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• Review Article •

Pay attention to the role of outdoor activities after school in the prevention of myopia and the physical and mental development of adolescents

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HIGHLIGHTS

- Encouraging students to engage in outdoor activities during after-school care offers multiple benefits, including promoting physical and cognitive development in preadolescent children and contributing to myopia prevention.
- Based on a review of published literature, we conclude that participating in outdoor activities during after-school care not only promotes physical health but also effectively helps prevent myopia.
- Future educational and public health initiatives should prioritize the role of outdoor activities in after-school care, fostering collaboration between schools and families to encourage children's physical activity and ensure their holistic growth and well-being.

Abstract: Myopia, a common cause of visual impairment, together with the global decline in physical fitness and increasing prevalence of childhood obesity, has become a prominent global health problem. The beneficial effect of increasing the time of outdoor activities on the incidence of myopia and physical well-being in children has been widely recognized. However, in countries with highly competitive education systems, such as China, parents and school administrators may be reluctant to increase their children's time for extracurricular outdoor activities for fear of affecting their academic performance. Therefore, it is crucial to accurately assess the role of after-school outdoor activities in preventing and controlling myopia, as well as in promoting the physical and mental development of adolescents. Schools and families should be encouraged to collaboratively support children's engagement in outdoor activities to foster their healthy growth.

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Full Text

Given the dual benefits of outdoor activities—improving visual health and promoting overall physical and mental well-being—it is essential to encourage schools and families to work together to support children's engagement in such activities. By doing so, it is hoped that a balanced environment can be created, one that values both academic achievement and healthy development. Policymakers, educators, and parents must recognize the long-term advantages of integrating outdoor activities into children's daily lives, as this approach can help alleviate the burden of myopia, enhance physical fitness, and support emotional and cognitive development. Ultimately, fostering a culture that views outdoor activities as an essential component of education and health will be key to ensuring the well-rounded development of future generations.

Keywords: after-school care; child development; myopia; academic achievement; outdoor activities

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Myopia is highly prevalent globally, especially in East and South-East Asia countries,^[1-5] where the prevalence among young individuals who have completed 12 to 13 years of education has soared to 70 to 90 %, compared to 20 to 30% two or three generations ago. Furthermore, the prevalence of high myopia (SE < -6 D) and underlying pathological myopia is about 10% to 20%. It is predicted that by 2050, nearly 50% of the global population may be myopic, with about 10% highly myopic.^[6] Most risk factors for myopia are associated with outdoor activities, whether proximal (those closely related to relevant biological pathways that regulate eye growth, such as exposure to bright light or retinal defocus) or distal (factors influencing exposure patterns, such as attitudes toward children's time spent outdoors after school, on weekends, or during the holidays).^[7] A reduction in outdoor activity not only correlates with a decline in physical fitness but also with an increase in childhood obesity, both of which are significant consequences associated with reduced levels of physical activity. Our study indicates that increasing outdoor physical activity can enhance physical fitness and decrease the incidence of myopia without compromising academic performance.^[8] However, Chinese school-age children still allocate little time to outdoor activities, which may be primarily be attributed to a combination of heavy academic pressure, restricted urban activity space, the allure of electronic devices, inadequate awareness of the importance of outdoor activities, air quality issues,

and extreme weather conditions. Therefore, we advocate for increasing the proportion of outdoor physical activities within the framework of outdoor trusteeship for primary and secondary school students.

THE EFFECT OF OUTDOOR ACTIVITIES ON MYOPIA

The effect of outdoor activities in preventing myopia has been substantiated by existing research. A three-year randomized controlled trial revealed that students who spent more time outdoors exhibited significantly lower rates of myopia compared to those in the control group, indicating that increasing outdoor time during the school year can effectively decrease the incidence of myopia. Furthermore, children in the intervention group experienced a lesser increase in myopia than their counterparts in the control group, suggesting additional time spent outdoors may help slow the progression of myopia. These results indicate that enhancing the amount of the time spent outdoors during school hours can not only diminish the incidence of myopia but also attenuate its rate of increase.^[9] A prospective cohort study conducted among school-age children in northeast China demonstrated that those who spent more time outdoors had a markedly lower incidence of myopia than the control group, and their myopia progressed less than that of the control group.^[10] Additionally, a randomized controlled study involving 693 first-year students from

16 schools showed that students in the intervention group, who were exposed to at least 11 hours of outdoor time per week under light intensity of 1000lux or more, experienced significantly reduced myopia progression and axial elongation of the eye ($P < 0.002$ or $P < 0.003$), compared to the control group. The risk of rapid myopia progression was reduced by 54% ($P < 0.003$); notably, this myopic protection was significant for both non-myopic and myopic children.^[11] Moreover, a prospective cohort study called "Tian-Tian 120" conducted by the Taiwan School Student Visual Acuity Screen (TSVAS) showed that taking students outdoors for 120 minutes a day reduced the prevalence of vision loss among students in grades 1 through 6, thereby reversing the previous long-term upward trend.^[12] Myopia is becoming increasingly prevalent among school-age children, and engaging in after-school outdoor activities can, to a certain extent, prevent and slow the progression of myopia. This suggests that outdoor activities and sports may increase children's exposure to outdoor light, thereby contributing to the healthy development of the eyes and reducing the onset and progression of myopia.

