Myopia Management in Your Practice

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About Me

Thank You!

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Financial Disclosures

Educational/ Clinical Consultant:

- Paragon Vision Sciences
- CooperVision
- Valley Contax

Outline

Part 1

- Definition
- Prevalence
- Pathogenesis

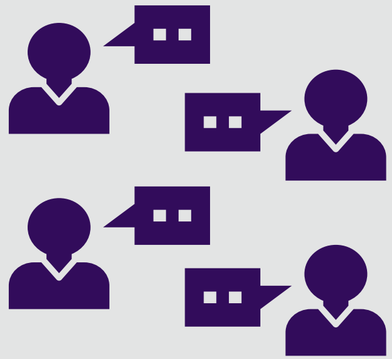
Part 2

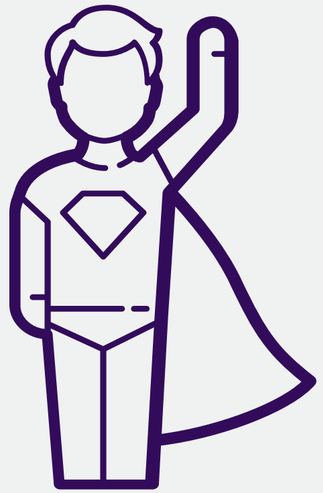
- Risk Factors for Developing Myopia
- Ocular Disease Associated with Myopia

Part 3

- Myopia Management Treatment Options

Why Myopia Management?





Code of Ethics: “To keep their patients' eye, vision, and general health paramount at all times”

Part 1

Definition

Prevalence

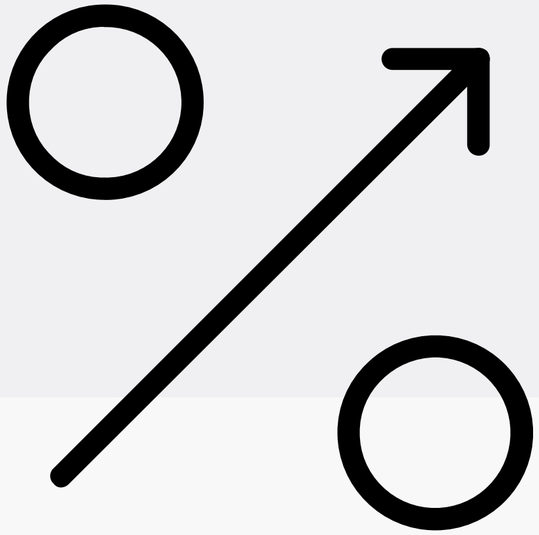
Pathogenesis

Definition

Defining Myopia

> -0.50 D	> -5.00 D
Myopia	High Myopia
-1.50 D	-4.00 D
“Moderate Vision Impairment”	“Blindness”

WHO-BHVI Meeting on Myopia, 2015



Prevalence

Prevalence: Globally

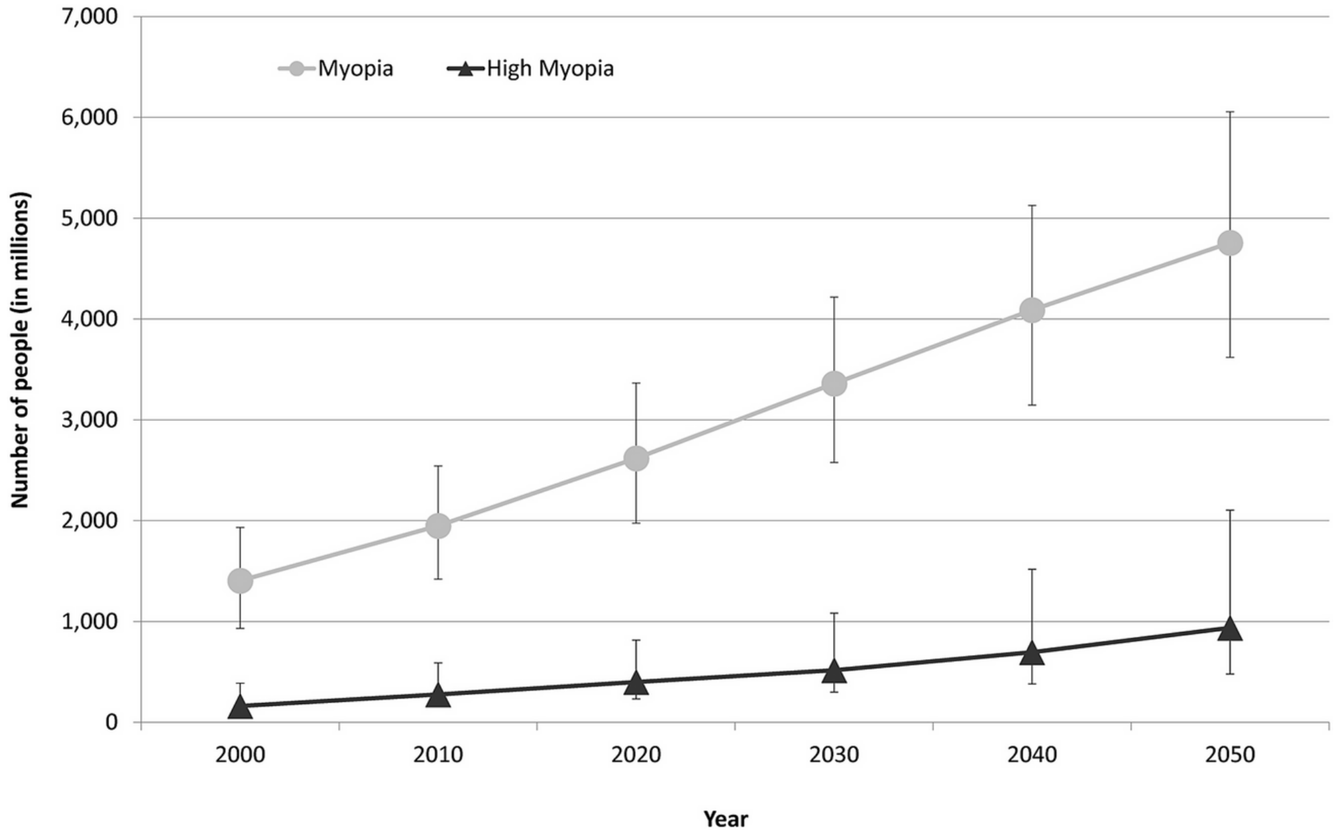
2010

Myopic: 28.3% (1.95B)

Highly Myopic: 4% (930M)

Holden, et al. Ophthalmology 2016

Prevalence: Globally



Holden, et al. Ophthalmology 2016

Prevalence: Globally

	2010	2050
Myopic	28.3% (1.95B)	>50% (5B)
Highly Myopic	4% (227M)	10% (930M)

East Asian Countries: 80-90% of high school grads

- 10-20% have sight-threatening pathologies

Ma, et al. Invest Ophth Vis Sci 2016
Lin, et al. Ann Acad Med Singapore, 2004

Prevalence: United States

Myopic Adults

2010 — 2050

30%

48.5%

>58.6%

Holden, et al. Ophthalmology 2016

Prevalence: United States

Myopic Children (11-13 yo)

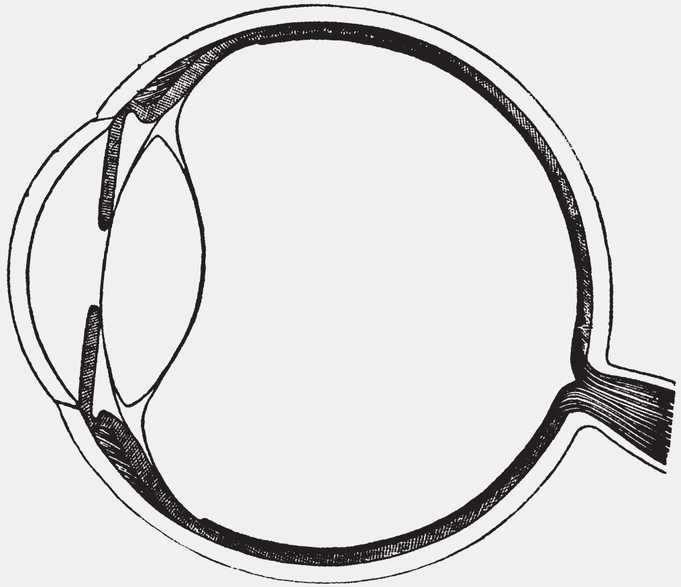
1994 — 2013

12%

49.4%

"These projections are based on conservative assumptions and, given the published relationship between level of education and myopia, increased provision of education could markedly increase these trends"

Vitale, et al. Arch Ophth, 2009; Hrynchak, et al. Optom Vis Sci, 2013; Theophanous, et al. Ophthalmol, 2018..



Pathogenesis

Emmetropization

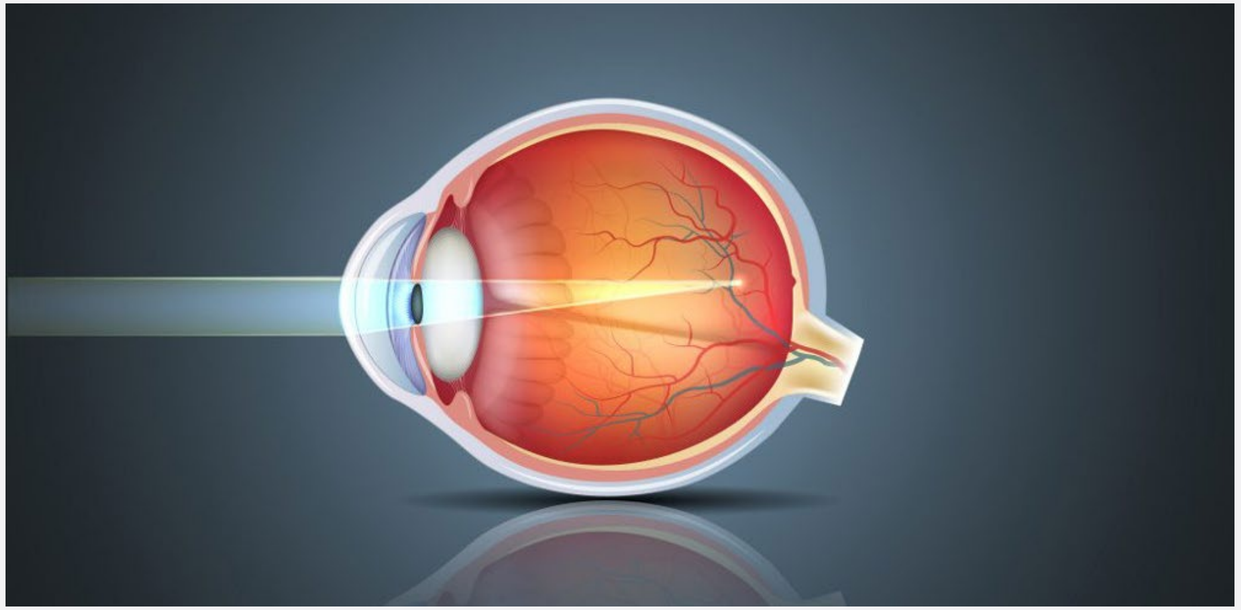
Normal Physiologic Process:

- Corneal and lenticular refractions harmonize with the increasing axial length

Axial Length:

- Most influential factor for proper emmetropization

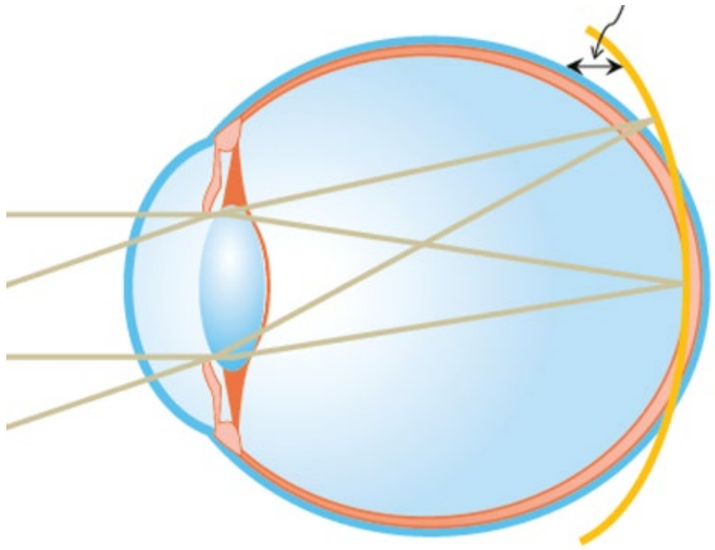
Myopia



Theories

Accommodative Lag Theory (c. 2000)

Peripheral Refraction Theory (c. 2020)



Theories

Accommodative Lag Theory (c. 2000)

- Under-accommodation during near work
- Image focused behind the retina at fovea
- Relative hyperopia stimulates eye growth
- Treat with plus at near: Bifocals, PALS

Theories

Optom Vis Sci. 2002 Apr;79(4):268-73.

Do progressing myopes show re

Rosenfield M[1], Desai R, Portello JK.

