Outdoor Learning and Children's Eyesight

Richard Hobday

1 Background

In 2015, a news report entitled 'The Myopia Boom' appeared in the journal *Nature* (Dolgin, 2015). It proved highly influential, being one of the first articles to raise public awareness among a Western readership of an epidemic of myopia, or short sight, sweeping through countries in East and Southeast Asia. At the time, about 70–90% of children leaving secondary schooling in Chinese cities, and in Japan, Singapore, the Republic of Korea, Hong Kong and Taiwan, were becoming myopic. They required glasses, or other forms of correction, for clear distance viewing. Some of them—between 10 and 20%—had high levels of myopia which put them at high risk of losing their sight. A marked increase in myopia was apparent in the United States and Europe too. Around half of young adults were affected. This was double the prevalence of half a century earlier (Dolgin, 2015).

In 2016, it was estimated that if the rise of myopia was not stopped, by 2050 half the world's population, by then some 5 billion people, would be short-sighted. If so, about one billion of them will be highly myopic, and so risk losing their sight (Holden et al., 2016). High myopia is currently a major cause of blindness worldwide, especially in East Asia (Ikuno, 2017). There is growing recognition there of the huge social and economic burden the myopia epidemic will cause in the years ahead. One public health policy introduced in Taiwan, China, and other East Asian countries, is to make sure children go outside between lessons and at other times during the school day. Another is to reduce the amount of close work they undertake (Jan et al., 2020). Research is confirming what was widely believed over a century ago. Time spent outdoors in daylight prevents school myopia in children (Wu et al., 2020). Also, intensive, competitive education increases the risk of the onset and progression of the condition (Morgan et al., 2018).

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2 What Causes Myopia?

The great German astronomer Johannes Kepler (1571–1630) gave the first accurate explanation of myopia four hundred years ago. Kepler showed the condition is the result of abnormal lengthening of the eye. This makes light focus ahead of the retina at the back of the eye rather than onto it which results in blurred vision. Kepler also noted that short sight was more common among young people who spend a lot of time doing close work (Mark, 1971).

During the 19th century, when school attendance became compulsory in many countries, myopia became a common problem among children. However, the cause proved difficult to identify. There were many competing theories. Some eye experts argued that short sight was an entirely inherited condition. For them, there was no convincing evidence that close work, or any other aspect of school life, damaged children's eyesight. Others believed schools, and the way children were taught in them, were the cause. If so, 'school myopia' as it became known, was a preventable condition. Theirs became the dominant view; and so measures were put in place in schools to protect children's eyesight. The pioneer of this preventive approach was Professor Hermann Cohn (1838–1906), an eye specialist at Breslau University in Prussia (Hobday, 2016).

3 Daylight and Myopia in the Classroom

Prussia was among the first modern states to require its children to attend school. In 1867, Cohn published the results of a survey of Prussian children's vision. He had measured the eyesight of 10,060 children, and found four times more myopia among those in elementary schools in towns than those attending in schools in rural areas. Cohn also discovered that the longer children were in school the more likely they were to become short-sighted. Also, myopia became more common, and more severe, as educational levels increased (Cohn, 1867). In Prussia's high schools, or 'Gymnasium', the percentages of myopia went up progressively from the first year of school attendance to the sixth. More than half of the children he examined in the final year of their education in these schools were short-sighted (Cohn, 1867).

Cohn also investigated the effects of lighting on myopia. He compared daylight levels in classrooms with the number of myopic children in them. If buildings surrounding schools darkened their interiors, rates were high. Cohn paid particular attention to the height, width, number and orientation of classroom windows. Based on his findings he proposed a minimum window area for schools of one-fifth the floor area (Cohn, 1867). Cohn wrote that there could never be too much natural light in a school; as long as heat and glare from the sun were properly controlled. Based on his own research, and that of other scientists, he considered some myopia to be inherited. But, in many cases, heredity was not the cause. It was close work in bad light (Cohn, 1886).