THE EFFECT OF OUTDOOR ACTIVITIES ON PHYSICAL DEVELOPMENT

There is compelling research evidence indicating that outdoor activities confer significant health benefits. According to data from the 2014 National Student Physical Fitness and Health Survey, children who engage in more than one hour of physical activities daily, particularly outdoor activities, demonstrate a pass rate in comprehensive physical fitness tests that is 0.41 times higher than that of children who participate in less than one hour per day.^[13] Furthermore, a systematic review encompassing 89 studies has revealed that school-based outdoor activities interventions are linked to enhanced physical health outcomes, specifically manifesting as increased maximal oxygen uptake in children and adolescents.^[14] Additionally, it has been established that students who participate in outdoor activities exhibit improved physical health, along with a notable reduction in body mass index (BMI) and body fat percentage throughout the academic year. This underscores the

positive role that outdoor activities in preventing obesity and fostering a healthy lifestyle.^[8] Outdoor activities make a substantial contribution to children's physical health, and by participating in a diverse range of sports, children can not only enhance their physical fitness but also mitigate the risk of obesity and associated chronic diseases. Regular engagement in outdoor activities improves children's cardiac and pulmonary function, muscle strength and coordination, which is particularly crucial for growing children.

THE EFFECT OF OUTDOOR ACTIVITIES ON BRAIN DEVELOPMENT

The available randomized controlled trials examining the effects of increased outdoor activities on academic achievement are limited and exhibit considerable heterogeneity in terms of sample size, participant characteristics, and study duration. One meta-analysis revealed that outdoor activities resulted in a 1.12 points increase in math scores compared to control groups. However, it is noteworthy that three out of the four included randomized controlled trials had follow-up periods of less than two months.^[15] Evidence from other long-term follow-up studies regarding the impact of increased outdoor activities time on academic achievement is inconsistent, with two trials reporting no significant effect^[16-17] and three trials finding a beneficial effect on math achievement in elementary school children.^[18-20] These improvements in academic performance are partly attributed to the positive effects of outdoor activities on cognitive functions, including enhanced attention and memory. Additionally, studies have also shown that participation in extracurricular outdoor sports for one academic year does not negatively impact math achievements.^[8] According to research, academic success is linked to cognitive functions such as memory, perception, intelligence, and action processes. Engagement in outdoor physical activity increases blood flow to the brain, promotes neuron growth and connectivity, and consequently enhances cognitive function and learning ability. Furthermore, outdoor physical activities have been shown to improve children's attention, memory and executive function.

THE CURRENT EDUCATION SYSTEM DOES NOT PAY ENOUGH ATTENTION TO OUTDOOR ACTIVITIES

Existing research indicates that the age range of 7-9 years old in primary school is a high-incidence stage for myopia. The primary school curriculum typically consists of 6-8 class hours per day, with a 10-minute break between each class, including a "big break" lasting 30 minutes. However, the elementary school curriculum does not guarantee two hours of outdoor activities a day.^[21-22] Since 2018, many provinces and cities have initiated after-school care services.^[23] As announced by the Guangdong Provincial Department of Education, Tianhe District has established a new model for after-school care and fully implemented these services in line with the approach of "utilizing school resources as the primary means and supplementing with external resources". On the basis of parents' voluntary choice and the principle of not increasing the schoolwork burden on primary school students, two types of after-school care services are provided: "free care and personalized service". The first type is the free basic hosting service, which is supervised by the teachers from the school and primarily focuses on student safety and homework completion. This service runs from the end of the school day until 6 p.m. The second type is the paid hosting service, designed to cater to the individual development of students. Third-party institutions are brought into the school to offer reading, science, technology, sports, art and other interest-based group activities according to students' interests and needs. These third-party institutions charge appropriate fees. Nevertheless, the content and format of after-school care are not mandatory with regard to addressing the risk factors for myopia. To some extent, after-school trusteeship has transformed into an "enrichment class" after regular school hours, with the majority of the content focusing on cultural (homework assistance) and art (music, gymnastics, calligraphy, painting) learning activities.

