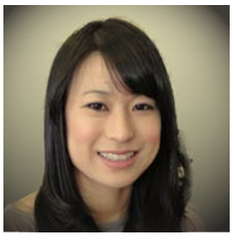
MYOPIA: A PUBLIC HEALTH CRISIS IN WAITING

The prevalence of myopia and high myopia is on the rise across the world. Recent work from the Brien Holden Vision Institute estimates that by 2050, five billion (50%) people will be myopic, one billion (10%) highly myopic. This may have important implications for planning comprehensive eye care services, including refractive services such as spectacles and contact lenses for correcting and slowing myopia progression. Optical and environmental interventions can help in preventing and managing high myopia related ocular complications and reduce the burden of myopia.



Dr. Monica Jong
B. Optom, PhD
Senior research fellow, Brien Holden Vision Institute, Australia.

Doctor Monica Jong is a senior research fellow at the Brien Holden Vision Institute and her clinical research is focussed on myopia control and high myopia.
She received her optometry degree and PhD from the University of Melbourne, and her thesis examined the relationship between retinal structure and retinal function in retinitis pigmentosa using OCT. She was also the recipient of the David and Sandra Smith Fellowship which allowed her to pursue her postdoctoral studies in ocular blood flow imaging in Type 2 diabetes at the Department of Ophthalmology, University Health Network, University of Toronto. Some of Monica's activities at the Brien Holden Vision Institute include managing the analysis of the Zhongshan Opthalmic Center (ZOC) and BHVI high myopia database in China, advocating for the recognition of high myopia as a cause of blindness through her role in the International Agency for the Prevention of Blindness (IAPB).

Prof. Padmaja Sankaridurg
Program Leader, Myopia Program at the Brien Holden Vision Institute, Australia.

Prof. Padmaja Sankaridurg is Program Leader, Myopia Program at the Brien Holden Vision Institute. She was awarded her B.Opt degree from the Elite School of Optometry, Chennai, India in 1989, Ph.D in 1999 from the University of New South Wales, Australia and MIP in 2012 from University of Technology, Australia. After working for a number of years at the L.V. Prasad Eye Institute, India as the Chief of Contact Lens Services, she took up a position at the Brien Holden Vision Institute (formerly the Institute for Eye Research) and the Vision Cooperative Research Centre.
She is also a Conjoint Professor at the School of Optometry and Vision Science, University of New South Wales, Australia. She has been actively researching myopia for approximately 12 years. In addition, she is also involved in post graduate supervision and manages the Intellectual Property portfolio of the Institute. She has over 50 articles in peer reviewed journals.

Prof. Kovin Naidoo
CEO, Brien Holden Vision Institute, Australia. OD, MPH, PhD, FAAO, FCOptom(Hon)

An academic, researcher, educator and internationally celebrated public health leader, Prof. Kovin Naidoo has been revolutionising access and delivery to eye care for the disadvantaged throughout the world. A powerful public health advocate, he has devoted his working life to reducing avoidable blindness and vision impairment, with specific emphasis on refractive error.

Professor Naidoo is the CEO of the Brien Holden Vision Institute and Chairperson of the International Agency for the Prevention of Blindness (Africa), Associate Professor of Optometry at the University of KwaZulu-Natal (UKZN), and Adjunct Faculty at Salus University in Philadelphia. He is also a Vision Impact Institute advisory board member.
He has published extensively in epidemiology and public health.

KEYWORDS
myopia, high myopia, vision impairment, myopic macular degeneration, myopia control, myopia management, public health issue

> **"The economic burden of uncorrected distance refractive error was estimated to be US$202 billion per annum, of which myopia is the main cause."**

In recent times, the issue of myopia has featured heavily in mainstream media with headlines such as "the myopia boom"[1] and "night time contact lenses stop children becoming short-sighted".[2] The growing concern surrounding myopia has already led to governments in some parts of the world taking measures to ameliorate this problem. In Taiwan, a law was passed "banning too much screen time," and public health campaigns in Singapore encouraged children to spend more time outdoors. Given these messages, we may be left wondering about the size of the burden of myopia, and the strategies and/or solutions required to reduce it.