His work proved influential. By the beginning of the last century, high levels of daylight in classrooms and play outdoors were two measures that were widely believed to prevent myopia. Cohn's ideas proved popular among British eye specialists who introduced his concept of 'ocular hygiene' into schools. Some argued that children should not be taught to read and write, or do close work at a young age; especially if they were at high risk of myopia or showed the first signs of it. Chief among them was the ophthalmologist Dr Nathaniel Bishop Harman (1869–1945). Working with Dr James Kerr (1862–1941), who was School Medical Officer for London from 1902 to 1911, Harman began setting up special 'myope classes' to try to educate very short-sighted children in a manner that protected their vision from further decline. These classes were soon taken up in a number of other countries; notably in the United States where they became known as 'sight-saving classes' (Harman, 1945).

In 1903, Kerr measured the eyesight of 20,000 children attending London schools. He found higher levels of myopia among girls than boys. His colleague, Dr Harman, later wrote that the difference may have been due to the way girls lived and were educated:

> This excessive incidence amongst the girls may in part be accounted for by the fact that the boys played about in the clean, wide streets, sharpening their wits and their physical faculties, whilst the girls were kept at home to help in domestic duties. That is part of the condition that tends to produce this difference in visual acuity. The other part is the nature of the work done in schools: girls do finer work, boys do no needlework; so that in vision-testing boys have an advantage, for their accommodation muscles are in a better state of tone on account of their outdoor life, and at the same time they are less fatigued by their school work. (Harman, 1909)

Based on these findings Harman recommended that reading and other close work in schools, especially needlework, should be reduced to a minimum. He argued that girls who excelled in fine sewing should have their vision tested in case they were myopic. Also, if girls were to protect their sight they had to be able to exercise outdoors, just like boys. At the time, parents objected to their girls playing in the streets. So Harman called for more playgrounds and open spaces in cities (Harman, 1909). Some of the ideas promoted by leading eye specialists such as Cohn, and then Harman, were adopted in the decades that followed. For example, by the 1950s, high levels of natural light had become a statutory requirement in all British schools to protect children's sight; even though daylight's impact on eyesight was still poorly understood (Hobday, 2016).

4 Changing Attitudes

In the 1960s, there was a marked reversal in medical thinking on myopia. A report published by the British Medical Research Council concluded that myopia was almost entirely inherited (Sorsby, 1962). The results of studies of twins seemed to show that the environment in which children were raised had hardly any effect

on myopia. This research was later found to be deeply flawed. Nevertheless, it proved highly influential, and genetic determinism became the prevailing orthodoxy. It remained so until recently (Morgan & Rose, 2019). Consequently for more than 50 years, myopia has not been considered preventable. The idea that reading in dim light damages eyesight became a 'Medical Myth' (Vreeman & Carroll, 2007). And there was less emphasis on high daylight levels in classrooms (Hobday, 2016). Also, attitudes towards myopia changed. A century ago, all forms of myopia, whether moderate or high, were considered harmful to children by some experts, which is why measures were put in place to try and prevent it. But over time, myopia has come to be regarded by both the eye-care professions and the public as an inconvenience and not a disease. Yet myopia is not a benign condition. It can affect children's self-perception, quality of life, and choice of career. It can also cause significant psychological distress (Wang et al., 2019).

Research now shows that any level of myopia, whether it is severe or mild, significantly increases the risk of developing sight-threatening conditions such as cataract, retinal detachment, glaucoma, and macular degeneration. There is no safe threshold for myopia (Flitcroft, 2012). So the old saying 'a myopic eye is a diseased eye' has some validity (Aylesworth, 1938).

