

Myopia

NATIONAL
ACADEMIES Sciences
Engineering
Medicine

Causes, Treatment, and Prevention
of an Increasingly Common Disease

Committee on Focus on Myopia: Pathogenesis and Rising Incidence
Board on Behavioral, Cognitive, and Sensory Sciences



Myopia

**Causes, Prevention, and Treatment
of an Increasingly Common Disease**



Consensus Study Report

Agenda

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- 7 Current and Emerging Treatment Options for Myopia
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Introductions and Overview

01



Study Sponsors:

American Academy of Optometry

American Optometric Association

Health Care Alliance for Patient Safety

Herbert Wertheim School of Optometry & Vision
Science, University of California, Berkeley

Johnson & Johnson Vision

National Eye Institute

Reality Labs Research

Research to Prevent Blindness

Warby Parker Impact Foundation





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National Academies Study Process

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The National Academies of Sciences, Engineering, and Medicine

Bridging Science and Society for >150 Years

The National Academies provide independent, trustworthy advice and facilitate solutions to complex challenges by mobilizing expertise, practice, and knowledge in science, engineering, and medicine.



Board on Behavioral, Cognitive, and Sensory Sciences

- Established in 1997
- Provides vision on how to advance public policy and practice by leveraging cutting-edge research in behavioral, cognitive, and sensory sciences
- Dozens of reports on topics across a wide swath of science including evaluations of substance abuse programs, aging, intelligence & counter-intelligence, suicide prevention, replicability in science, antiracism and DEI in STEMM, how people learn and many others.

Current Core Sponsors	
American Psychological Association	National Aeronautics and Space Administration
National Institutes of Aging	National Science Foundation

Our Consensus Study Process



Abbreviated Statement of Task

- What are the gaps in knowledge and barriers to progress in understanding the link between known risk factors for myopia development in children and the mechanisms controlling eye growth?
- To what extent do changes in environmental factors (e.g., outdoor time, near work, electronic devices) explain the rapid increase in myopia prevalence?
- What are the socioeconomic, demographic, and regional barriers to diagnosing refractive correction in underserved populations? What research efforts might lead to effective methods for mitigating these issues?



Stages of the Committee's Work

Evidence Gathering

- One public workshop
- Five commissioned papers
- Review of published research

Deliberation and Report Development

- Closed session discussions to evaluate the evidence
- Arrive at consensus, develop conclusions and recommendations

Evidence Gathering: Public Workshop

Workshop on the Rise in Myopia: Exploring Possible Contributors and Investigating Screening Practices, Policies, and Programs December 5-6, 2023

Foundations of the Study

Martin Banks, Ph.D., Herbert Wertheim School of Optometry & Vision Science, University of California, Berkeley
Bill Geisler, Ph.D., University of Texas at Austin Center for Perceptual Systems
David Williams, Ph.D., University of Rochester Institute of Optics

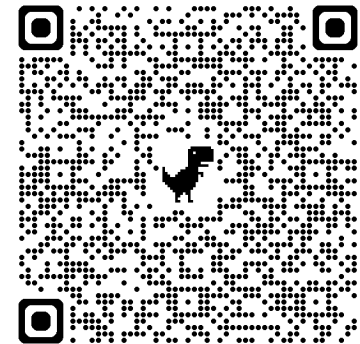
Exploring Novel International Initiatives and Implications for the Development and Progression of Myopia

David Mackey, AO, University of Western Australia Medical School, Centre for Ophthalmology and Visual Science
Daniel Ting, MBBS (Hons), M Med(Ophth), FAMS, PhD (UWA), Singapore National Eye Centre
Pei-Chang Wu, M.D., Ph.D., Chang Gung University
Andrew Bastawrous, OBE, London School of Hygiene & Tropical Medicine & Peek Vision
Priya Morjaria, Ph.D., International Center for Eye Health & Peek Vision

Myopia Screening Practices, Policies, and Programs

Megan Collins, M.D., M.P.H., Johns Hopkins Berman Institute of Bioethics
Donna Fishman, M.P.H., National Center for Children's Vision and Eye Health
Jessie Mandle, M.P.H., Healthy Schools Campaign

The workshop also included presentations by authors of the commissioned papers listed on the next slide.



Evidence Gathering: Five Commissioned Papers

- **Bullimore, M.** (2024). Animal models of myopia: Lessons for the understanding of human myopia.
- **Hammond, C., & Williams, K.** (2024). Perspectives on genetic and environmental factors in myopia, its prediction, and the future direction of research.
- **Harewood, J., Contreras, M., Huang, K., Leach, S., & Wang, J.** (2024). Access to myopia care—A scoping review.
- **Khanal, S., Harrington, S., & Tomiyama, E.** (2024). Treatment of childhood myopia.
- **Marcos, S.** (2024). Optical and visual diet in myopia.