The size of the problem

Recent work from the Brien Holden Vision Institute estimates that the prevalence of myopia (≤ -0.50 D) will increase worldwide, from 28% (2 billion) of the global population in 2010, to nearly 50% (5 billion) of the world population by 2050. As a consequence, the prevalence of high myopia (≤ -5.00D) is also likely to increase from 4% (277 million) in 2010, to nearly 10% (1 billion) by the year 2050.[3] Figure 1 illustrates the prevalence of myopia and high myopia from 2000 through to 2050.

The shift towards myopia

The shift towards myopia has been rapid in some parts of the world, such as the USA, where the prevalence of myopia increased from 26% to 42% from 1972 to 2004.[4] In Singapore, the prevalence of myopia was 47% in adults in their 20s, and 26% in adults in their 50s.[5]

High myopia (≤ - 7.90 D) in the USA has already increased 8-fold over 30 years from 0.2% to 1.6%.[4] In 18-year-old Taiwanese students, 21.0% had high myopia (≤ -6.00 D) in 2000 compared with 10.9% in 1983.[6] Globally in 2000, most people with myopia were below age 40, and little myopia was seen in those over 40. By 2030, the prevalence of myopia is projected to be approximately 50% for all age groups above 20 years, and by 2050 to 68%[7] (Fig. 2). Regions with traditionally little myopia, such as Eastern Europe and Southern Africa will also see a large shift towards myopia in the near future, approaching prevalences of 50% and 30% by 2050. This is likely due to lifestyle changes as a result of urbanisation and development (Fig. 3).[3]

What are the consequences?

Uncorrected refractive error is the leading cause of distance vision impairment globally, affecting 108 million people, and is the second most common cause of global blindness.[8] The economic burden of uncorrected distance refractive error was estimated to be US$202 billion per annum, of which myopia is the main cause.[9] With the rising prevalence of myopia, the economic burden of uncorrected refractive error associated with myopia will rise. In addition, myopia is associated with ocular complications such as myopic macular degeneration, retinal detachment, cataract and glaucoma, which impose a significant health and economic burden. Myopic macular degeneration is already a frequent cause of vision impairment in Japan,[10] China,[11] Netherlands[12] and Denmark[13]. It is important to note that any level of myopia

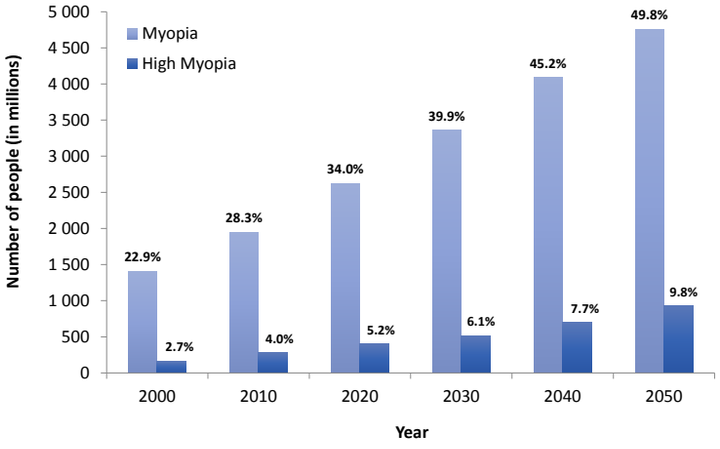


FIG. 1| The estimated global prevalence of myopia and high myopia per decade from 2000 to 2050 based on current trends. The number of people in millions is listed on the y-axes. Adapted from Holden *et al.*[3]