5 Myopia and the Digital Age

As the prevalence of myopia has risen around the world, the age of onset has fallen. Becoming short sighted in early childhood allows more time for the condition to progress toward high myopia (Ikuno, 2017). Unfortunately, in recent years the demands placed on children's eyesight have increased. More and more younger children are spending many hours each day indoors online using laptops, e-readers, tablets, and mobile phones. This digital lifestyle puts them at greater risk of myopia; and also of vitamin D deficiency, obesity, sleep disorders, anxiety and depression (Dresp-Langley, 2020). So, in addition to 'school myopia' there is now 'digital eyestrain' to contend with (Sheppard & Wolffsohn, 2018). The confinement of children indoors during the early months of the COVID-19 pandemic appears to have made myopia more prevalent in younger children. There is evidence of a significant increase among those aged 6–8 years (Wang et al., 2021). There are concerns that 'myopigenic' habits acquired during this formative period of their lives could become entrenched and have negative impact on their visual health in the years ahead (Wong et al., 2020).

6 Myopia and Educational Pressures

The Myopia Boom of the last three decades seems to have started among pre-school and primary school children (Lin et al., 2004). In urban China, pre-schooling is

highly competitive and places great emphasis on early academic achievement. The syllabus in kindergartens and childcare centres is demanding and can include digital technologies (Pan et al., 2018). By contrast, in some rural areas of China myopia rates remain comparatively low. The findings of a study from 2018 suggest this is because children are not under the same educational pressure. Chinese children in rural schools devote less time to intensive learning and more time in outdoor play in their early years compared to their peers in cities. Nevertheless, the study found that students who had completed six years of primary school still had a much higher prevalence of myopia compared with those in the first year of attendance. One-third of the increase among the older children was attributed to a reduction in the amount of time they spent outdoors (Pan et al., 2018).

The results of other research in schools shows that an additional 1–2 h per day outdoors reduce the incidence of myopia in children by between 25 and 50%. This is most effective in children under 12 years of age (He et al., 2015; Wu et al., 2013, 2020). Also, there is evidence that time spent outdoors in daylight can slow the progression of the condition as well as prevent it (Ho et al., 2019). Taiwan and China now have national programmes which stipulate two hours per day outdoors in schools. China also has a 1–2-h daily period of outdoor time specified in its national myopia control programme (Jan et al., 2020). However, there is resistance to this from parents and teachers because of a belief that giving children more time outdoors will adversely affect their education (Jan et al., 2020). The Chinese government's plans also include a ban on written homework in the first two years of school and further limits for older children.

7 'Myope Classes'—Again?

The measures being introduced to prevent myopia in Asian countries will be familiar to readers of Dr Harman's writings on the subject from a century ago. However, Harman went much further in his approach to 'ocular hygiene' and to myopia prevention. In particular, he recognised the harm that early-onset myopia and high myopia could inflict on children and that their eyesight needed to be protected from further deterioration. So he developed a form of education for them which was largely based on oral instruction and practical work. He described this as a return to an 'almost prehistoric' approach. It was, he suggested, similar to that of a wise elder passing on the skills and traditions of a tribe to children (Harman, 1913). There was no place in Harman's syllabus for what he regarded as the modern, inferior substitute for such personalised education—the book. He did not approve of teachers relying on books to educate the young. And he was adamant that children should not learn to read before it was absolutely necessary for them to do so: "Educationally there is no gain in early reading, rather the reverse. Physically, early reading is a habit to be banned." (Harman, 1915).

In support of Harman, it is worth noting that among hunter-gatherer societies, myopia is rare. The impact of compulsory school attendance on their children's

eyesight can be dramatic. Within a single generation, incidence rates for myopia can reach 60% (Morgan & Rose, 2019). Significantly, there is one country that has achieved high academic standards in its schools yet has not followed the global onward trend of myopia. In 2018, a study of 16–19-year-old Norwegians found just 13% of them were affected by myopia (Hagen et al., 2018). Why the prevalence is so much lower than in East Asia and elsewhere is unclear at the present time. However, one notable difference between Norway and other countries is that young children are outdoors for long periods. According to a survey of Norwegian Kindergartens, during the summer they spend more than two-thirds of their time outside and during winter semester it is still about a third of the time. Norway's Kindergartens are designed to facilitate this (Moser & Martinsen, 2010).