Top Takeaway Messages

Myopia is a disease

Exposure to outdoor settings reduces myopia onset

Paucity of data on myopia prevalence in the US prevents adequate tracking and policy decisions

Improved understanding of mechanisms involved in myopia onset and progression would aid development of better treatment.

Top Takeaway Messages, continued

Health impacts of this global myopia epidemic disproportionately affect the most vulnerable communities

Safety is a fundamental component of effective treatment

Intentional intervention at a young age is ideal, as early-onset myopia has wide-reaching quality of life and economic implications

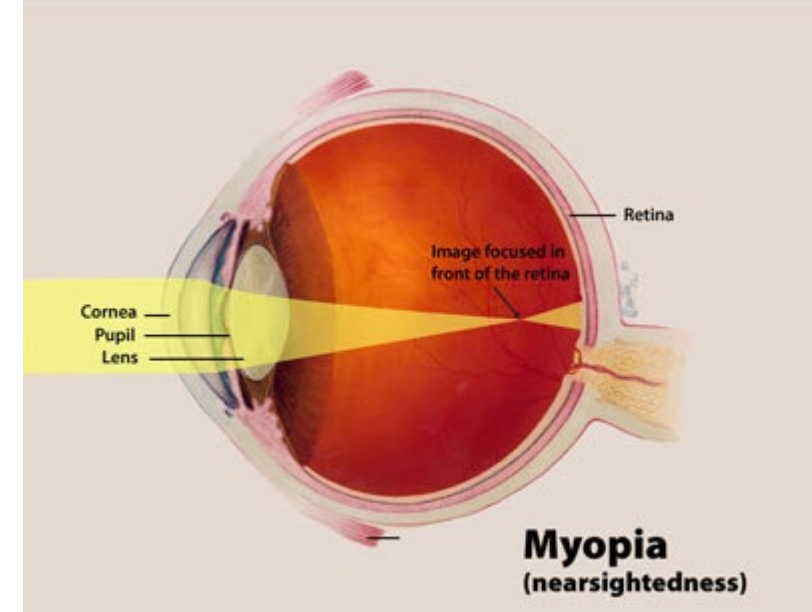
Understanding Myopia and Its Prevalence

03



Understanding Myopia and Its Prevalence

Myopia (nearsightedness) is refractive error resulting from abnormal elongation of the eye



Source: NEI-medialibrary-9409846.png

Understanding Myopia and Its Prevalence

Understanding of myopia prevalence in the U.S. is hampered by data limitations (variable definitions, age of data)

Between ~1970s and early 2000s, U.S. prevalence for ages 12 to 54 increased from 25% to 41.6%.

Myopia is predicted to continue to increase in the United States and globally; in some parts of the world, myopia prevalence already exceeds 90%



Understanding Myopia and Its Prevalence

Recommendations and funding priorities

1. U.S.: collect consistent data nationwide for a central repository
2. International: develop consistent definitions and measurement methods