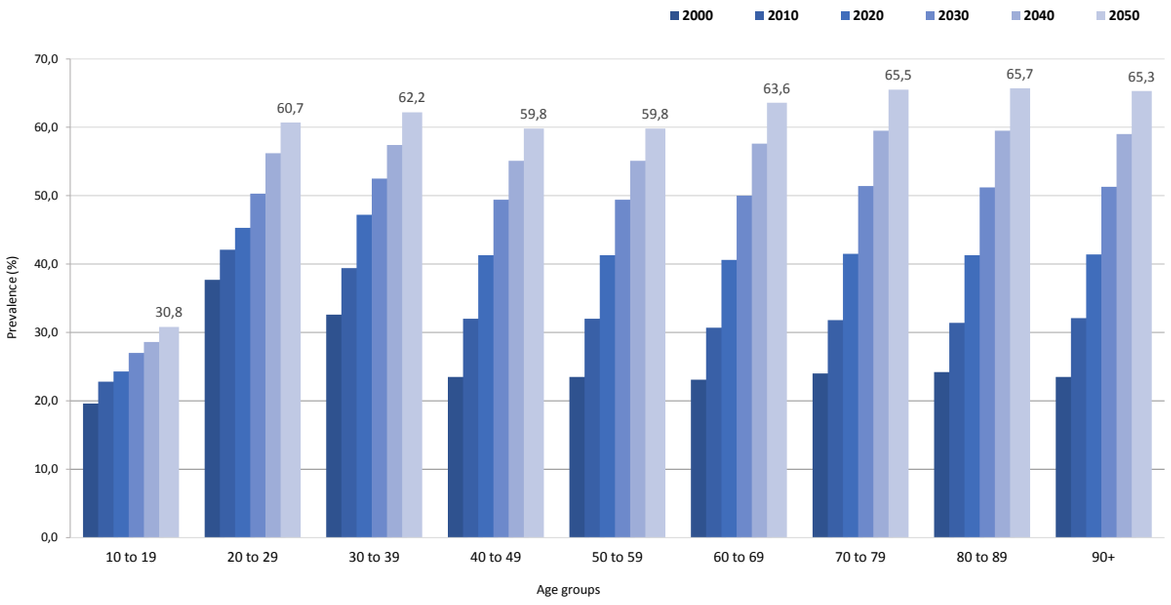


FIG. 2| The global generational shift in myopia indicates that in the earlier decades of 2000 up to 2030, the majority of myopia is occurring in those under forty years with little myopia seen in those over forty. After 2030, the prevalence of myopia will be affecting all age groups. Adapted from Holden *et al.*[3]

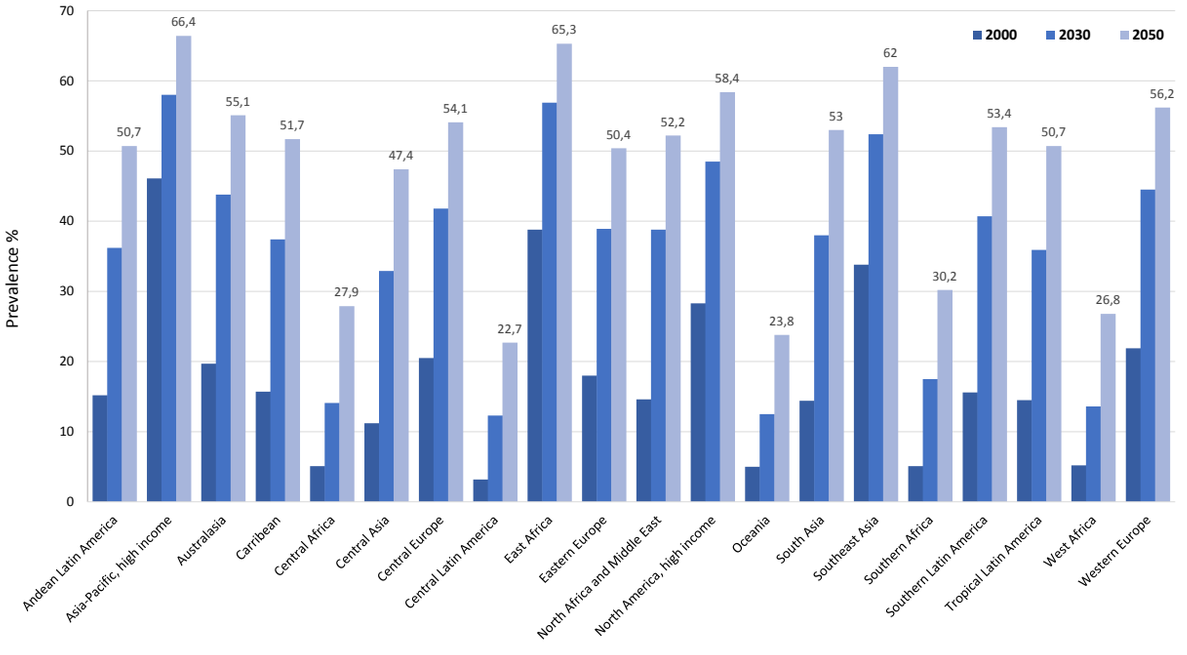


FIG. 3| The increasing prevalence of myopia estimated across the world from the year 2000 to 2050. Modified from Holden *et al.* 2016.[3]