8 Outdoor Learning and Myopia

For reasons that are not understood, the Norwegian education system protects most children from myopia; even though it is not designed to do so. Norway serves as a valuable model which other countries who wish to reduce the burden of myopia could copy. Currently, there are no reports of 'myope classes' in East Asia, or elsewhere, for children who have become myopic at a young age, or those severely affected. Their education continues as normal. But if the health risks are to be mitigated, this has to be addressed.

There has been much confusion and disagreement about the cause, or causes, of myopia for decades. Thankfully, research now confirms that increasing the time school children spend outdoors in daylight can reduce the incidence of myopia by half. Outdoor activities can also slow the progression of myopia among those already affected. Given these findings, greater emphasis should be placed on outdoor learning and play in schools and rather less on intensive, competitive education at a young age. The latter clearly harms children's health and happiness and will affect their future lives adversely. The cost to society in the years ahead will be significant too.

The available evidence suggests that stopping the Myopia Boom requires a new approach both to children's education and to wider public health policy. Raising awareness of the need for this among parents, educators, government agencies—and children—is essential. Effective preventive strategies have to be devised and implemented. Outdoor education could be central to this.

Recommended Further Reading

1. Dolgin, E. (2015). The myopia boom. *Nature*, *519*(7543), 276–8.
2. Dresp-Langley, B. (2020). Children's health in the Digital Age. *Int J Environ Res Public Health*, *17*(9), 3240.
3. Pan, C.W., Wu, R.K., Li, J. & Zhong, H. (2018). Low prevalence of myopia among school children in rural China. *BMC Ophthalmol*, *18*(1), 140.

References

Aylesworth, F. A. (1938). The young myope. *Canadian Medical Association Journal, 39*(4), 374–375.

Cohn, H. (1867). *Untersuchungen der Augen von 10,060 Schulkindern nebst Vorschlagen zur Verbesserung der den Augen nachtheiligen Schuleinrichtungen. Eine atiologische Studie.* Leipzig: F. Fleischer.

Cohn, H. (1886). *Hygiene of the eye in schools.* Simpkin, Marshall and Co.

Dolgin, E. (2015). The myopia boom. *Nature, 519*(7543), 276–278.

Dresp-Langley, B. (2020). Children's health in the digital age. *International Journal of Environmental Research and Public Health, 17*(9), 3240.

Flitcroft, D. I. (2012). The complex interactions of retinal, optical and environmental factors in myopia aetiology. *Progress in Retinal and Eye Research, 31*(6), 622–660.

Hagen, L. A., Gjelle, J. V. B., Arnegard, S., Pedersen, H. R., Gilson, S. J., & Baraas, R. C. (2018). Prevalence and possible factors of myopia in Norwegian adolescents. *Science and Reports, 8*(1), 13479.

Harman, N. B. (1909). The effects of school life upon the vision of the child. *Proceedings of the Royal Society of Medicine, 2* (Sect Study Dis Child), 206–16, 209.

Harman, N. B. (1913). The education of high myopes. *Proceedings of the Royal Society of Medicine, 6* (Sect Ophthalmol), 146–63, 148.

Harman, N. B. (1915). The education of children with defective vision. *Proceedings of the Royal Society of Medicine, 8* (Sect Ophthalmol), 107–22, 111.

Harman, N. B. (1945). Sight-saving classes. *BMJ, 1*(4384), 53–54.

He, M., Xiang, F., Zeng, Y., Mai, J., Chen, Q., Zhang, J., et al. (2015). Effect of time spent outdoors at school on the development of myopia among children in China: A randomized clinical trial. *JAMA, 314*(11), 1142–1148.

Ho, C. L., Wu, W. F., & Liou, Y. M. (2019). Dose-response relationship of outdoor exposure and myopia indicators: A systematic review and meta-analysis of various research methods. *International Journal of Environmental Research and Public Health, 16*(14), 2595.