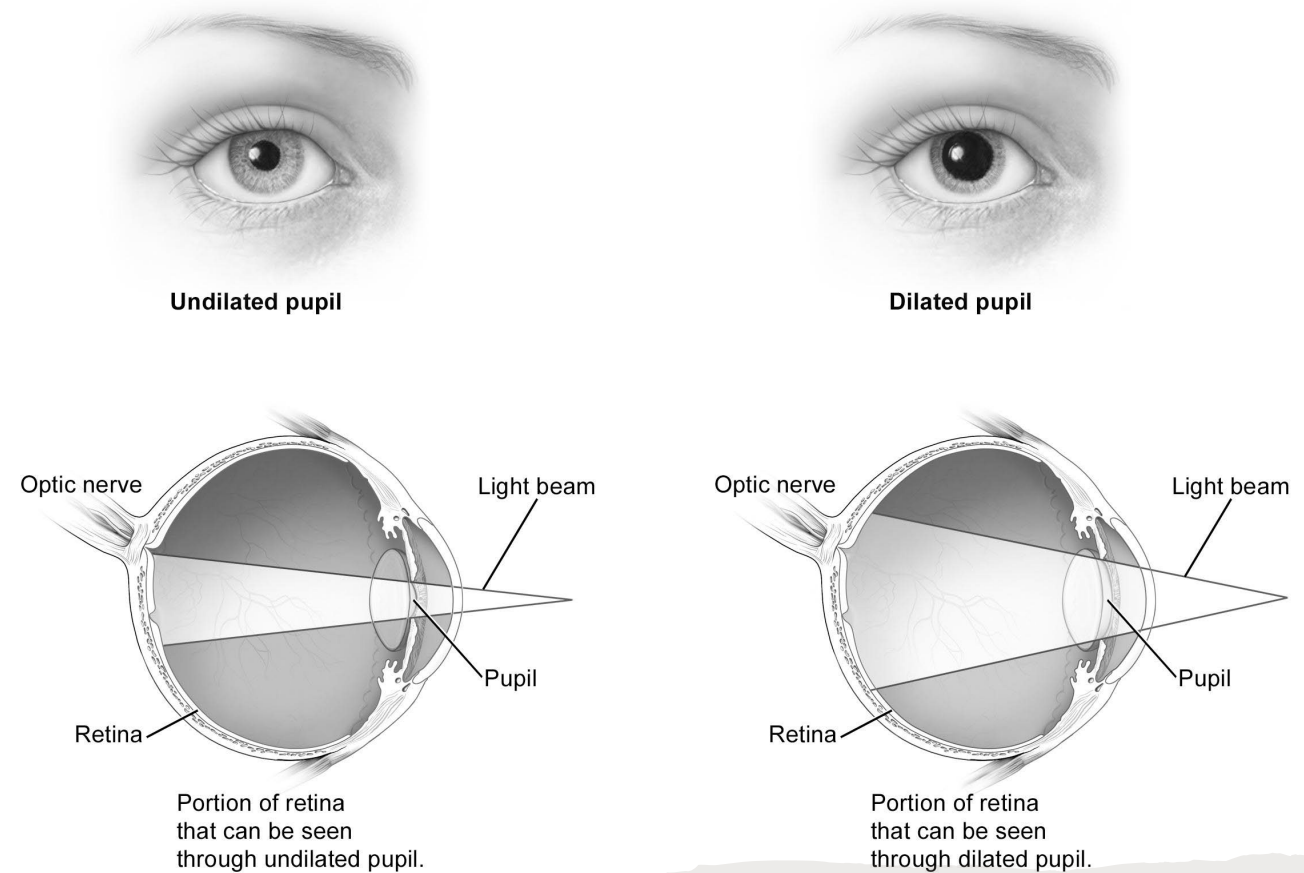
Assessment and Diagnostic Technologies

04



Assessment and Diagnostic Technologies

Cycloplegia is a critical component of an eye exam in children.



Assessment and Diagnostic Technologies

- Axial length and other structural measurements of the eye should be obtained when resources allow.
- Design assessments and tests to better understand the myopic eye, its development, and its environment (the visual diet).
- Develop consensus standards for the assessments and diagnostics deemed most important for population-level studies.



Assessment and Diagnostic Technologies

Myopia onset usually occurs in childhood. Because of the importance of identifying myopia as early as possible, it is imperative that diagnostic technologies are child-friendly to the greatest possible extent.

Assessment and Diagnostic Technologies

Recommendations and funding priorities

1. Use cycloplegic drops for accurate assessment
2. Develop better diagnostic myopia technologies
3. Establish consensus on myopia treatment standards
4. Make technology adaptable, accessible, portable

Onset and Progression of Myopia

05





Onset and Progression of Myopia

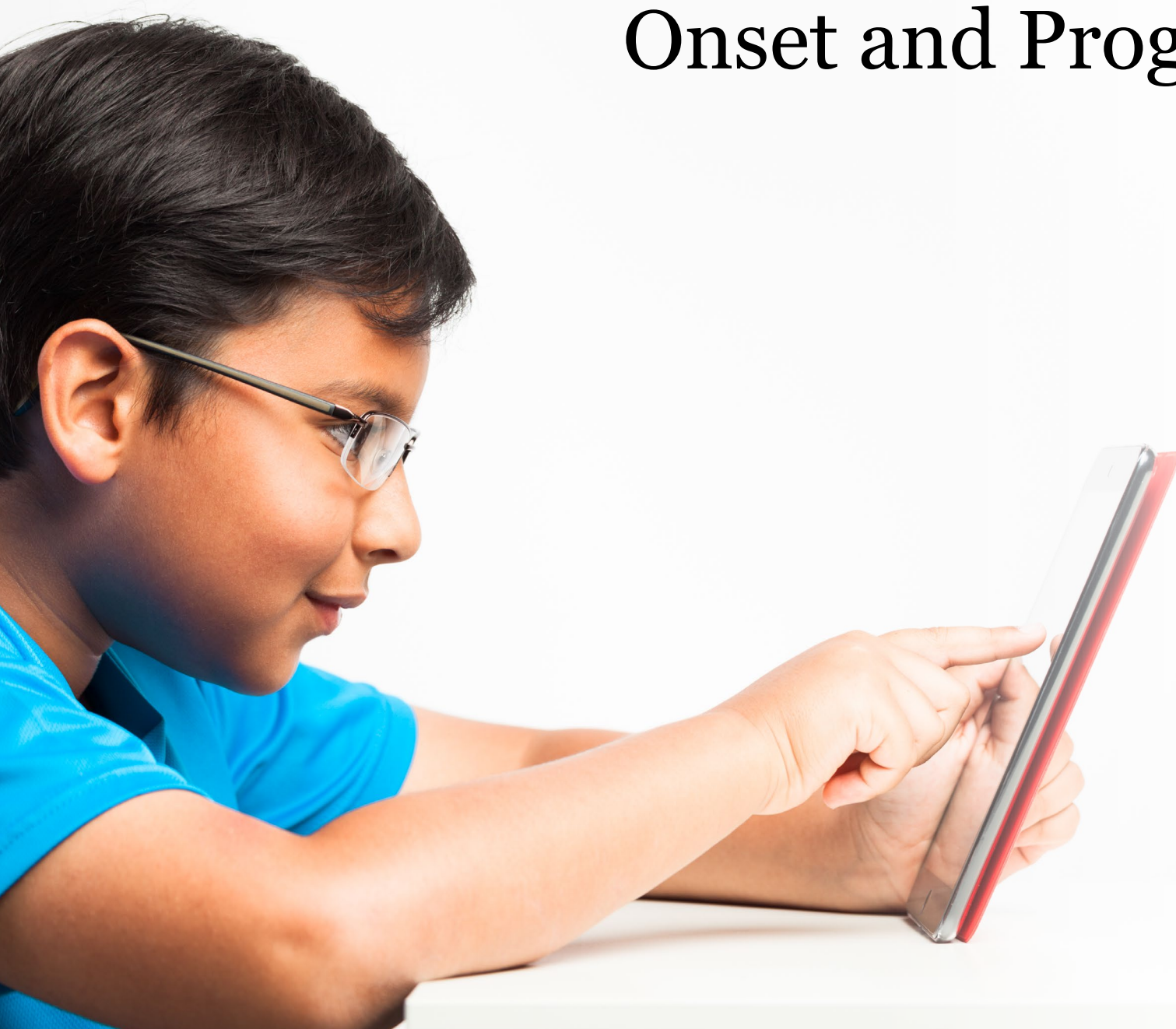
While genetics plays a role in the onset and progression of myopia, much of genetic risk is modifiable by the environment.