Author information

Abstract

Refractive error and accommodative respons
increased lag of accommodation either prec
levels of 2.5, 3, 4, and 5 D, and both the slo
subjects exhibited accommodative stimulus
myopic upon entry into the study and whos
accommodation. These findings do not su
accommodative response during nearwo

Accommodativ
progression in
correction

David A. Berntsen [a], Loraine T
1

Show more

https://doi.org/10.1016/j.visr

Under an Elsevier user licer

Abstract

The relationship be
investigated using l
correction in the C
Error (CLEERE) S
error at baseline v
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Format: Abstract

onset myopia

Invest Ophthalmol Vis Sci. 2012 Feb 13;53(2):640-9. doi: 10.1167/iovs.11-7769. Print 2012 Feb.

A randomized trial using progressive addition lenses to evaluate theories of myopia progression in children with a high lag of accommodation.

Send to

Berntsen DA[1], Sinnott LT, Mutti DO, Zadnik K.

Author information

Abstract

PURPOSE: To compare the effect of wearing, then ceasing to wear, progressive addition lenses (PALs) versus single vision lenses (SVLs) on myopia progression in children with high accommodative lag to evaluate accommodative lag and mechanical tension as theories of myopia progression.

METHODS: Eighty-five children (age range, 6-11 years) with spherical equivalent (SE) cycloplegic autorefraction between -0.75 D and -4.50 D were randomly assigned to wear SVLs or PALs for 1 year; all children wore SVLs a second year. Children had high accommodative lag and also had near esophoria if their myopia was greater than -2.25 D SE. The primary outcome after each year was the previous year's change in SE.

RESULTS: When the children were randomly assigned to SVLs or PALs, the adjusted 1-year changes in SE were -0.52 D (SVL group) and -0.35 D (PAL group; treatment effect = 0.18 D; P = 0.01). When all children wore SVLs the second year, there was no difference in myopia progression between SVL and former PAL wearers (0.06 D; P = 0.50). Accommodative lag was not associated with myopia progression.

CONCLUSIONS: The statistically significant, but clinically small, PAL effect suggests that treatments aimed at reducing foveal defocus may not be as effective as previously thought in myopic children with high accommodative lag. Finding no evidence of treatment loss after discontinuing PAL wear supports hyperopic defocus-based theories such as accommodative lag; however, not finding an associat
between accommodative lag and myopia progression is inconsistent with the PAL effect being due to d
(Clinical Trials.gov number, NCT00335049.).

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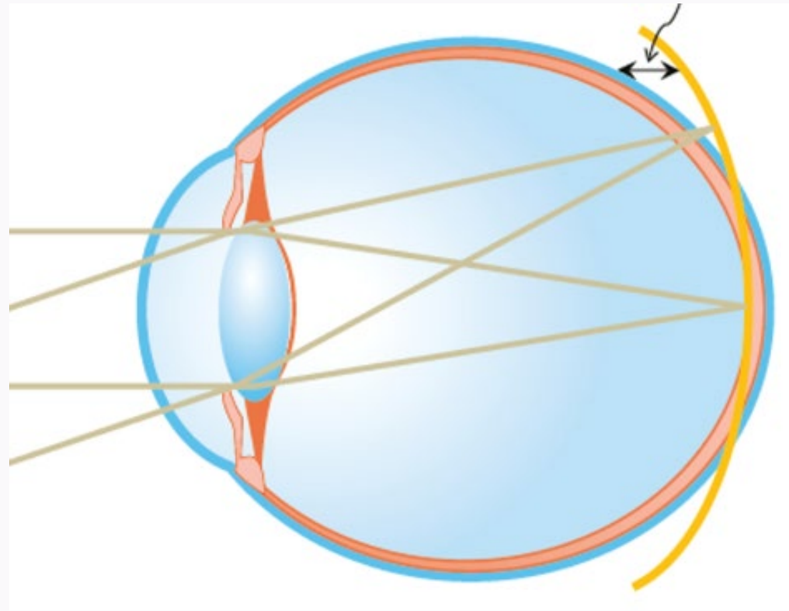
"Accommodat
progression"

"The statistically significant, but clinically small, PAL effect suggests that treatments aimed at reducing foveal defocus may not be as effective as previously thought in myopia children with high accommodative lag"

Theories

Peripheral Refraction Theory (c. 2020)

- Shorter off-axis eye length
- Image focused behind the retina in periphery
- Relative hyperopia stimulates eye growth
- Treat with plus in periphery: Ortho -K, MFs



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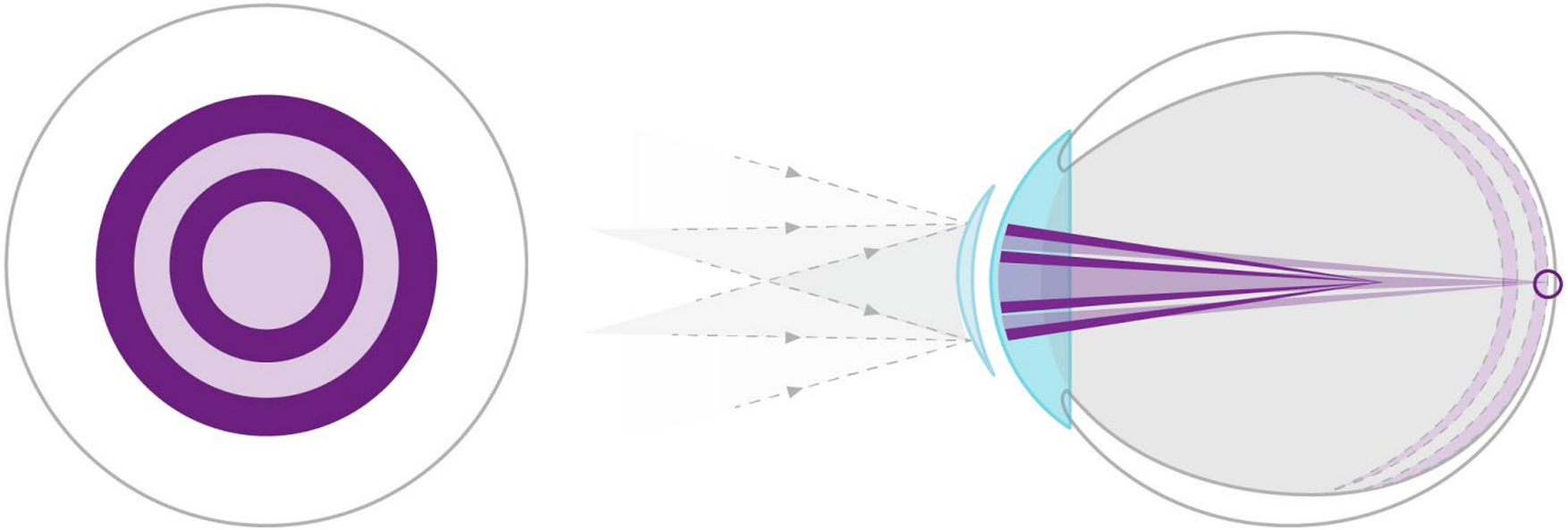

Treatment zones creating myopic defocus

Correction zones

Chamberlain, et al. Opt. and Vis. Sci. 2019.

Theories

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Peripheral Refraction Theory (c. 2020)

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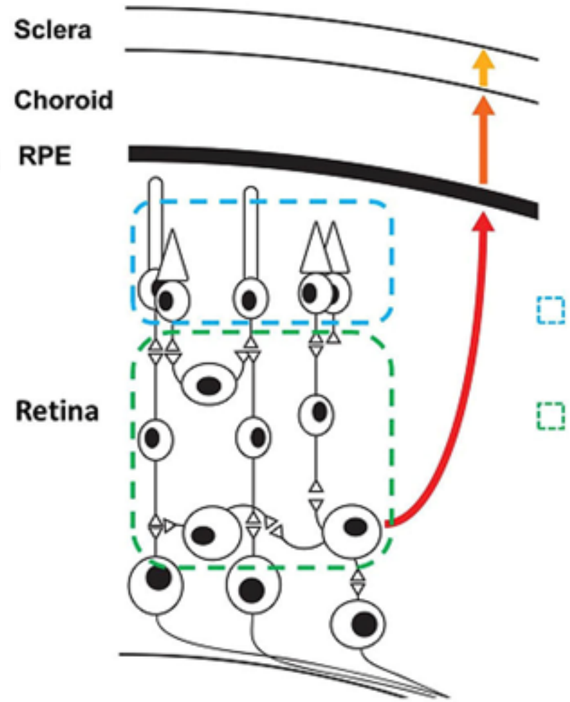
Peripheral Refraction Theory

Signal Cascade through the Choroid



Sclera: Cellular Proliferation/Eye Growth
- Growth Factors (TGF-β, bFGF)
- Retinoic Acid

Choroid: Blood Supply/Signalling Tissue?
- Nitric Oxide
- mAChRs
- Choroids from myopic eyes can stimulate proliferation of scleral cells (retinoic acid?)

Retinal Pigment Epithelium (RPE): Blood-Retina Barrier
- Retinoic Acid
- Transporters (cation, monoamine)

Outer Retinal Circuitry: Photoreceptors
Light adaptation – first stage
- Gap junction coupling (NO, DA)

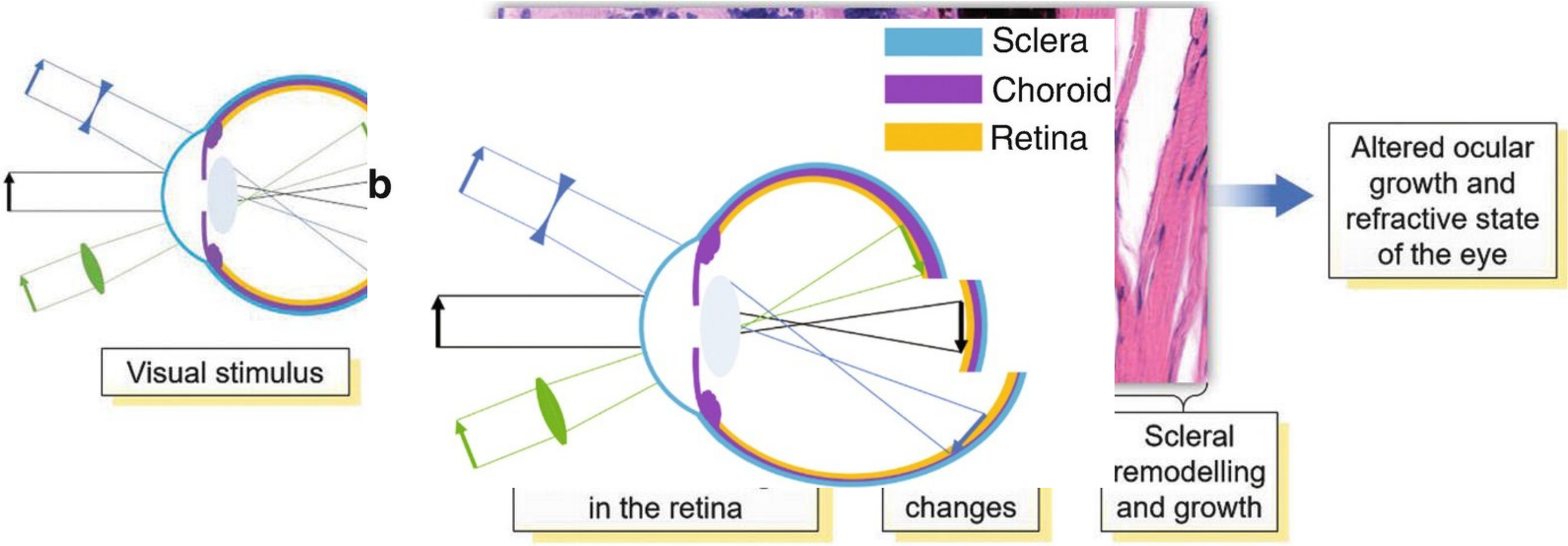
Inner Retinal Circuitry: Amacrine , bipolar, horizontal cells
Visual Image Processing
- Changes in space, time, movement (ACh)
- Focus/Defocus (EGR-1, DA)
- Contrast: Light intensity & colour contrast (DA, NO)
- Light adaptation – second stage (gap junctions: NO, DA)

Neurotransmitters/Neuromodulators
- DA
- NO
- ACh/mAChRs
- GABA/Glycine
- Retinoic Acid
- Peptides