THE EXPLORATION OF CARRYING OUT OUTDOOR ACTIVITIES IN AFTER-SCHOOL TRUSTEESHIP

The primary reason for the limited time Chinese school-age children allocate to outdoor activities may

be attributed to the immense academic pressure, causing teachers, parents and students themselves to hesitate in dedicating excessive time to such activities, lest it adversely impacts their academic performance. To address this phenomenon, Zhongshan Ophthalmic Center embarked on a large-scale clinical trial to investigate whether increasing the duration of extracurricular physical activities influences the academic performance of primary school students. This study enrolled 2,032 children from 24 schools, who were randomly assigned to either the intervention group (12 schools, 1,012 children) or the control group (12 schools, 1,020 children). The intervention group participated in 2 hours of after-school program on weekdays, which included sports activities, while the control group had the autonomy to arrange their own extracurricular activities. At the conclusion of one school year, both groups were evaluated based on their math test scores, overall physical performance scores, and the incidence of myopia. In this randomized controlled trial, children who participated in an additional two hours of extracurricular sports activities after school did not exhibit inferior academic performance compared to those who had the freedom to schedule their extracurricular time over the course of more than one school year. Moreover, children in the intervention group demonstrated significantly higher physical fitness scores than their counterparts in control group. Nevertheless, due to the relatively brief follow-up period in this trial, outdoor physical activities did not significantly decrease the incidence of myopia. Initially, the trial was designed to assess the incidence of myopia at the end of the second school year. However, upon learning of the beneficial effects of extracurricular physical activities during a project workshop, the local government promptly issued policy guidance recommending the implementation of 2 hours of extracurricular physical activities across the county. This led to the premature termination of the trial. Despite this, the existing evidence is strong enough to indicate that incorporating two additional hours of extracurricular physical activities daily after school can positively impact the physical health of primary school children without compromising academic performance.

CONCLUSION

Guiding students to participate in outdoor activities

during after-school care exerts numerous positive effects on the physical and cognitive development of preadolescent children, as well as on the prevention of myopia. Regular participation in such outdoor activities not only promotes physical health and enhances cognitive function, but also bolsters mental health and effectively mitigates the risk of myopia. Future education and public health policies should emphasize the significance of outdoor activities within after-school care programs and encourage schools and families to support children's outdoor exercise, thereby fostering their healthy development. The implementation of these measures must emphasize collaboration among schools, families, and society to create a cohesive approach and nurture a supportive external environment. Furthermore, governments at all levels should steer relevant policies and furnish the necessary resources and support to ensure that children can fully reap the health benefits afforded by outdoor activities.

PROSPECT

Further research is warranted in the future to elucidate the specific effects of various types of outdoor activities on different aspects of children's development, as well as to investigate the long-term effects of sustained participation in such activities, particularly with regard to myopia prevention. Only then can we gain a clearer understanding of the importance of after-school sports activities for children's holistic development, thereby providing a theoretical basis and practical guidance for formulation of more effective education and health policies. Moreover, examining the equity of children's participation in outdoor activities emerges as a crucial direction for future research. Exploring strategies to eliminate disparities in access to outdoor activity opportunities among children from diverse socio-economic backgrounds will be a pivotal consideration in practice. Only by ensuring that all children have ample opportunities for outdoor activities can we truly facilitate their healthy growth and comprehensive development.

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References

1. Dolgin E. The myopia boom. *Nature*. 2015, 519(7543): 276-278. DOI: 10.1038/519276a.
2. Morgan I, Rose K. How genetic is school myopia? *Prog Retin Eye Res*. 2005, 24(1): 1-38. DOI: 10.1016/j.preteyeres.2004.06.004.
3. Morgan IG, He M, Rose KA. EPIDEMIC OF PATHOLOGIC MYOPIA: what can laboratory studies and