Onset and Progression of Myopia

Time outdoors has
protective effects on
myopia onset



Onset and Progression of Myopia



Data supporting roles for near work and electronic devices in myopia is limited or inconclusive

Additional research is needed to determine specific features of visual diet that cause or inhibit myopia

Onset and Progression of Myopia

Recommendations and funding priorities

1. Promote outdoor time for children outdoors (at least one hour per day in school and up to 2 hours total)
2. Fund research on myopia mechanisms
3. Encourage industry collaboration

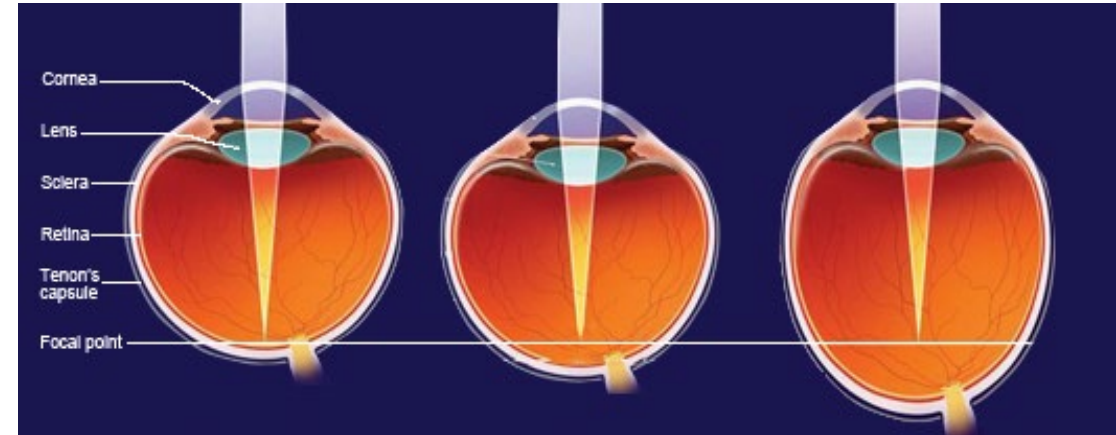
Myopia Pathogenesis: From Retinal Image to Scleral Growth

06



Myopia Pathogenesis: From Retinal Image to Scleral Growth

- Myopia results from excessive elongation of the eye, leading to a mismatch between the focal length and axial length of the eye.