Jin, et al. Am J Ophth, 2016

Peripheral Refraction Theory

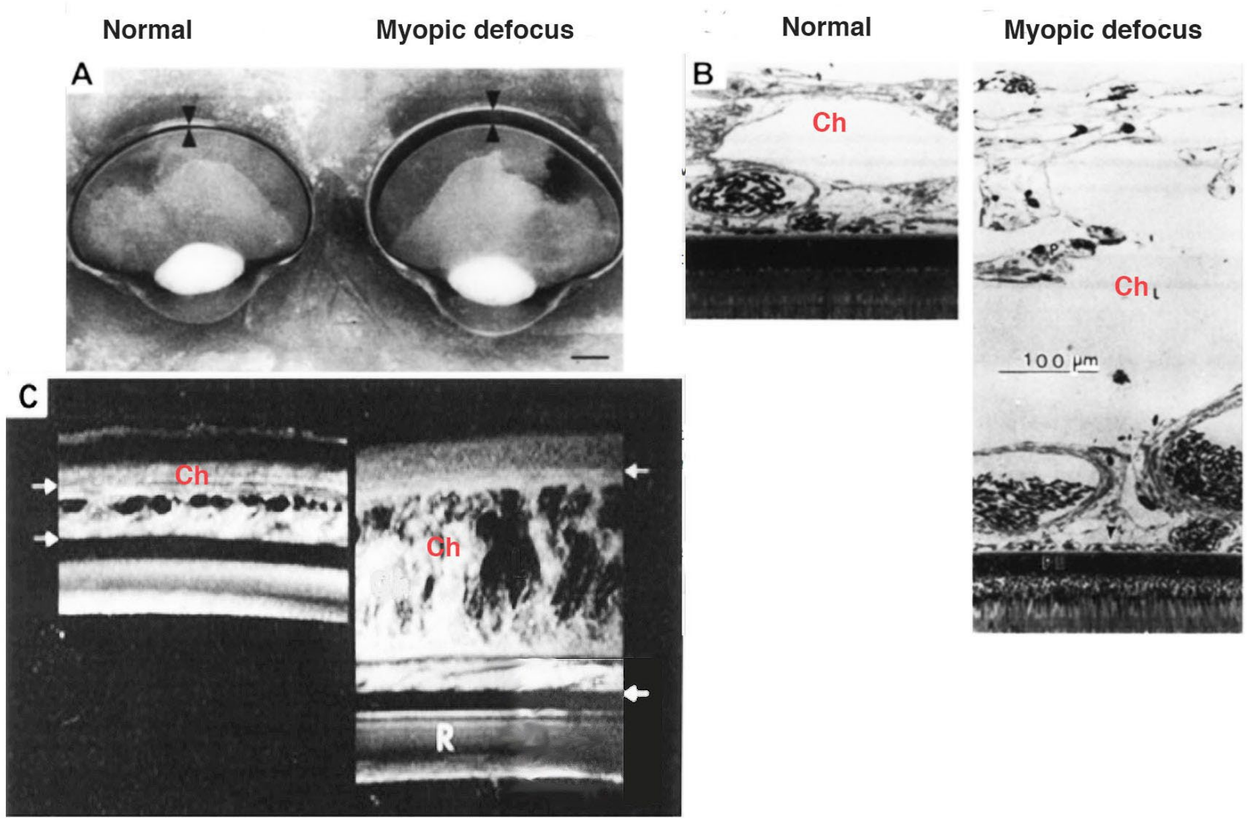
Signal Cascade through the Choroid



Wallman et al. Vision Res., (1995), Chakraborty, et al. Updates on Myopia, 2019

Peripheral Refraction Theory

Signal Cascade through the Choroid



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Peripheral Refraction Theory

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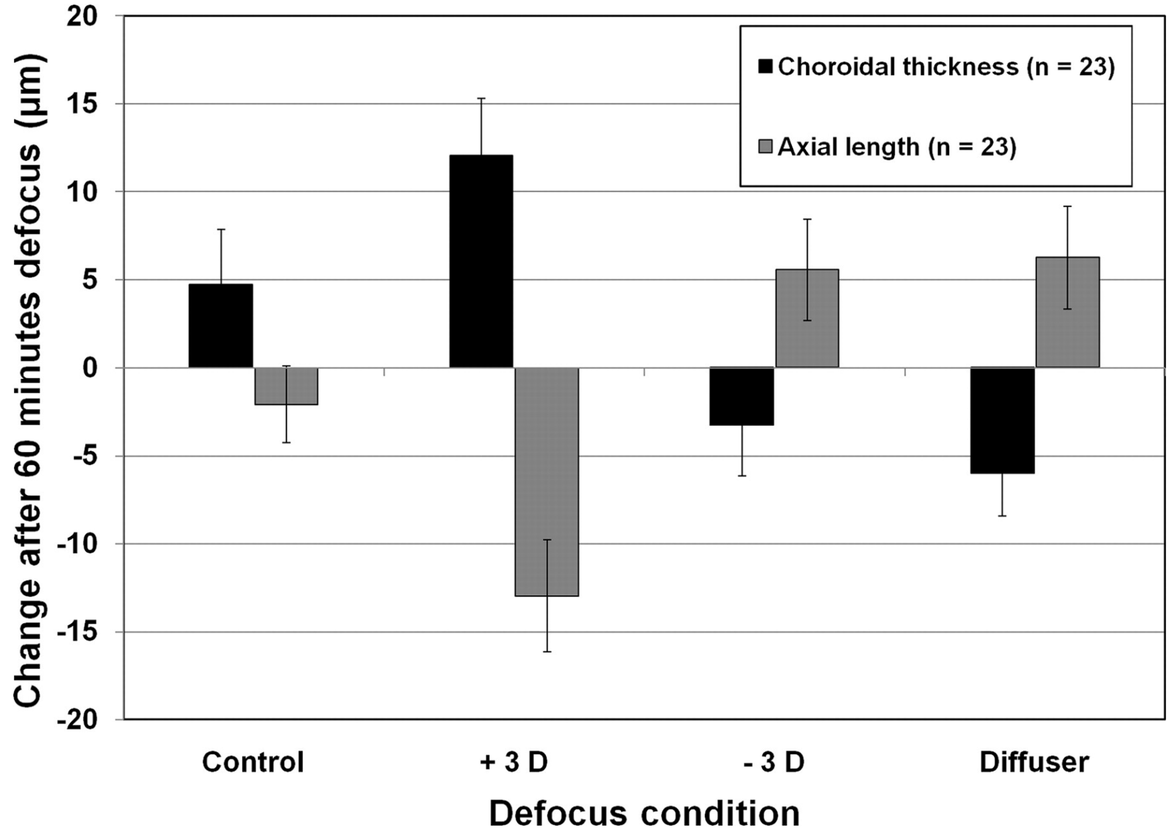


Scott et al., IOVS. 2010

Peripheral Refraction Theory

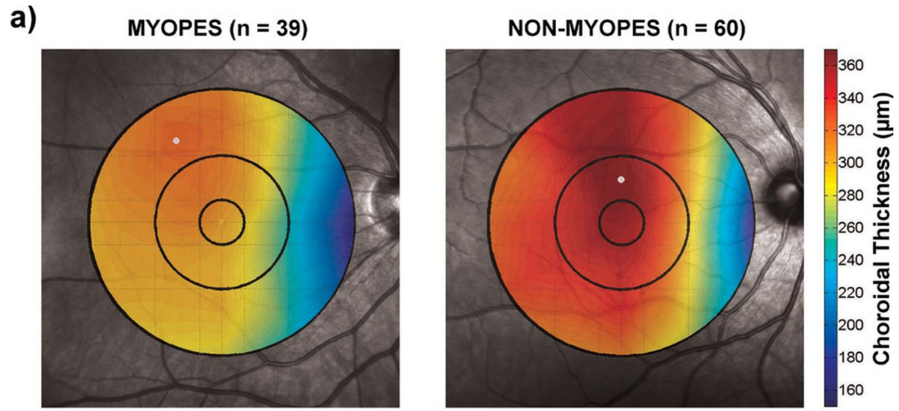
Signal Cascade through the Choroid

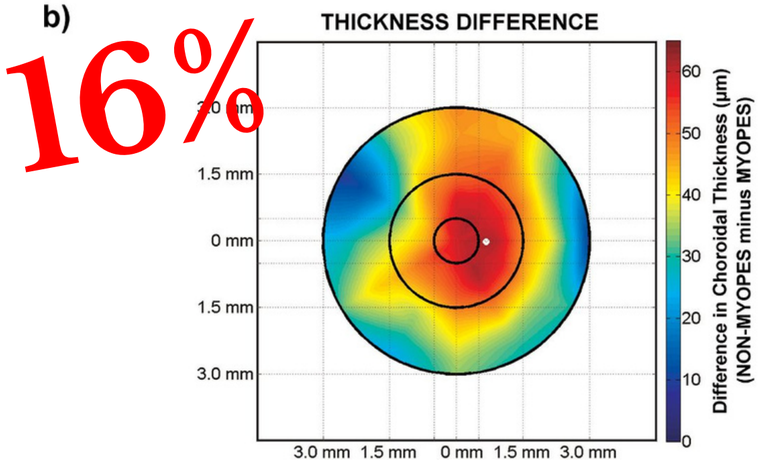
Subjects:

- n= 104 subjects, ages 10-15
- 41 myopic, 63 non-myopic

Conclusions

- 16% thinner subfoveal choroidal thickness
- 6%= passive stretching





Jin, et al. Am J Ophth, 2016

Peripheral Refraction Theory

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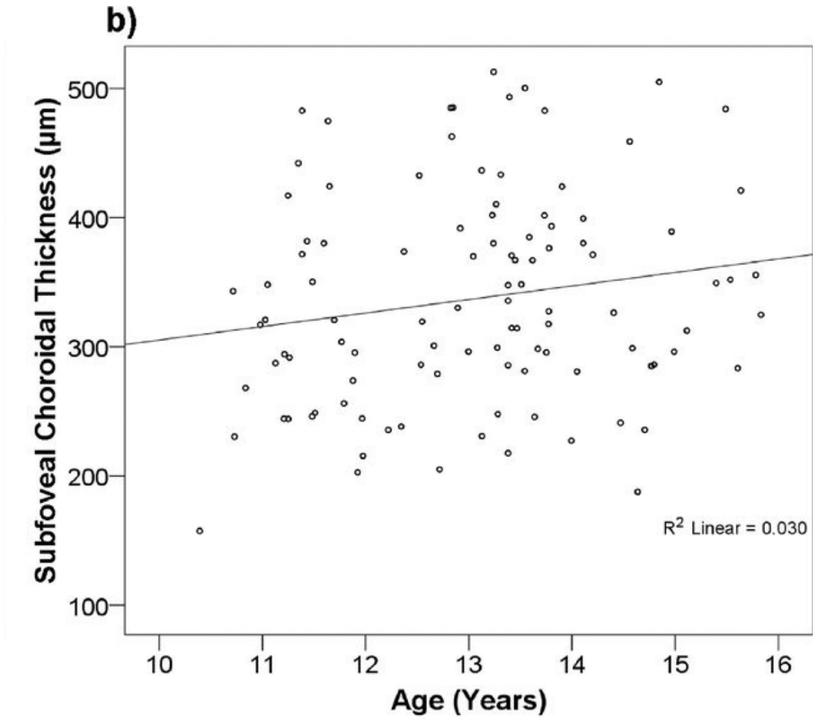
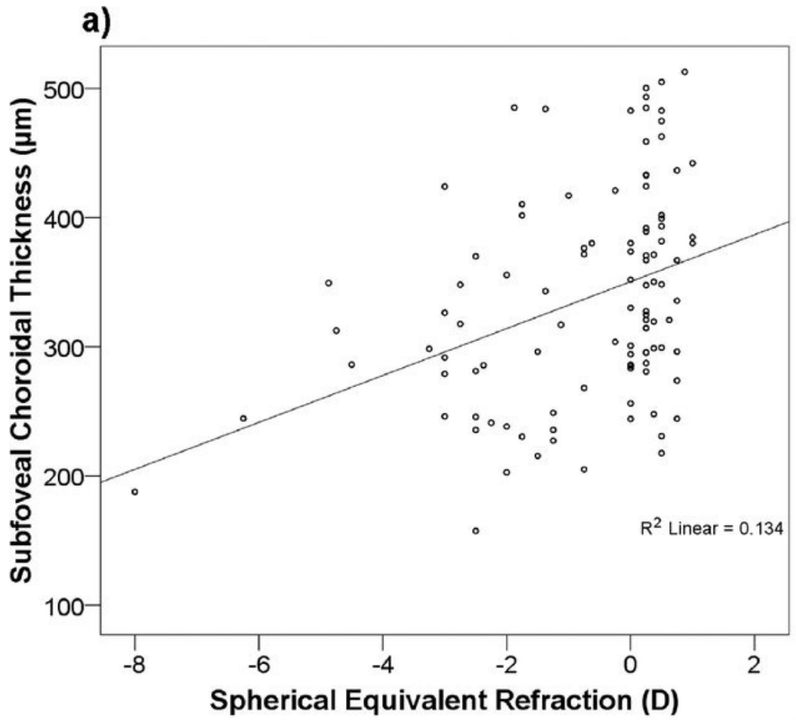




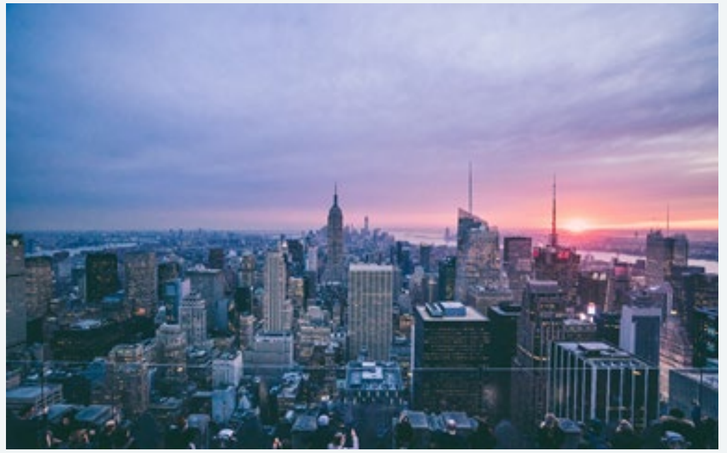
Choroidal thinning occurs early in refractive error development process

