higher the school stage is, the less the physical exercise duration is, and the age is inversely proportional to the physical exercise duration of children and adolescents. Ding Xiaoyan and others selected 14 schools in six urban areas of Nanjing and conducted a questionnaire survey on 4161 students in these schools. The results showed that the proportion of physical exercise more than 1 hour per day in primary schools, junior middle schools and senior high schools in urban areas of Nanjing was 20.99%, 11.06% and 9.94% respectively [19]. Yang Yang *et al.* also found that with the growth of children and adolescents' school period, the proportion of physical exercise more than 1 hour per day is constantly decreasing. The proportion of physical exercise more than 1 hour per day of primary school, middle school and high school students in Shanghai is 60.9%, 39.0% and 19.1% respectively [17].

5.2.3. Urban and Rural Areas

The research on the urban-rural differences in the physical exercise level of children and adolescents shows that there are differences in the length of physical exercise between urban and rural students. Wang Bin *et al.* selected 6401 primary and secondary school students aged 9 - 18 in Tianjin by stratified cluster random sampling and conducted a questionnaire survey. The results showed

that the proportion of physical exercise more than 1 hour per day for senior primary school students, junior middle school students and senior high school students in rural areas was 26.8%, 30.5% and 13.8% respectively, and 45.6%, 24.3% and 9.4% in cities. The proportion of physical exercise more than 1 hour per day for junior middle school students and senior high school students in rural areas was higher than that in cities. The proportion of senior students in rural primary schools who exercise less than half an hour a day is higher than that in cities [20].

6. The Effect of Physical Exercise on Myopia in Children and Adolescents

6.1. Cross Sectional Study of Physical Exercise on Myopia in Children and Adolescents

The results of the correlation between the time of physical exercise and the prevalence of myopia in children and adolescents showed that the time of physical exercise in students with normal vision was longer than that in students with myopia. Other researchers have also found that the time of physical exercise every day is a protective factor for the eyesight of primary and middle school students when analyzing the influencing factors of poor eyesight of primary and middle school students in Lanzhou and Hefei. The proportion of myopia of students with daily physical exercise time less than 30 min is significantly higher than that of students with daily physical exercise time more than 30 min [21]. Yang Biansheng *et al*. showed that the detection rate of suspected myopia was 54.27% and 61.62% for students who exercised more than 1 hour and less than 1 hour every day, with a significant difference ($P < 0.01$) [22]. Chen Dingyan and others conducted a questionnaire survey on 3952 senior one students. The results showed that students with normal eyesight had better physical activity than those with myopia. In the last seven days, they participated in intensive physical exercise for at least three days. The students with normal eyesight and myopia accounted for 32.63% and 26.06% respectively; In the last 7 days, the students who participated in moderate intensity physical exercise for at least 3 days accounted for 36.45% and 29.33% respectively. And through multivariate analysis, it was found that taking part in moderate intensity physical exercise was a protective factor for vision [23].

In conclusion, there is a close relationship between physical exercise and the prevalence of myopia in children and adolescents. Taking part in physical exercise is beneficial to the visual health of children and adolescents.

6.2. Intervention Study of Physical Exercise on Myopia in Children and Adolescents

Appropriate physical exercise is not only conducive to physical health, but also a protective factor for children and adolescents' vision. As early as more than 20 years ago, Wang Jie and others have begun to explore the role of table tennis in

improving vision. 23 sophomores conducted table tennis training for two semesters, no less than 10 weeks per semester and no less than 30 minutes per week. Before and after the experiment, students' naked eye vision and corrected vision have been significantly improved [24]. Song Shaoxing *et al.* conducted table tennis training for 61 students in a sports school for 3 years (4 times a week, 1.5 h each time), and selected 61 students in a primary school as the control group. Thirty myopic students in sports schools were selected to observe the effect of table tennis training on the progress of children's myopia. The study found that children who have long-term table tennis training have better eyesight than those who have not trained. Children who have suffered from myopia have significantly improved their eyesight after 3 years of table tennis training [25]. Hu Chaoxia found that participating in table tennis, basketball and middle and long-distance running training has a beneficial impact on the vision of children and adolescents, among which table tennis has the best effect on improving the vision of children and adolescents [26]. Xiao baijuan also found that the effect of table tennis on improving pseudomyopia in children and adolescents is better than that of middle and long distance running, [27]. Zhang Zeyu found that after 12 weeks of table tennis training, the visual acuity of the experimental group was significantly higher than that of the control group, and the difference between the experimental group and the control group was extremely significant. The retest results showed that the visual acuity of those who insisted on table tennis training continued to improve, and the visual acuity of those who gave up decreased compared with that at the end of the experiment [28].

To sum up, physical exercise can improve the vision of children and adolescents to a certain extent. Foreign studies mostly describe the current situation of myopia epidemiology, and there are few studies on physical exercise to prevent and control the vision of children and adolescents [29]. At present, the intervention research of physical exercise on children and adolescents in China is mostly focused on table tennis, badminton, basketball, football and middle and long-distance running. Among them, table tennis has the best effect on improving children and adolescents' visual acuity, especially for children and adolescents with pseudomyopia.

7. Summary

At present, the rate of poor eyesight of children and adolescents in China remains high. The rate of poor eyesight of girls is higher than that of boys. The rate of poor eyesight of men and women increases with the age. The rate of poor eyesight of urban students is higher than that of rural students, and the average eyesight is lower than that of rural students. There is a serious shortage of physical exercise time for children and adolescents in China. It is still a long way to go to meet the requirements of medium and high-intensity physical activities of more than 60min per day recommended by the physical activity guide for Chinese adolescents. The proportion of male students exercising for more than one

hour is higher than that of female students. The proportion of male and female students exercising for more than one hour per day is decreasing with the growth of age. The proportion of rural junior high school and high school students exercising for more than one hour per day is higher than that of urban students. The proportion of rural primary school students exercising for less than half an hour per day is higher than that of urban students. There is a close relationship between physical exercise and the prevalence of myopia in children and adolescents. Taking part in physical exercise is beneficial to the visual health of children and adolescents.

8. Innovation and Research Contribution of This Paper

This paper systematically reviews the current situation in the field of research on the influence of physical exercise on the eyesight of adolescents and children. Starting from the causes and harms of myopia, it analyzes the status of myopia and physical exercise of Chinese adolescents and children, and finds that the shortcomings of the current research are mainly reflected in the following aspects:

1) Most cross-sectional studies at home and abroad focus on the impact of physical exercise duration on the eyesight level, while few studies focus on the effects of different intensity, frequency the effect of continuous physical exercise on the eyesight of children and adolescents.

2) Most of the visual acuity measurement methods used in relevant studies are questionnaire survey or "e" type visual acuity chart, lacking more accurate examination methods, such as cycloplegia optometry. Especially when pseudomyopia is common in children and adolescents, inaccurate visual acuity examination may cause great bias to the study.

3) Cross sectional studies show that children and adolescents with normal vision have longer exercise time than myopic students. However, there are few studies on the effect of physical exercise on the development of vision of myopic children and adolescents, and most studies have not distinguished between true myopia and pseudomyopia.

Conflicts of Interest

The author declares no conflicts of interest.

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