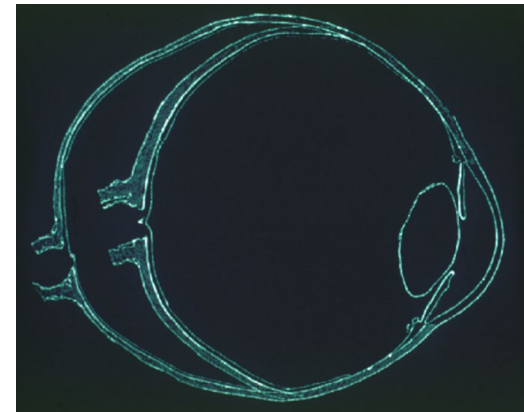
Normal Eye

Myopic Eye

Highly Myopic Eye

Source: <https://www.slideshare.net/MtuMzima/kibpptx>

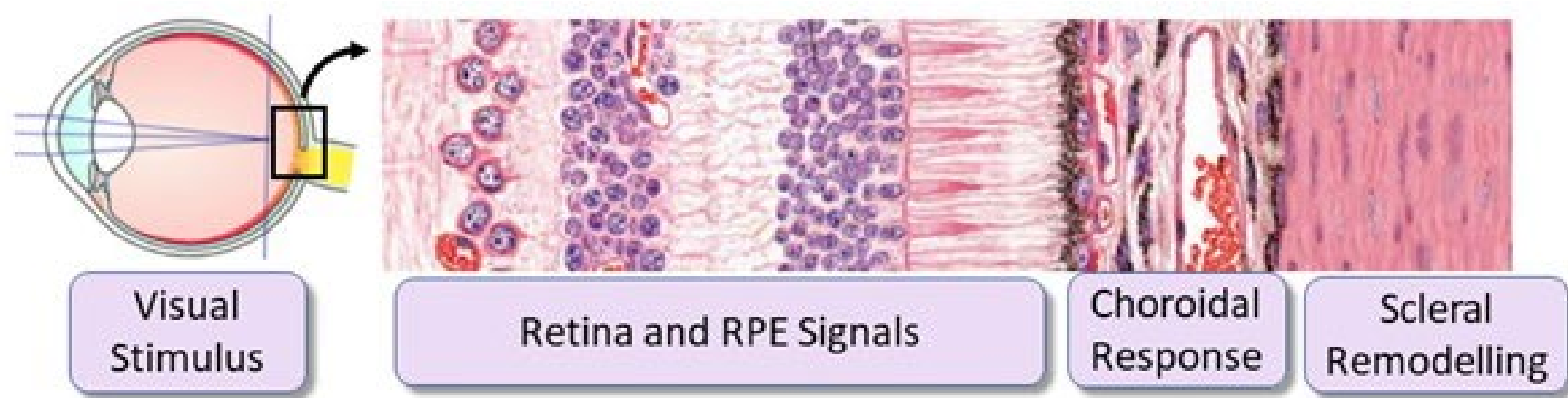
- The abnormally elongated eye puts highly myopic individuals at risk for serious blinding eye diseases.



Source: *The Myopias: Basic Science and Clinical Management* by Brian J. Curtin
Harpercollins College Div (January 1, 1985) ISBN-10 : 0061406724

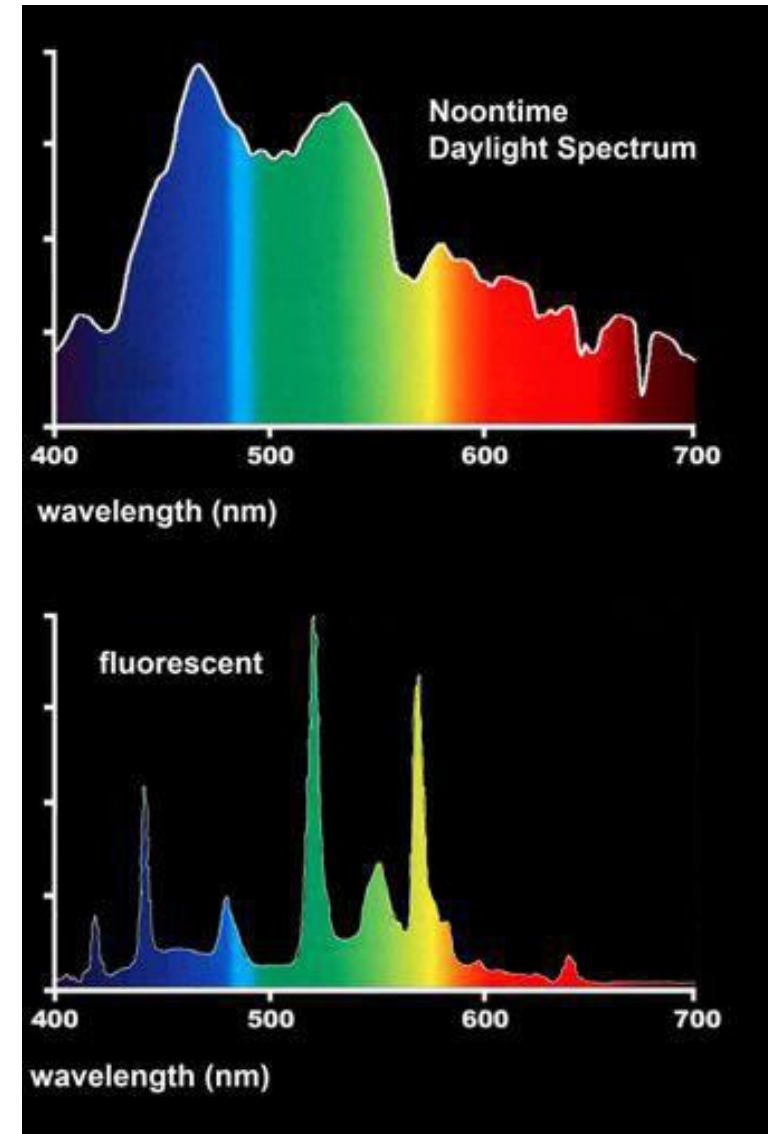
Myopia Pathogenesis: From Retinal Image to Scleral Growth