Jin, et al. Am J Ophth, 2016

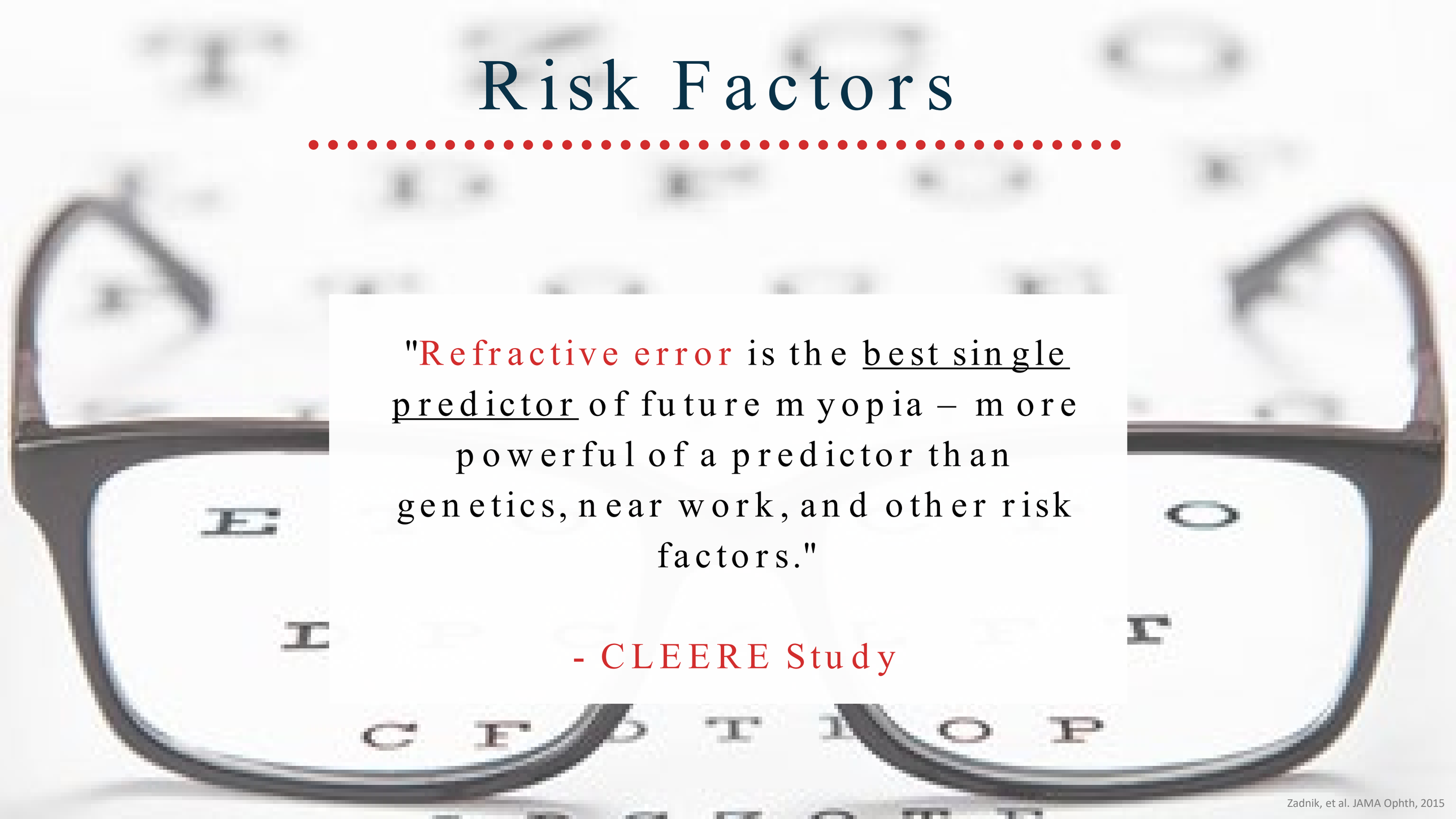
Part 2

- Risk Factors for Developing Myopia
- Ocular Disease associated with Myopia

Risk Factors



Risk Factors



"Refractive error is the best single predictor of future myopia – more powerful of a predictor than genetics, near work, and other risk factors."

- CLEERE Study

Zadnik, et al. JAMA Ophth, 2015

Risk Factors

Age	Refractive Threshold for Risk of Myopia Development
6	< +0.75 D
7-8	≤ +0.50 D
9-10	≤ +0.25 D
11	≤ +0.00 D

Zadnik, et al. JAMA Ophth, 2015

Clinical Pearl

START THE DISCUSSION EARLY

Risk Factors

Genetics

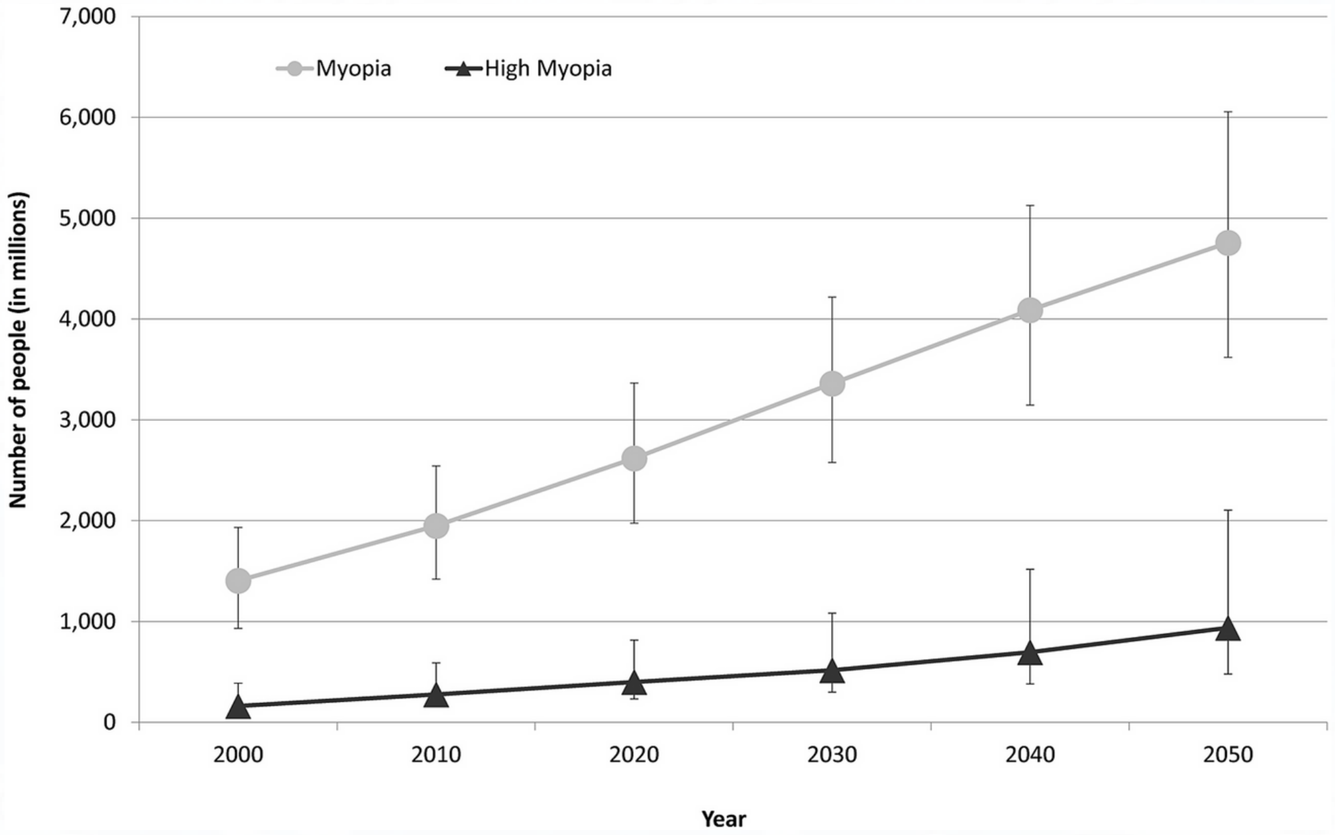
2x greater

5x greater

Jones, et al. Inv. Ophth, 2007

Risk Factors

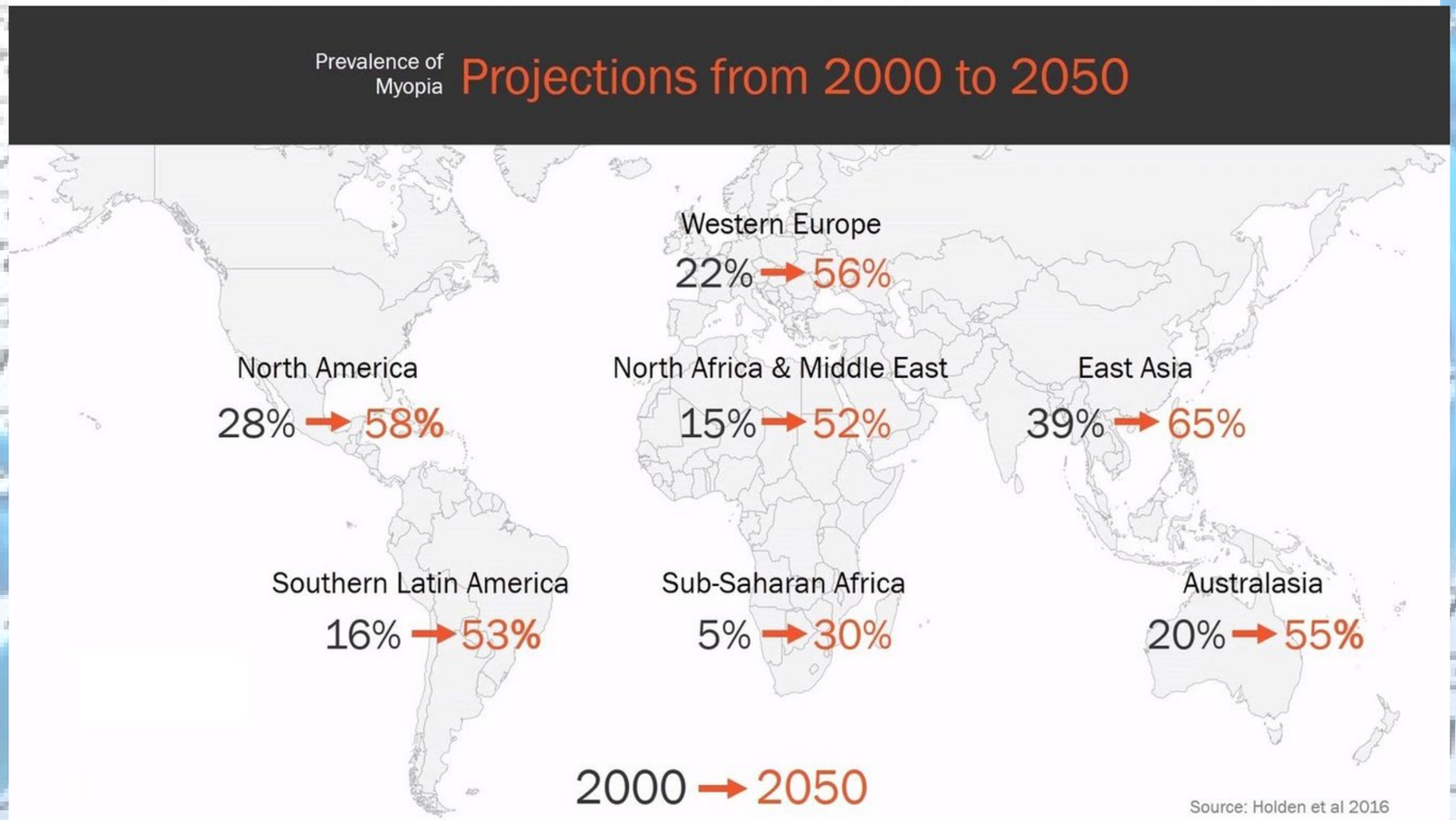
Genetics



Holden, et al. Ophthalmology 2016

Risk Factors

Genetics



Risk Factors

Genetics

Not Limited to a Single Race

Myopia Prevalence

- Higher in Indian & Chinese origin in Singapore
- Lower in Indians in India & Chinese in rural China