"The future estimates of myopia, suggest that at least one billion people are potentially at risk of developing permanent vision impairment and blindness associated with high myopia"

increases the risks of the above mentioned problems compared to emmetropes, but the risk increases exponentially once you reach high myopia.[14] For myopia of -5.00 D to -7.00 D, the risk of glaucoma is 3.3 times higher, the risk of cataract is 5.5 times higher, the risk of retinal detachment is 21.5 times higher, and the risk of myopic macular degeneration is 40.6 times higher.[14] The future estimates of myopia suggest that at least one billion people are potentially at risk of developing permanent vision impairment and blindness associated with high myopia.[15]

Strategies to manage the burden

Both environmental and genetic factors are thought to contribute to the onset and progression of myopia, but it has been suggested that environmental factors have a larger role to play in the rapid increase in the prevalence of myopia. A heavily indoor and near-activity based lifestyle[16,17], with less time outdoors[18], combined with the intense education commencing at very young ages, as is occurring in many East Asian countries, are major contributing factors.[16]

Evidence is now growing to support the use of interventions in slowing myopia progression. Optical interventions that modulate the visual feedback and environmental interventions promoting increased outdoor time can successfully delay and slow the progress of myopia in an individual. Optical strategies shown to slow the progress of myopia include ortho-K (30% to 57%)[19,20], multifocal-type soft contact lenses (25% to 72%)[20], and executive bifocals (39% to 51%).[21] Progressive addition spectacles are limited to 15% to 20.[21] Time outdoors has successfully reduced the number of new cases of myopia by up to 50%, and can effectively delay the onset of myopia, but its ability to slow the rate of progression of myopia is not clinically significant.[22,23] In addition, certain pharmaceutical approaches have also shown promise, with low dose atropine (0.01%) slowing the progress of myopia by almost 59%.[24] The long term effects of atropine use are not yet clear.

Future needs

An effective myopia management strategy that combines the individual's needs, based on their risk profile (for example, age, lifestyle, familial history), and matched to the appropriate intervention strategy is required to reduce the burden of myopia, both at the individual and the community level. Recognising the need, the World Health Organisation (WHO) convened a Global Scientific Meeting on Myopia in collaboration with the Brien Holden Vision Institute in Sydney, Australia in 2015. At this forum, leading experts in myopia met to examine the latest evidence, identify gaps in knowledge, and define policies for the management of myopia. It is expected that this report will be published soon and will provide myopia management guidelines for governments, industry, health care workers, and practitioners.

Conclusion

Close to five billion and one billion people will be affected by myopia and high myopia respectively by 2050. This will have important implications for planning comprehensive eye care services, including refractive services such as spectacles and contact lenses for correcting and slowing myopia progression, as well as preventing and managing high myopia related ocular complications. The optical industry also has a key role to play in education, developing, and supporting appropriate myopia management strategies to help reduce the burden of myopia. •

More information

For further details, "Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050" is available via open access at http://www.sciencedirect.com/science/article/pii/S0161642016000257.

REFERENCES

1. Dolgin E. The myopia boom. Nature 2015;519:276-8.

2. Knapton S. Night time contact lenses stop children becoming short-sighted. In: Telegraph T, ed.2015.

3. Holden BA, Fricke TR, Wilson DA, et al. Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050. Ophthalmology 2016.

4. Vitale S, Sperduto RD, Ferris FL, 3rd. Increased prevalence of myopia in the United States between 1971-1972 and 1999-2004. Archives of ophthalmology 2009;127:1632-9.

5. Pan CW, Dirani M, Cheng CY, Wong TY, Saw SM. The age-specific prevalence of myopia in Asia: a meta-analysis. Optometry and vision science : official publication of the American Academy of Optometry 2015;92:258-66.