Animal models of myopia provide convincing evidence that ocular growth is regulated by a conserved process initiated by a visual stimulus on the retina, which is then relayed through the RPE and choroid, and ultimately acts on the sclera to effect changes in eye size and refraction.



Myopia Pathogenesis: From Retinal Image to Scleral Growth

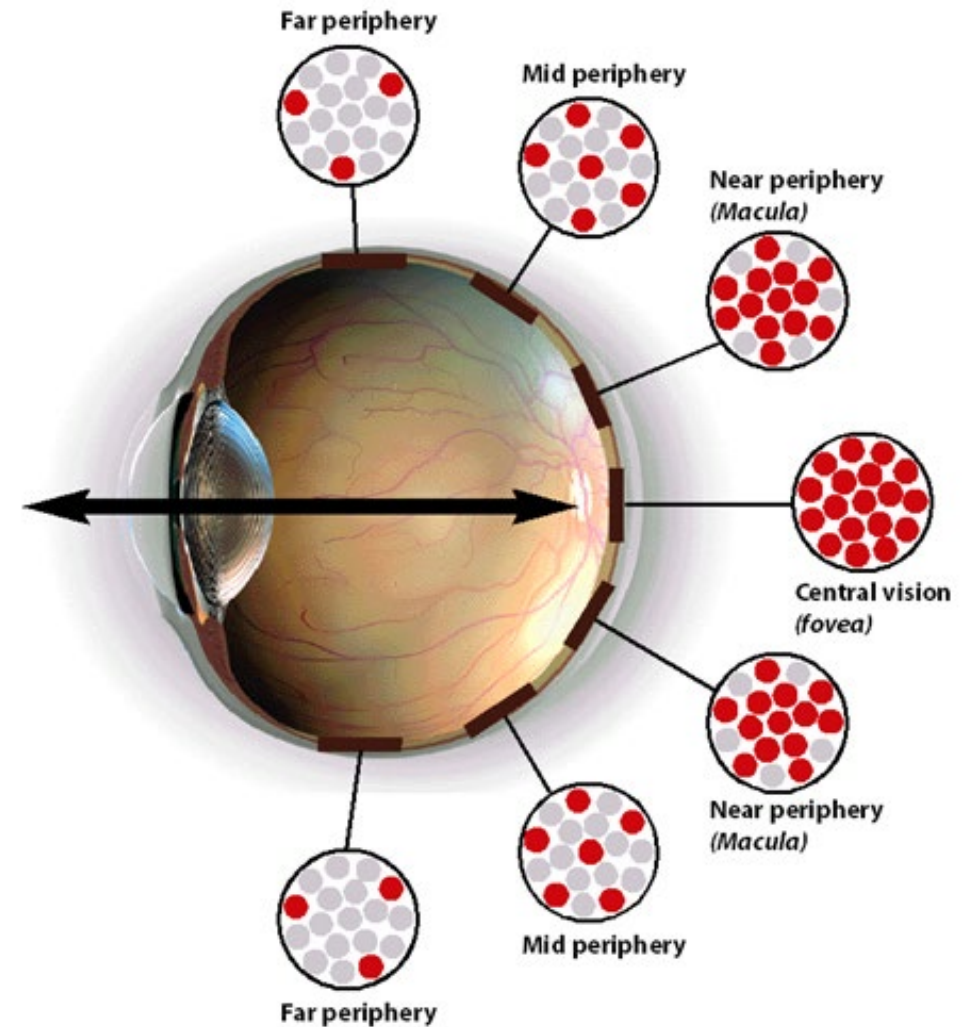
- Image properties necessary to maintain normal ocular growth, and those contributing to myopia development are currently unknown.
- Image properties, such as defocus, chromaticity, and luminance, are possible candidates responsible for fine tuning this process and may explain the apparent protective effect of outdoor activity on myopia development.



Source:
https://www.reddit.com/r/Biohackers/comments/15h58wu/are_there_any_lightbulbs_designed_to_mimick_the/

Myopia Pathogenesis: From Retinal Image to Scleral Growth

- Although the fovea centralis is the retinal area of sharpest vision, research indicates that the images on peripheral retina are also important for regulating eye growth. This finding has implications for optical correction of myopia.