Holden, et al. Ophthalmology 2016

Risk Factors

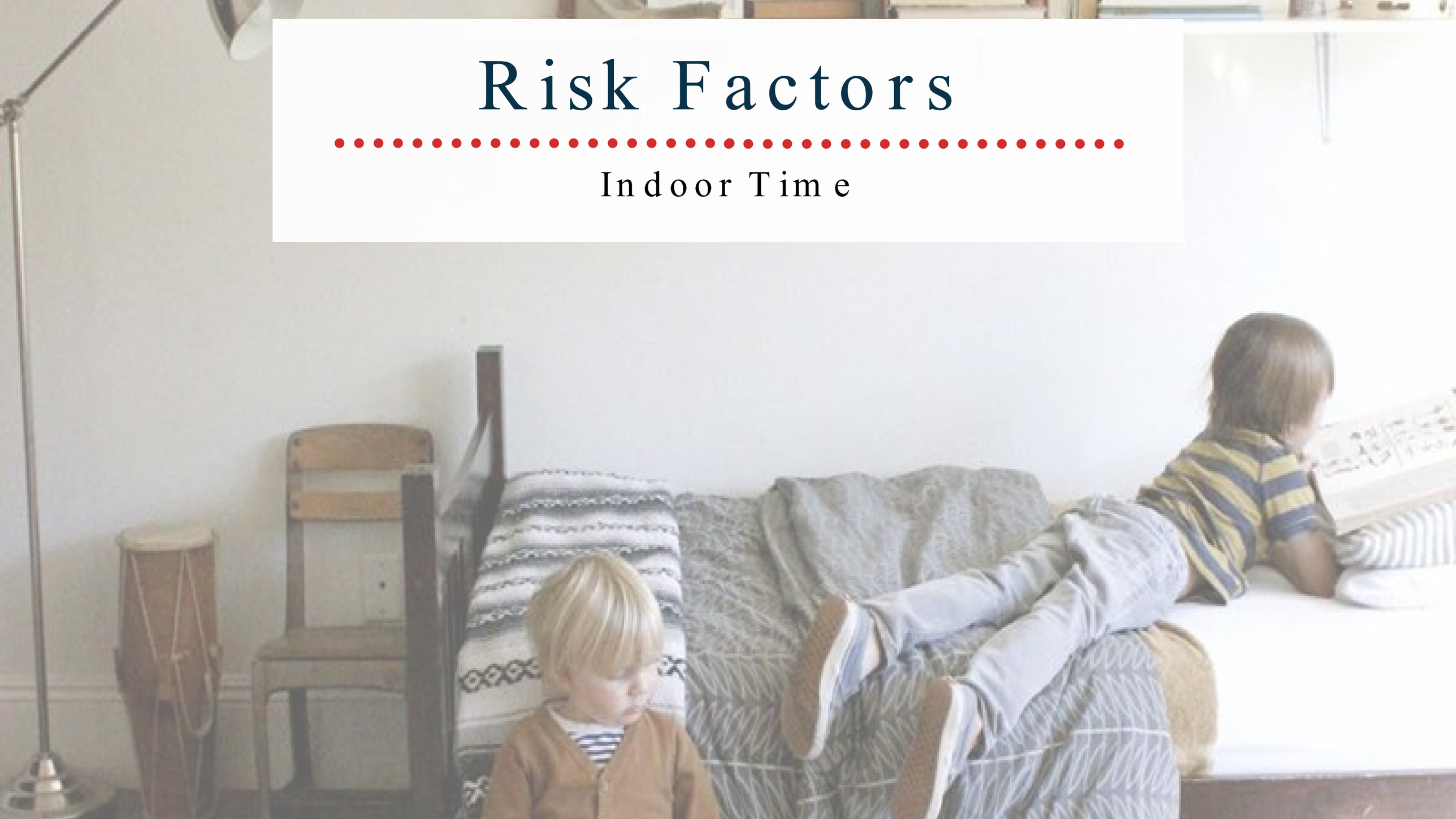
Urban Living

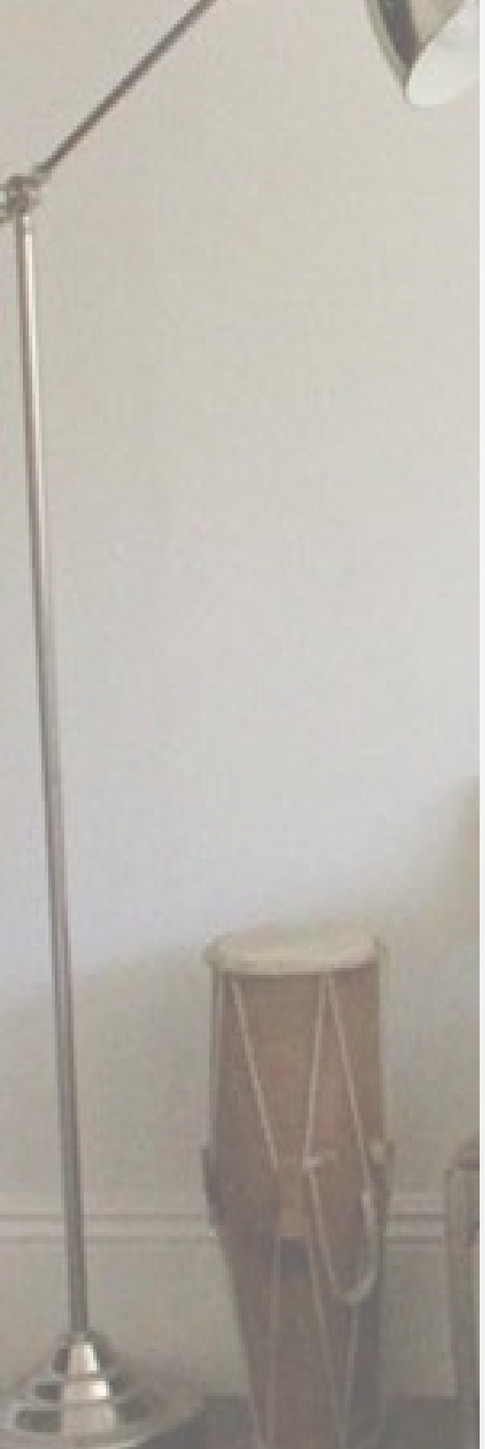
2.6%

INCREASED RISK

Risk Factors

Indoor Time



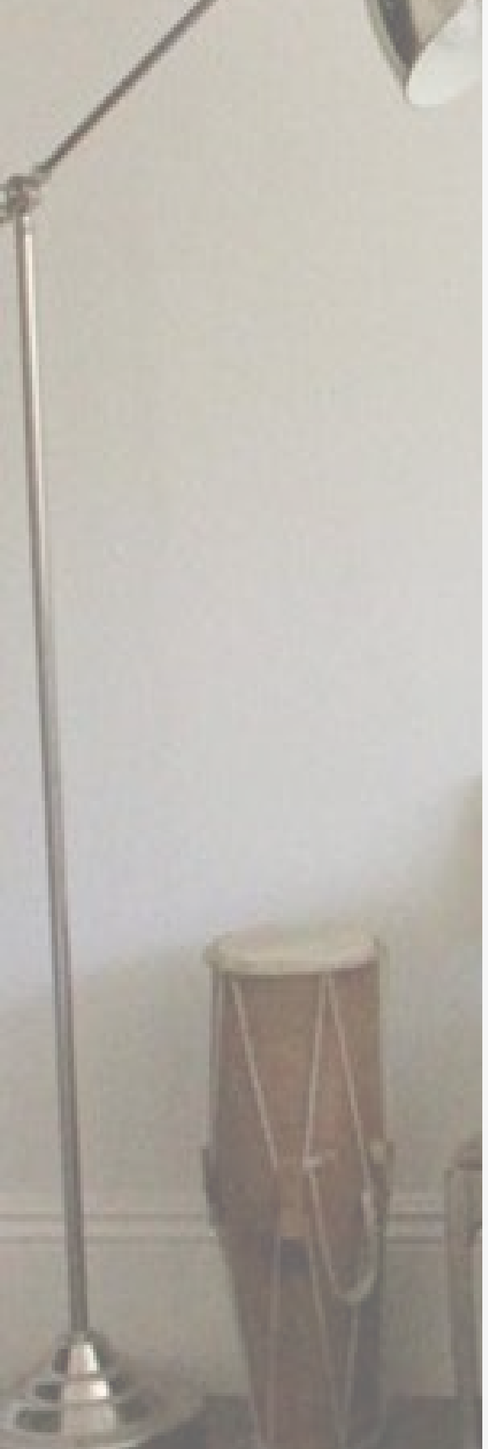


Risk Factors

Indoor Time

- Seasonal variation of myopic progression

lin, et al. Optom Vis Sci, 2014.



Risk Factors

Indoor Time

- Outdoor sports vs indoor sports

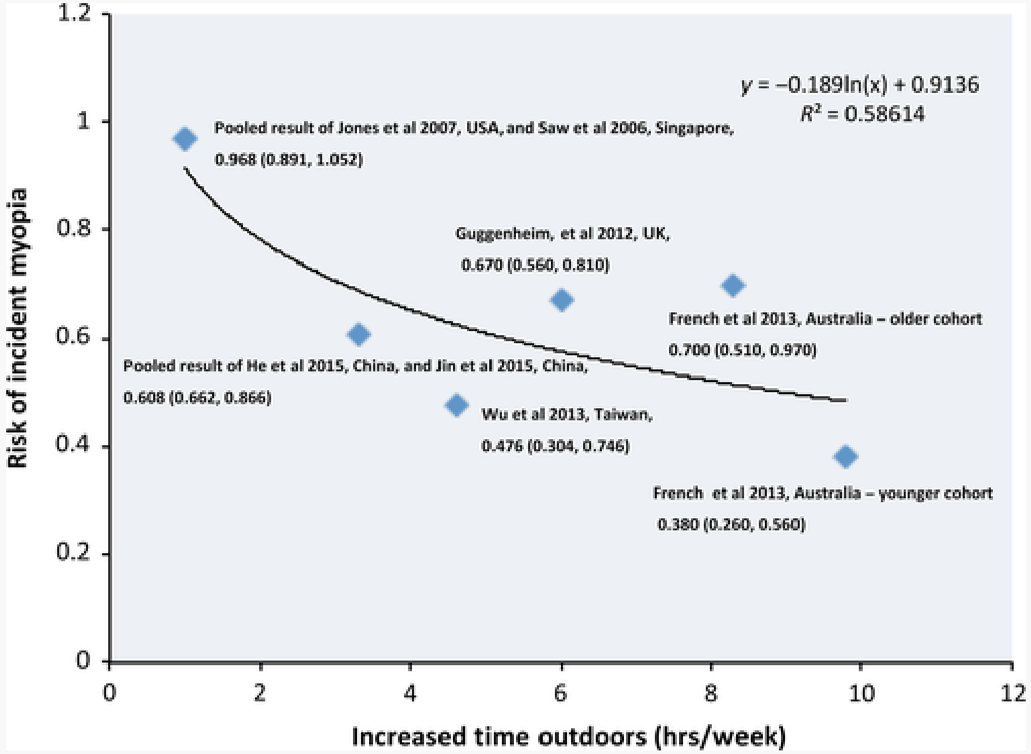
Q: Is outdoor time protective?

Rose, et al. Ophthalmology, 2008.