6. Lin LL, Shih YF, Hsiao CK, Chen CJ. Prevalence of myopia in Taiwanese schoolchildren: 1983 to 2000. Annals of the Academy of Medicine, Singapore 2004;33:27-33.

7. Wilson DA, Jong M, Sankaridurg P, Fricke TR, Resnikoff S, Naidoo K. A global generational shift in myopia. Association for Research in Vision and Ophthalmology. Seattle, USA2016.

8. Bourne RR, Stevens GA, White RA, et al. Causes of vision loss worldwide, 1990-2010: a systematic analysis. The Lancet Global health 2013;1:e339-49.

9. Fricke TR, Holden BA, Wilson DA, et al. Global cost of correcting vision impairment from uncorrected refractive error. Bulletin of the World Health Organization 2012;90:728-38.

10. Iwase A, Araie M, Tomidokoro A, et al. Prevalence and causes of low vision and blindness in a Japanese adult population: the Tajimi Study. Ophthalmology 2006;113:1354-62.

11. Wu L, Sun X, Zhou X, Weng C. Causes and 3-year-incidence of blindness in Jing-An District, Shanghai, China 2001-2009. BMC ophthalmology 2011;11:10.

12. Verhoeven VJ, Wong KT, Buitendijk GH, Hofman A, Vingerling JR, Klaver CC. Visual consequences of refractive errors in the general population. Ophthalmology 2015;122:101-9.

13. Buch H, Vinding T, La Cour M, Appleyard M, Jensen GB, Nielsen NV. Prevalence and causes of visual impairment and blindness among 9980 Scandinavian adults: the Copenhagen City Eye Study. Ophthalmology 2004;111:53-61.

14. Flitcroft DI. The complex interactions of retinal, optical and environmental factors in myopia aetiology. Progress in retinal and eye research 2012;31:622-60.

15. Holden BA, Jong M, Davis S, Wilson D, Fricke T, Resnikoff S. Nearly 1 billion myopes at risk of myopia-related sight-threatening conditions by 2050 - time to act now. Clinical & experimental optometry : journal of the Australian Optometrical Association 2015;98:491-3.

16. Morgan IG, Ohno-Matsui K, Saw SM. Myopia. Lancet 2012;379:1739-48.

17. Lim LT, Gong Y, Ah-Kee EY, Xiao G, Zhang X, Yu S. Impact of parental history of myopia on the development of myopia in mainland china school-aged children. Ophthalmology and eye diseases 2014;6:31-5.

18. Jones LA, Sinnott LT, Mutti DO, Mitchell GL, Moeschberger ML, Zadnik K. Parental history of myopia, sports and outdoor activities, and future myopia. Investigative ophthalmology & visual science 2007;48:3524-32.

19. Si JK, Tang K, Bi HS, Guo DD, Guo JG, Wang XR. Orthokeratology for Myopia Control: A Meta-analysis. Optometry and vision science : official publication of the American Academy of Optometry 2015;92:252-7.

20. Huang J, Wen D, Wang Q, et al. Efficacy Comparison of 16 Interventions for Myopia Control in Children: A Network Meta-analysis. Ophthalmology 2016;123:697-708.

21. Cheng D, Woo GC, Drobe B, Schmid KL. Effect of bifocal and prismatic bifocal spectacles on myopia progression in children: three-year results of a randomized clinical trial. JAMA ophthalmology 2014;132:258-64.

22. Wu PC, Tsai CL, Wu HL, Yang YH, Kuo HK. Outdoor activity during class recess reduces myopia onset and progression in school children. Ophthalmology 2013;120:1080-5.

23. 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 : the journal of the American Medical Association 2015;314:1142-8.

24. Chia A, Lu QS, Tan D. Five-Year Clinical Trial on Atropine for the Treatment of Myopia 2: Myopia Control with Atropine 0.01% Eyedrops. Ophthalmology 2015.

KEY TAKEAWAYS

- The prevalence of myopia and high myopia is on the rise across the world.

- Estimates suggest that by 2050, five billion (50%) people will be myopic, one billion (10%) highly myopic.

- Increasing myopia is associated with increased risk of sight threatening complications such as myopic macular degeneration, glaucoma and cataracts.

- There is evidence that optical and environmental interventions can slow the progress of myopia and reduce the burden of myopia.