Source: <https://socratic.org/questions/why-don-t-we-get-color-or-detail-information-from-our-peripheral-vision>

Myopia Pathogenesis: From Retinal Image to Scleral Growth

Recommendations and funding priorities

1. Fund interdisciplinary studies on myopia mechanisms
2. Support innovative multidisciplinary visual research
3. Support research examining key components in the retina to scleral chemical cascade

Current and Emerging Treatment Options for Myopia

07



Current and Emerging Treatment Options for Myopia

- Myopia treatment no longer refers to simply correcting blurry vision.
- Treatment options for myopia progression have increased over the last 20 years; however, they have limited effects and stop working after cessation.
- The preponderance of evidence suggests myopia progression should be treated when resources allow.



Current and Emerging Treatment Options for Myopia

- Improved understanding of mechanisms would aid in the development of better treatment options.
- Safety is a fundamental component of effective treatment as treatment will likely last through childhood.

Current and Emerging Treatment Options for Myopia

Recommendations and funding priorities

1. Support new myopia treatment strategies
2. Ensure treatment safety for children
3. Fund long-term clinical trials at earlier ages

Identifying Children with Myopia and the Links to Treatment: Methods and Barriers

08



Identifying Children with Myopia and the Links to Treatment: Methods and Barriers

Medically Underserved Populations

- Racial and ethnic minority groups
- People with lower socioeconomic status
- Rural communities
- Children with disabilities

Identifying Children with Myopia and the Links to Treatment: Methods and Barriers



1. Lack of awareness about visual health
2. Shortage of eye care professionals
3. Lack of national consensus and surveillance
4. Funding shortfalls to support vision health programs

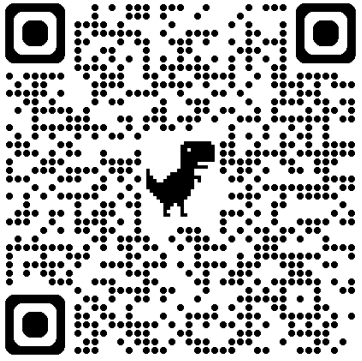
Identifying Children with Myopia and the Links to Treatment: Methods and Barriers

Recommendations and funding priorities

1. National consensus and data surveillance system
2. Vision screening before first grade, eye exam when needed
 - research on evidence-based approaches
 - funding for community-based programs
3. Myopia should be classified as a disease and a diagnosis

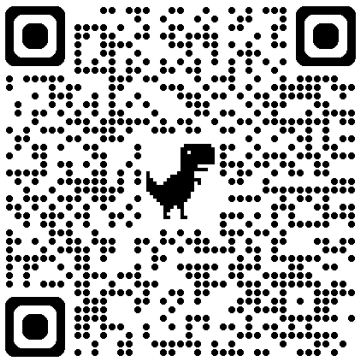
Thank you!

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For more information and to access the full report after public release, visit the study website: <https://www.nationalacademies.org/our-work/focus-on-myopia-pathogenesis-and-rising-incidence>

Or email:
Molly Dorries, mdorries@nas.edu
Dan Weiss, dweiss@nas.edu



Check out other studies under way at the Board on Behavioral, Cognitive, and Sensory Sciences:
<https://www.nationalacademies.org/bbcss/board-on-behavioral-cognitive-and-sensory-sciences>