Outdoor Time

Protective against Onset

<13 hours/week of outdoor time:
higher odds ratio of incident myopia

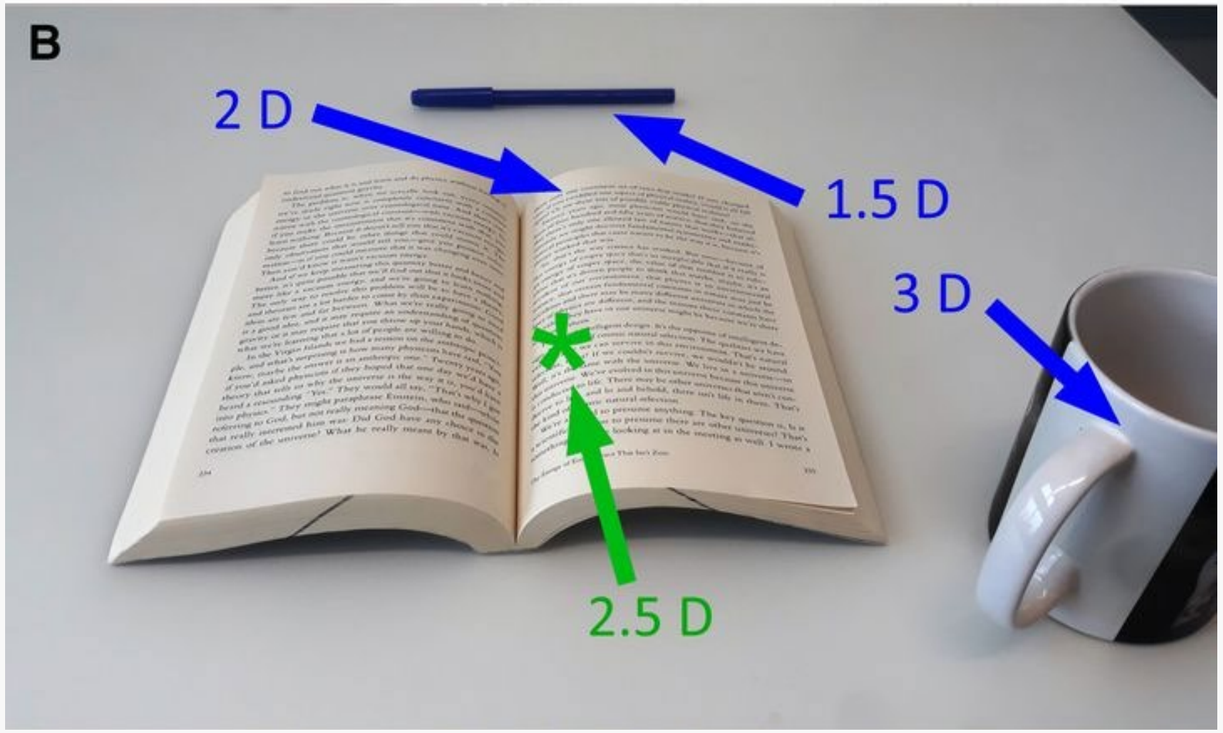


Odds of myopia development were reduced by 2% per additional hour

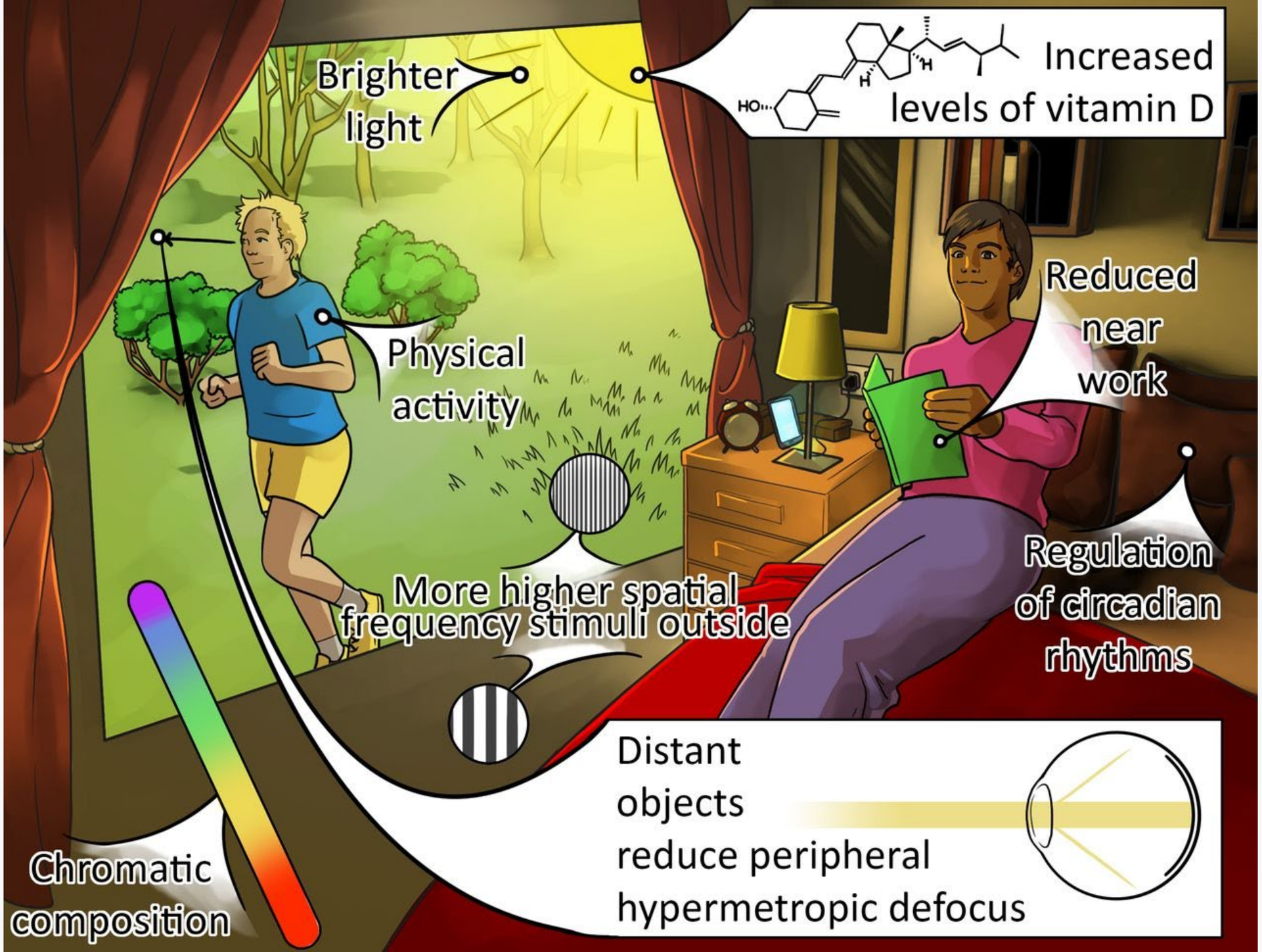
Xiong, et al. Acta Ophth, 2017.

Outdoor Time

Dioptric Demand

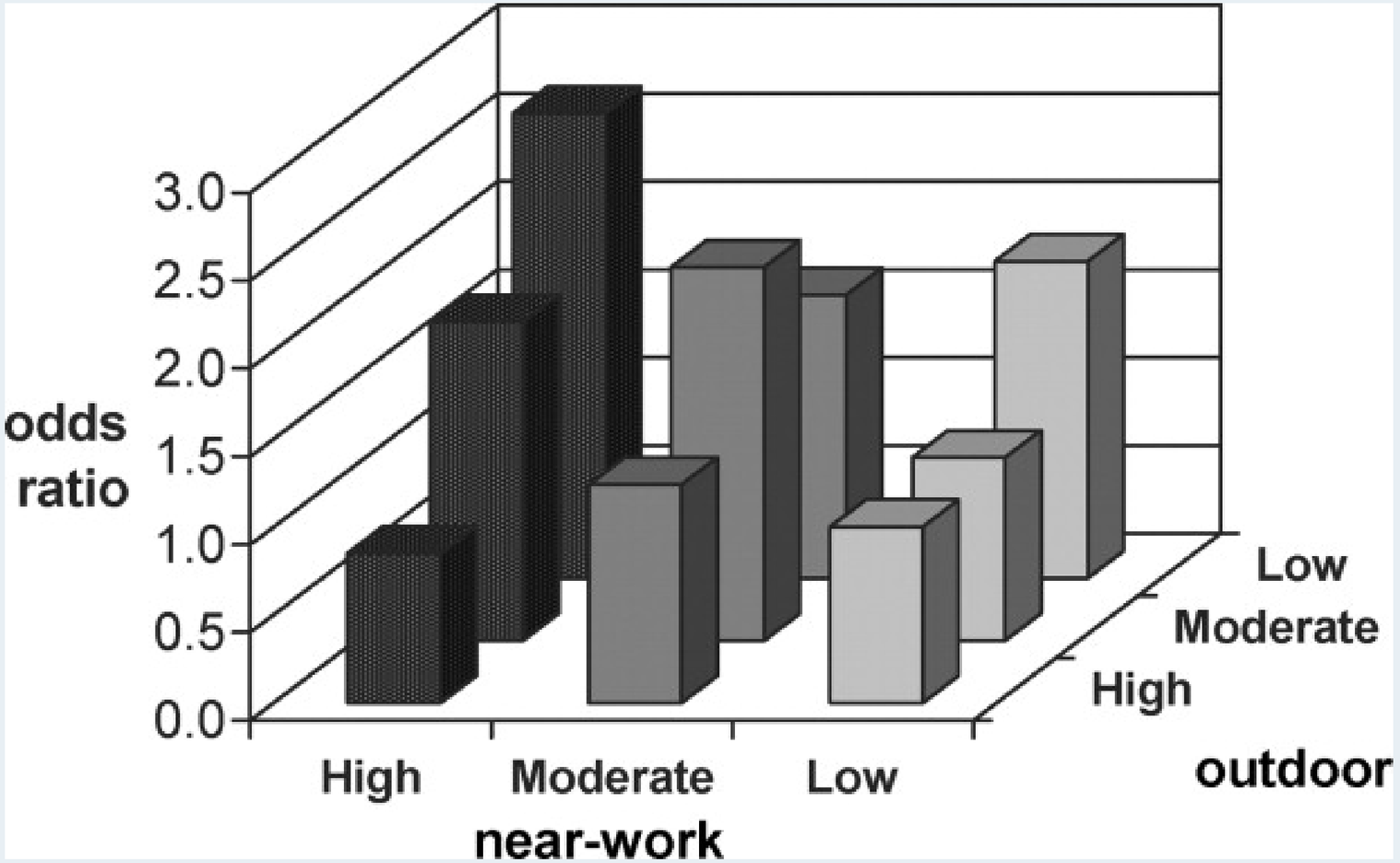


Lingham, et al. British J. of Ophth, 2020.



Lingham, et al. British J. of Ophth, 2020.

Outdoor Time & Near Work



Rose, et al. Ophthalmology, 2008.

Outdoor Time

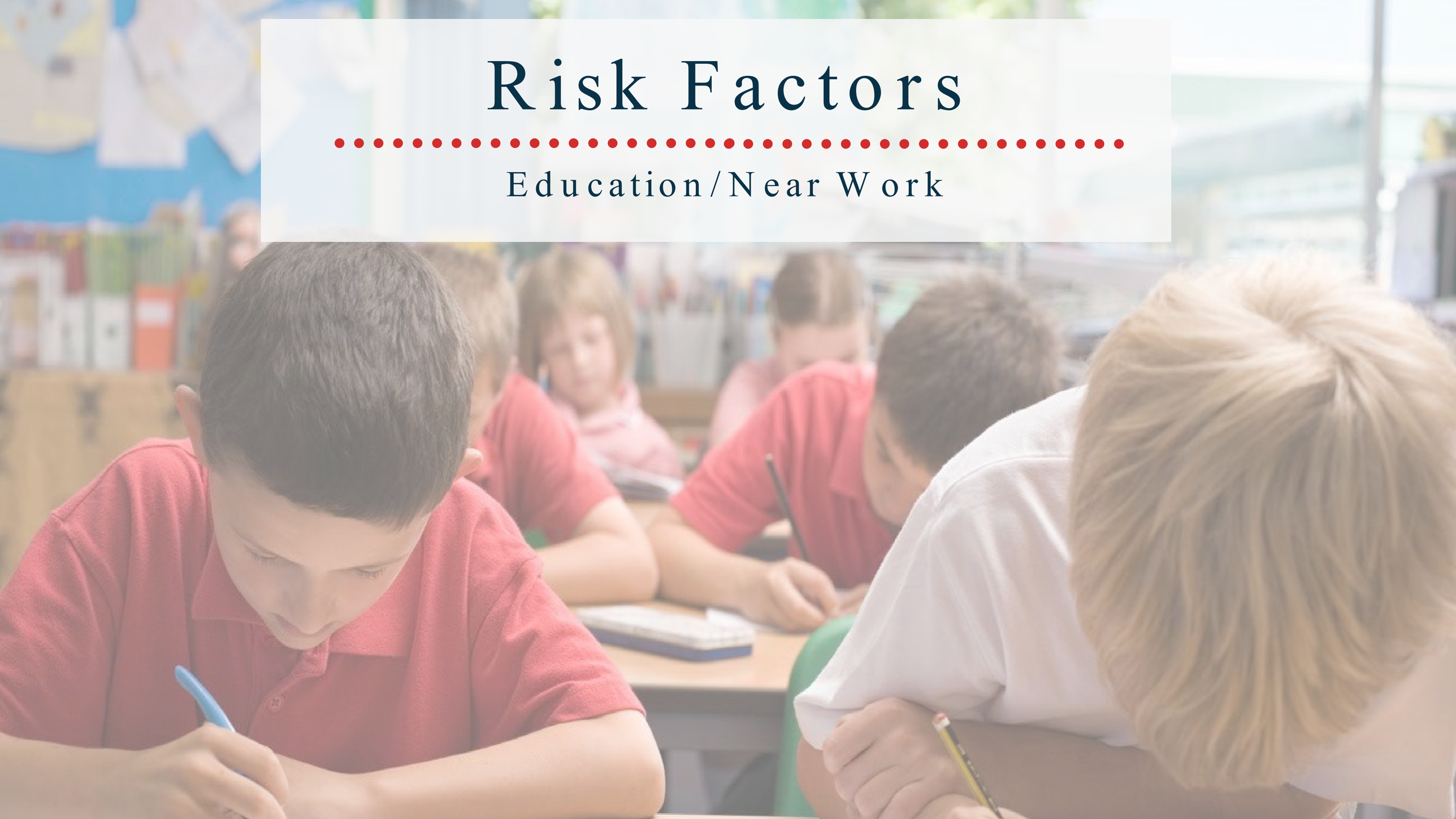
Recommend children increase outdoor time to 2 hours/day or 14 hours/week

Will have the greatest effect on delaying or preventing myopia onset in children.

Rose, et al. Ophthalmology, 2008.