Hobday, R. (2016). Myopia and daylight in schools: A neglected aspect of public health? *Perspectives in Public Health, 136*, 50–55.

Holden, B. A., Fricke, T. R., Wilson, D. A., Jong, M., Naidoo, K. S., Sankaridurg, P., Wong, T. Y., Naduvilath, T. J., & Resnikoff, S. (2016). Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. *Ophthalmology, 123*, 1036–1042.

Ikuno, Y. (2017). Overview of the complications of high myopia. *Retina, 37*(12), 2347–2351.

Jan, C., Li, L., Keay, L., Stafford, R. S., Congdon, N., & Morgan, I. (2020). Prevention of myopia, China. *Bulletin of the World Health Organization, 98*(6), 435–437.

Lin, L. L., Shih, Y. F., Hsiao, C. K., & Chen, C. J. (2004). Prevalence of myopia in Taiwanese schoolchildren: 1983 to 2000. *Annals of the Academy of Medicine, Singapore, 33*(1), 27–33.

Mark, H. H. (1971). Johannes Kepler on the eye and vision. *American Journal of Ophthalmology, 72*(5), 869–878.

Morgan, I. G., & Rose, K. A. (2019). Myopia: Is the nature-nurture debate finally over? *Clinical and Experimental Optometry, 102*(1), 3–17.

Morgan, I. G., French, A. N., & Rose, K. A. (2018). Intense schooling linked to myopia. *BMJ,* 6 Jun, 361.

Moser, T., & Martinsen, M. T. (2010). The outdoor environment in Norwegian kindergartens as pedagogical space for toddlers' play, learning and development. *EECERJ, 18*(4), 457–471.

Pan, C. W., Wu, R. K., Li, J., & Zhong, H. (2018). Low prevalence of myopia among school children in rural China. *BMC Ophthalmology, 18*(1), 140.

Sheppard, A. L., & Wolffsohn, J. S. (2018). Digital eye strain: Prevalence, measurement and amelioration. *BMJ Open Ophthalmology, 3*(1), e000146.

Sorsby, A. (1962). *Refraction and its components in twins. Privy Council. Medical Research Council Special Report no. 303.* London: HMSO.

Vreeman, R. C., & Carroll, A. E. (2007). Medical myths. *BMJ, 335*(7633), 1288–1289.
Wang, D., Yang, J., Xian, Y. J., Wu, P. P., & Lin, S. L. (2019). [Current status of social anxiety among primary school students with myopia in Urumqi, China and risk factors for myopia]. *Zhongguo Dang Dai Er Ke Za Zhi*, 21 Feb, (2), 184–188. Chinese.
Wang, J., Li, Y., Musch, D. C., Wei, N., Qi, X., Ding, G., Li, X., Li, J., Song, L., Zhang, Y., Ning, Y., Zeng, X., Hua, N., Li, S., & Qian, X. (2021). Progression of myopia in school-aged children after COVID-19 home confinement. *JAMA Ophthalmology,* e206239. https://doi.org/10.1001/jamaophthalmol.2020.6239. Epub ahead of print.
Wong, C. W., Tsai, A., Jonas, J. B., Ohno-Matsui, K., Chen, J., Ang, M., & Ting, D. S. W. (2020). Digital screen time during the COVID-19 pandemic: Risk for a further myopia boom? *American Journal of Ophthalmology, 223*, 333–337.
Wu, P. C., Chen, C. T., Chang, L. C., Niu, Y. Z., Chen, M. L., Liao, L. L., Rose, K., & Morgan, I. G. (2020). Increased time outdoors is followed by reversal of the long-term trend to reduced visual acuity in Taiwan primary school students. *Ophthalmology, 127*(11), 1462–1469.
Wu, P. C., Tsai, C. L., Wu, H. L., Yang, Y. H., & Kuo, H. K. (2013). Outdoor activity during class recess reduces myopia onset and progression in school children. *Ophthalmology, 120*(5), 1080–1085.

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