- epidemiology tell us? *Retina*. 2017, 37(5): 989-997. DOI: 10.1097/iae.0000000000001272.
4. Morgan IG, Ohno-Matsui K, Saw SM. Myopia. *Lancet*. 2012, 379(9827): 1739-1748. DOI: 10.1016/s0140-6736(12)60272-4.
 5. Morgan IG, French AN, Ashby RS, et al. The epidemics of myopia: aetiology and prevention. *Prog Retin Eye Res*. 2018, 62: 134-149. DOI: 10.1016/j.preteyeres.2017.09.004.
 6. 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(5): 1036-1042. DOI: 10.1016/j.ophtha.2016.01.006.
 7. Morgan IG, Wu PC, Ostrin LA, et al. IMI risk factors for myopia. *Invest Ophthalmol Vis Sci*. 2021, 62(5): 3. DOI: 10.1167/iovs.62.5.3.
 8. Wang D, Xiong R, Zhang J, et al. Effect of extracurricular after-school physical activities on academic performance of schoolchildren: a cluster randomized clinical trial. *JAMA Pediatr*. 2023, 177(11): 1141-1148. DOI: 10.1001/jamapediatrics.2023.3615.
 9. He M, Xiang F, Zeng Y, et al. Effect of time spent outdoors at school on the development of myopia among children in China: a randomized clinical trial. *JAMA*. 2015, 314(11): 1142-1148. DOI: 10.1001/jama.2015.10803.
 10. Jin JX, Hua WJ, Jiang X, et al. Effect of outdoor activity on myopia onset and progression in school-aged children in NorthEast China: the Sujiatun Eye Care Study. *BMC Ophthalmol*. 2015, 15: 73. DOI: 10.1186/s12886-015-0052-9.
 11. Wu PC, Chen CT, Lin KK, et al. Myopia prevention and outdoor light intensity in a school-based cluster randomized trial. *Ophthalmology*. 2018, 125(8): 1239-1250. DOI: 10.1016/j.ophtha.2017.12.011.
 12. Wu PC, Chen CT, Chang LC, et al. Increased time outdoors is followed by reversal of the long-term trend to reduced visual acuity in Taiwan primary school students. *Ophthalmology*. 2020, 127(11): 1462-1469. DOI: 10.1016/j.ophtha.2020.01.054.
 13. Zhang JS, Yan XJ, Hu PJ, et al. Analysis on the trend of prevalence of excellent and good physical fitness and health status among Chinese Han students aged 13 to 18 years and related influencing factors from 1985 to 2014. *Zhonghua Yu Fang Yi Xue Za Zhi*. 2020, 54(9): 981-987. DOI: 10.3760/cma.j.cn112150-20191121-00877.
 14. Neil-Sztramko SE, Caldwell H, Dobbins M. School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. *Cochrane Database Syst Rev*. 2021, 9: CD007651. DOI: 10.1002/14651858.cd007651.pub3.
 15. Meli AM, Ali A, Mhd Jalil AM, et al. Effects of physical activity and micronutrients on cognitive performance in children aged 6 to 11 years: a systematic review and meta-analysis of randomized controlled trials. *Medicina (Kaunas)*. 2021, 58(1): 57. DOI: 10.3390/medicina58010057.
 16. Sallis JF, McKenzie TL, Kolody B, et al. Effects of health-related physical education on academic achievement: project SPARK. *Res Q Exerc Sport*. 1999, 70(2): 127-134. DOI: 10.1080/02701367.1999.10608030.
 17. Coe DP, Pivarnik JM, Womack CJ, et al. Effect of physical education and activity levels on academic achievement in children. *Med Sci Sports Exerc*. 2006, 38(8): 1515-1519. DOI: 10.1249/01.mss.0000227537.13175.1b.
 18. Donnelly JE, Greene JL, Gibson CA, et al. Physical activity across the curriculum (PAAC): a randomized controlled trial to promote physical activity and diminish overweight and obesity in elementary school children. *Prev Med*. 2009, 49(4): 336-341. DOI: 10.1016/j.ypmed.2009.07.022.
 19. Shephard RJ. Habitual physical activity and academic performance. *Nutr Rev*. 1996, 54(4 Pt 2): S32-6. DOI: 10.1111/j.1753-4887.1996.tb03896.x.
 20. Gao Z, Hannan P, Xiang P, et al. Video game-based exercise, Latino children's physical health, and academic achievement. *Am J Prev Med*. 2013, 44(3): S240-S246. DOI: 10.1016/j.amepre.2012.11.023.
 21. Xu RB, Gao D, et al. Analysis of the current status of outdoor activity time of Chinese students in 2016. *Chin J Child Health Care*. 2018, 26(3): 254. DOI:10.11852/zgetbjzz2018-26-03-07.
 22. Wang ZH, Dong YH, Song Y, et al. Analysis on prevalence of physical activity time <1 hour and related factors in students aged 9-22 years in China, 2014. *Zhonghua Liu Xing Bing Xue Za Zhi*. 2017, 38(3): 341-345. DOI: 10.3760/cma.j.issn.0254-6450.2017.03.013.
 23. Deng L, Zhang YF. Problems and optimization strategies in the selection of policy instruments for after-school services in China—an econometric analysis based on 27 provincial policy texts. *J Mod Educ*. 2022, (2): 46-55. DOI: 10.3969/j.issn.2095-6762.2022.02.008.