Risk Factors

Education/Near Work




我
我
蓝天是白云的家，
树林是小鸟的家，
班级是我们的家。


1938

Risk Factors

Education/Near Work

Ex) If a child has 4 hours per day for near work (33 cm) in tutorial classes after school during weekdays (Monday to Friday), then he would most likely have 120% of additional odds of myopia

4 hours x 3 D x 5 days/week x 2% = 120%

Risk Factors

Education/Near Work

87%

WORLD'S STUDENT POPULATION IN HOME CONFINEMENT DURING 2020

UNESCO Report

Near Work

Potential Mechanisms

- Mechanical:
  - Temporary increase in axial length during near work
- Optical:
  - More hyperopic defocus during near work

Huang, et al. PLOS. 2015

Accommodative Lag

Normal: +0.25 - +0.75 D

- Higher accommodative lags correlated with increased risk for progressive myopia

Measure with MEM Retinoscopy

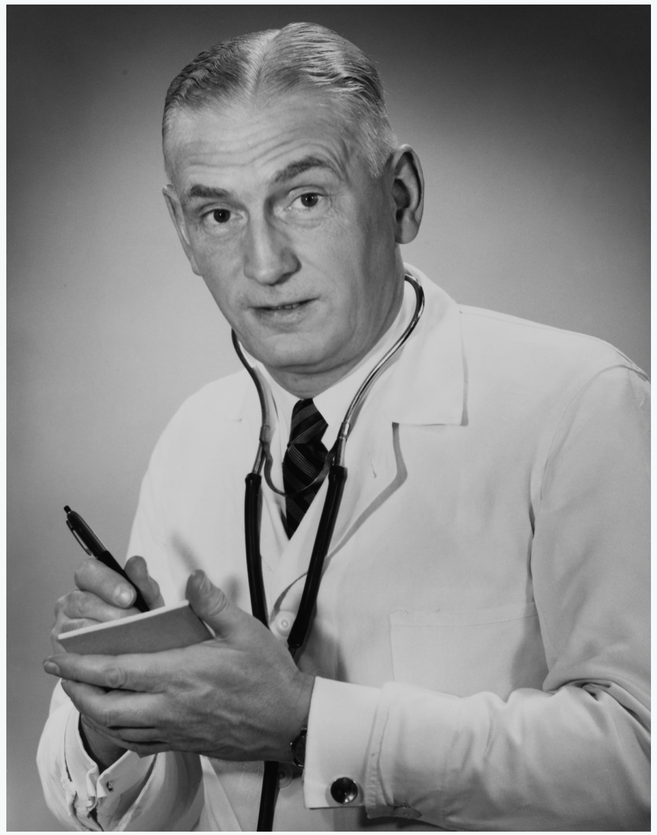
Accommodative Lag

Measure with MEM Retinoscopy

- Patient in full - correction
- W.D. = 40 cm or preferred W.D.
- Briefly hold lens in front while quickly assessing reflex
- With motion = +
- **Normal: +0.25 - +0.75 D**
- Higher → risk for progressive myopia

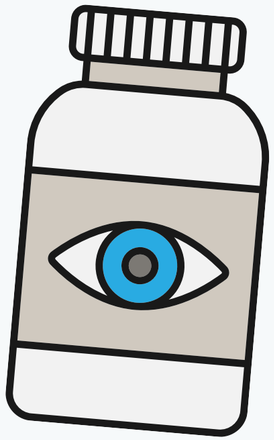
Early Intervention

Clinical Recommendations



If increased risk factors for myopia, Rx:

- ☐ Outdoor Time
- ☐ Breaks from near work
- ☐ More frequent follow-ups



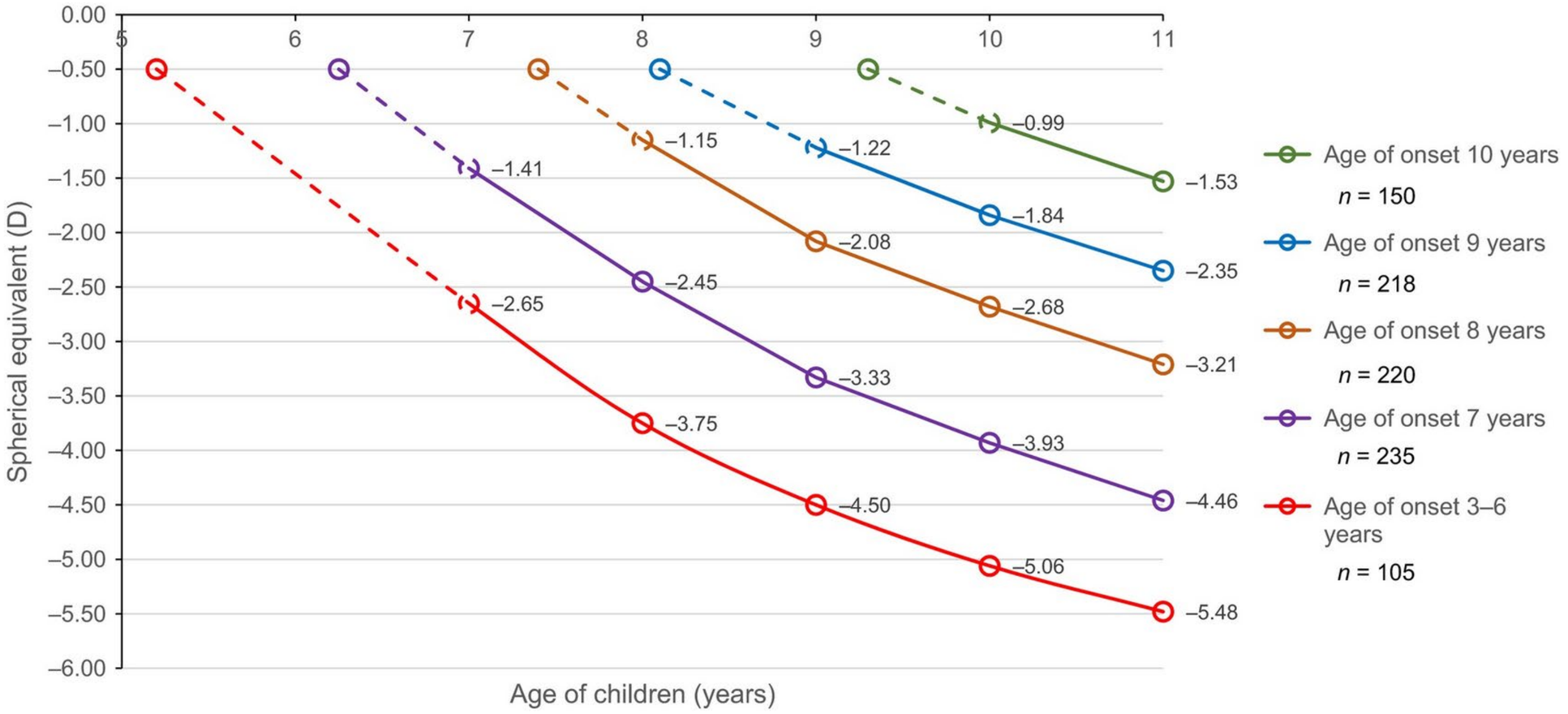
Early Intervention

Clinical Recommendation

Start myopia management discussion early

- "Your child is below normal ranges for vision development."
- "She is at increased risk for needing glasses for progressive myopia"
- "Progressive myopia is a vision condition that typically results in worsening vision every year when diagnosed early in childhood. Progressive myopia may require thicker glasses and increased dependence on those glasses every year."
- "Good news is, if we catch it early, we can slow down her vision changes. Let's schedule a 6 month follow up."

Early Intervention



Chua, et al. Ophthalmic Physiol Opt 2016.

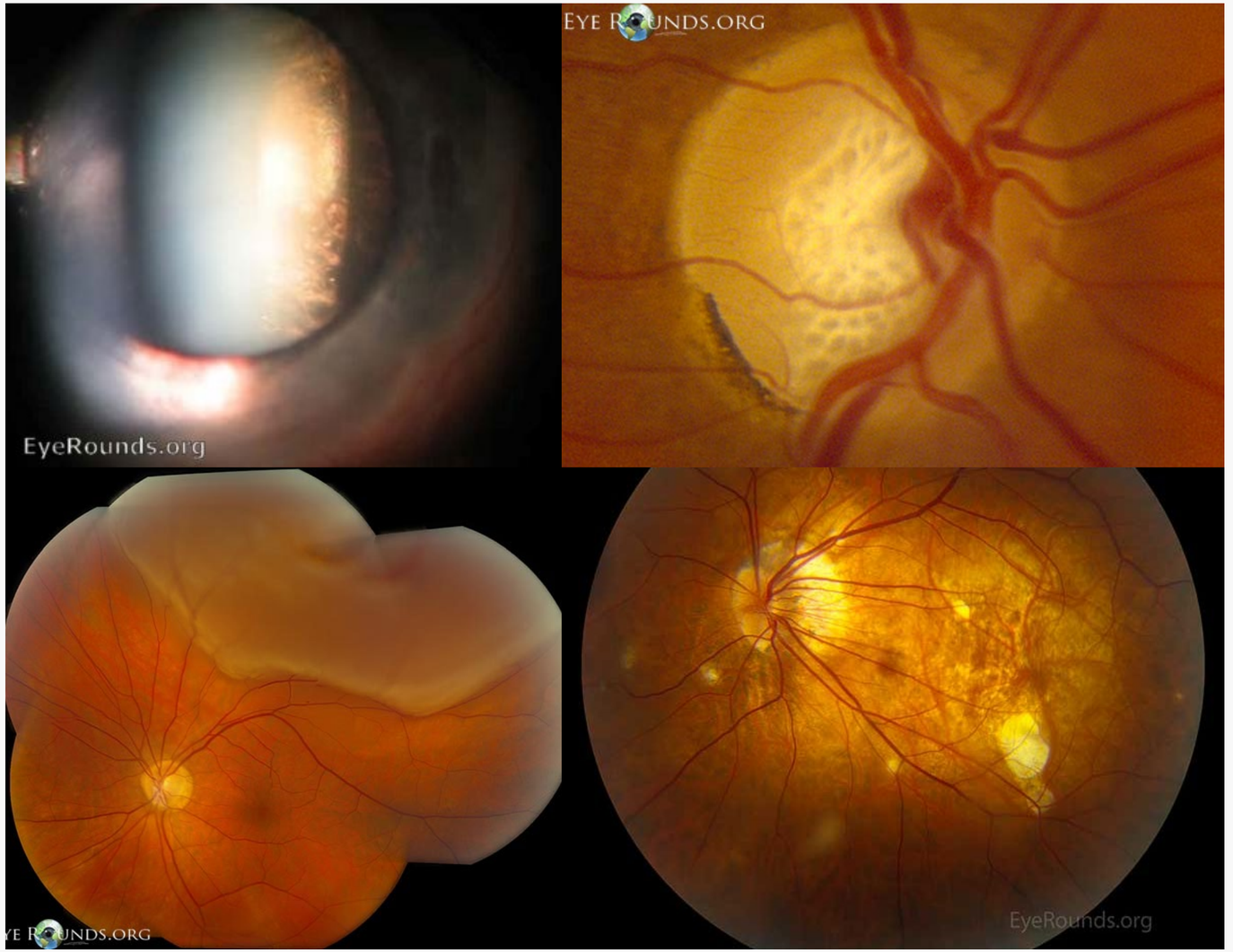
Early Intervention

Age	Average Stability
15	50%
18	75%

Conclusion : We cannot predict how any single individual child will respond to any intervention for myopia, but based on averages, we need to keep the children in such interventions likely through mid -20s

COMET Group. Invest Ophth. 2013.

Ocular Disease Associated with Myopia



Ocular Disease Associated with Myopia

	-2.00 D	-4.00 D	-6.00 D	>-8.00 D
PSC Cataract	1.6 x	3.2 x	5.4 x	12.3 x
Glaucoma	1.7x	2.5 x	14 x	N/A
Retinal Detachment	3.1x	9.0 x	21.5 x	44.2 x
Myopic Maculopathy	2.2 x	9.7x	40.6 x	126.8 x

Flitcroft, et al. Progr Retinal Eye Res., 2012.

Cataracts

Refractive Error	-1.00 D to -3.00 D	-3.00 D to -6.00 D	Over -6.00 D
Cataract	2x	3x	5x

Possible mechanisms:

- Increased oxidative damage secondary to faster vitreous degeneration

Annechien, et al. Invest. Ophth., 2020.

Cataracts

Increased Risk of Post-Surgery RDs

- disruption of capsular - zonular diaphragm + vitreous traction with thinner peripheral retina = higher risk of RD
- Risk related to refractive error

Annechien, et al. Invest. Ophth., 2020.

Glaucoma

Refractive Error	-1.00 D to -3.00 D	-3.00 D to -6.00 D	Over -6.00 D
Glaucoma	2x	3x	14x

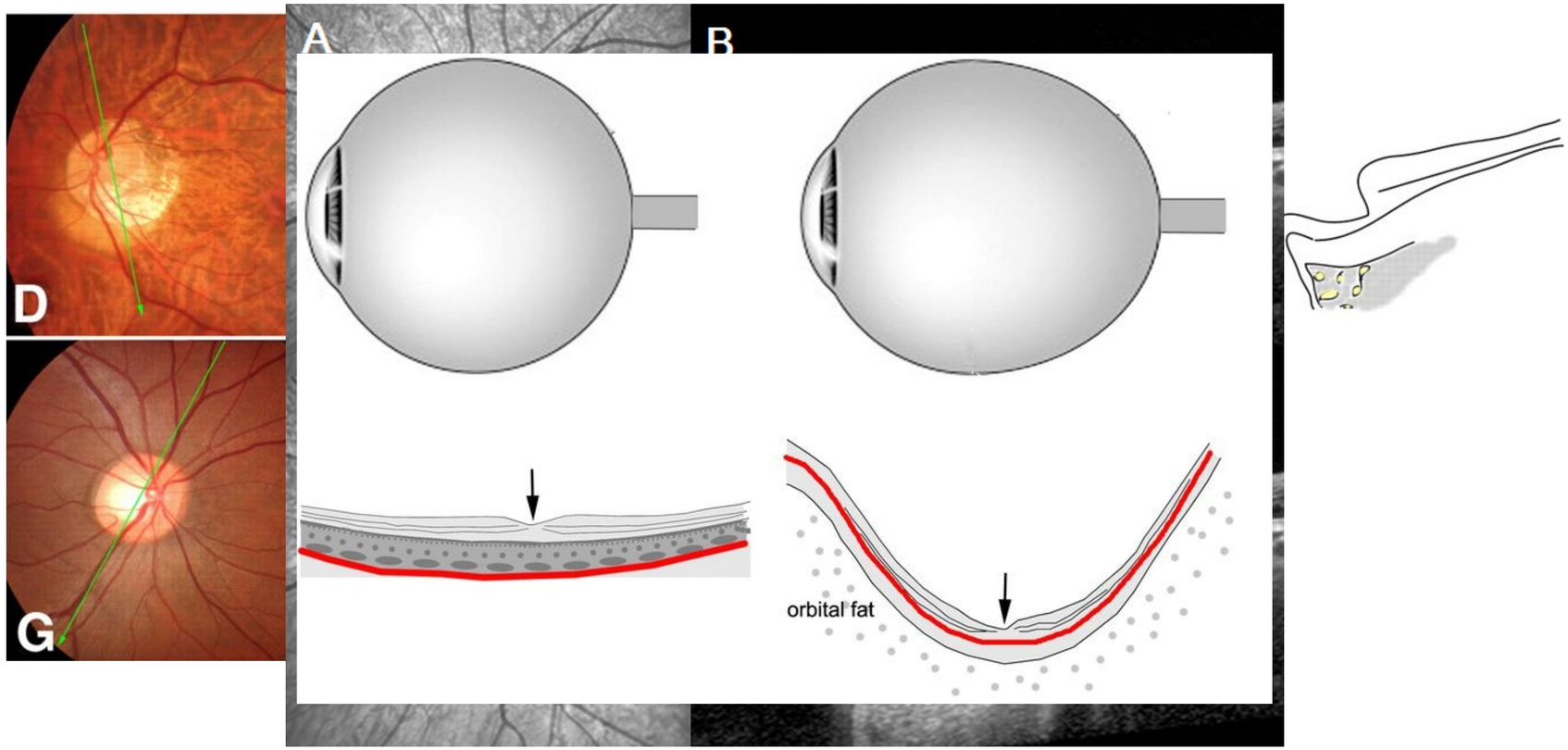
Possible mechanisms:

- Axial elongation →
  - Tilting of optic disc
  - Damage to axons in lamina cribosa

Annechien, et al. Invest. Ophth., 2020.