Deep Dive and Additional Questions



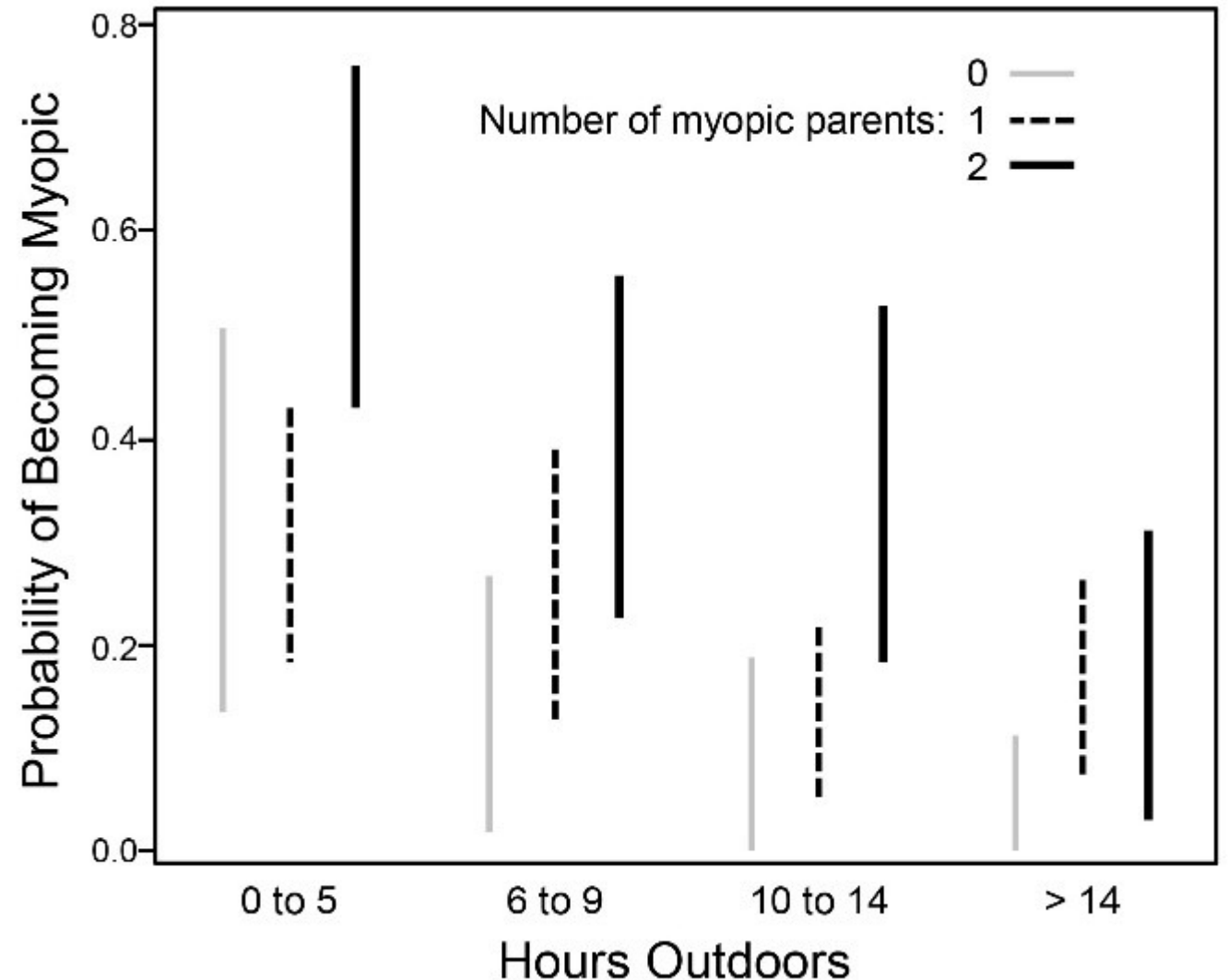
The Taiwan Experience

Lessons Learned:

1. Steadily increasing rates of myopia in children from 1980s through 2010
2. Peaked at about 50% of children with myopia
3. Instituted 2 hours of outdoor time in 2010
4. Followed by decreasing numbers in each year

The Taiwan Experience

Taiwan implemented the time outdoors strategy and it appears to be having a beneficial effect.



Recommendations and funding priorities: Supporting new treatment options

What we know:

- Predictors of myopia progression
- Past myopia progression does not predict future progression.
- Myopia tends to progress faster when onset is at younger ages

What we don't know:

- Effect of treatment in preschool-aged children
- Effect of treatment in children with high myopia

Recommendations and funding priorities: Supporting new treatment options

What we do know:

- The largest treatment effect of any published treatment option remains under *0.75 diopters over 2 years*.
- Some treatment options are effective in the first year and less effective in subsequent years.

What we don't know:

- How and when treatment should be stopped?
- Is rapid eye growth during rebound more detrimental than slow and steady growth?

Treatment Options: Priorities for Future – **Clinical/Translational**

- Pharmaceutical
 - Identify dosing characteristics including concentration and cadence to slow eye growth
- Time outdoors
 - Determine optimal parameters for time outdoors including duration per day, spectral distribution, time of day, and needed safety measures to prevent or delay myopia onset.
- Optical
 - Develop optical corrections for best visual performance including spectral composition of light, peripheral refractive characterization, and contrast.
- Combination Therapy

Ideal characteristics of Myopia Control Therapies

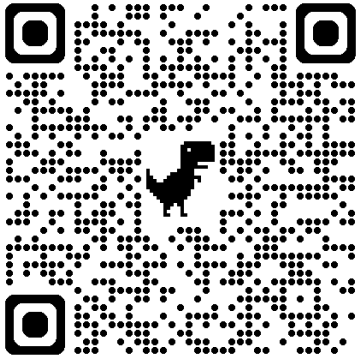
- Preventative
- Feasible for a child
- Meaningful treatment effects (similar or accruing) with each year of use, without rebound effects
- Effective in a diverse populations
- Based on robust mechanism and translational research
- FDA-approved
- Safe
- Beneficial for long-term ocular health
- Cost effective

Questions?



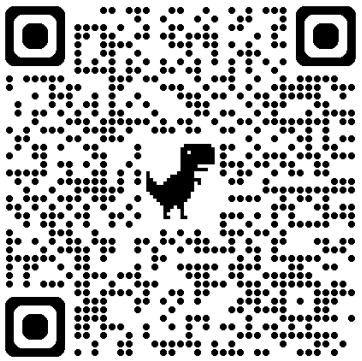
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