Glaucoma

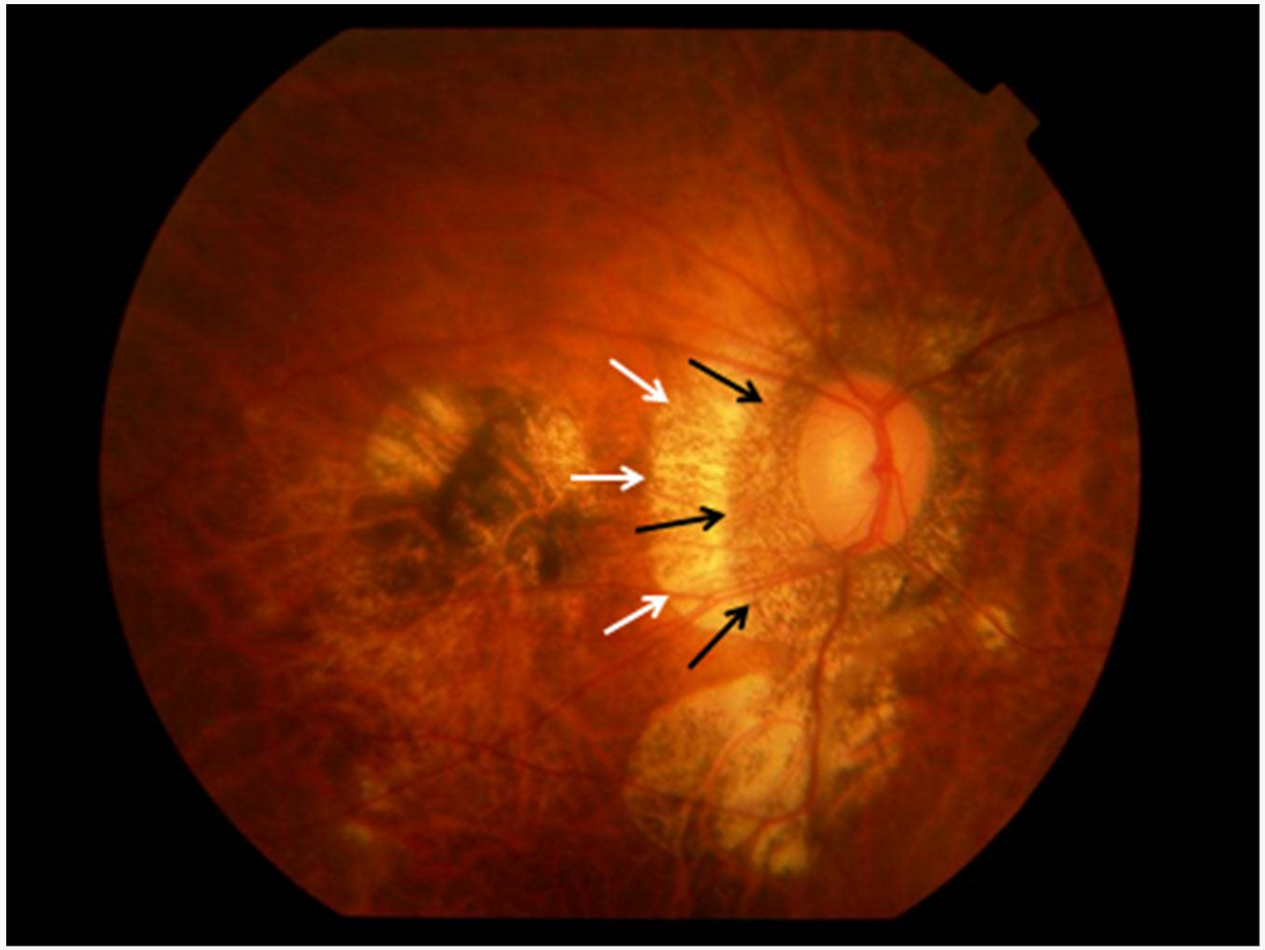
Mechanism of Action



Kim, et al. PLoS One., 2019.

Glaucoma

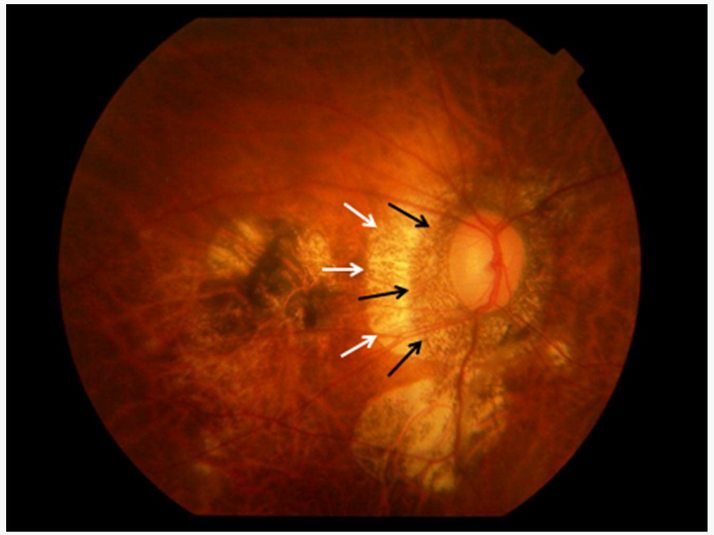
Peripapillary Atrophy



The larger the parapapillary delta (black arrows) zone the larger the risk for glaucoma development

Jonas, et al. PLoS One., 2017.

Glaucoma

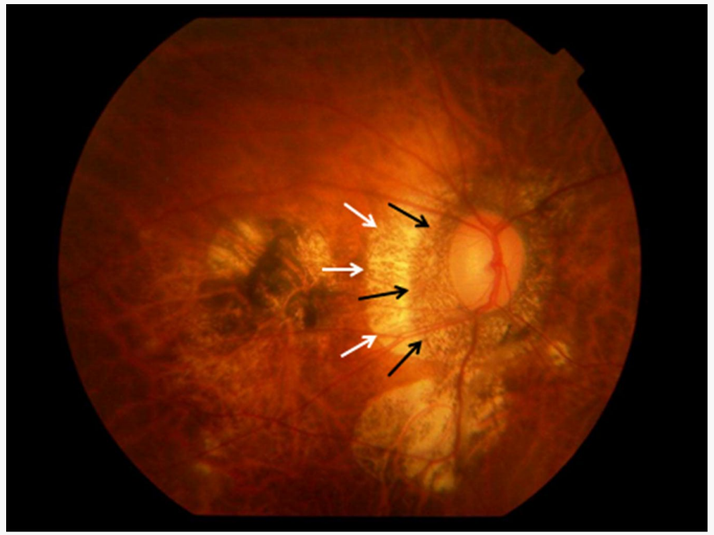


Retrospective Study of POAG & Myopia

- 28% with POAG had high myopia
- Those <40 yo with high myopia had higher POAG prevalence than the older participants in lower myopia group

Shim, et al. Curr Eye Res., 2017. (Korea National Health and Nutrition Examination Survey)

Glaucoma



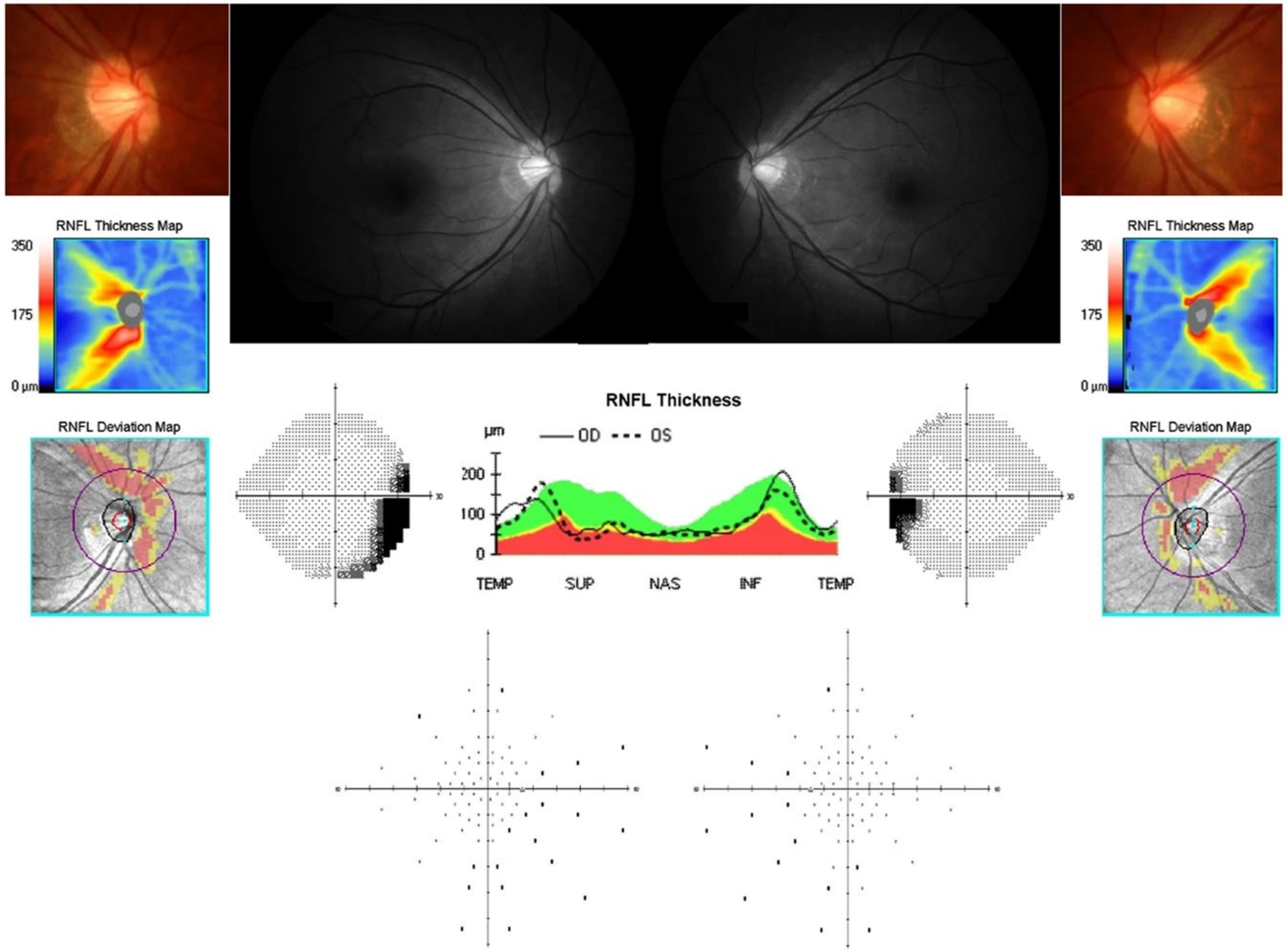
Clinical Recommendation

- Screen at age of 30 with SE of -10.00 D or worse
- Screen at age of 50 with SE of -6.00 D to -10.00 D

Haarman, et al. Invest. Ophth. Vis. Sci., 2020.

Glaucoma?

Visual Field Loss Secondary to Myopia



Park, et al. Sci. Rep. 2019.

Retinal Detachment

Refractive Error	-1.00 D to -3.00 D	-3.00 D to -6.00 D	Over -6.00 D
RD	3x	9x	22x

Possible mechanism

Axial elongation, resulting in stretching of the retinal tissue

Poor prognosis of RD repair compared to non-myopes

Annechien, et al. Invest. Ophth. Vis. Sci 2020.

Retinal Detachment

Poor Prognosis of RD Repair

BCVA of < 20/200 after RD

High myopia: 34%

w/o High Myopia : 19%

Less success with reattachment of macula

Annechien, et al. Invest. Ophth. Vis. Sci 2020.

Myopic Macular Degeneration

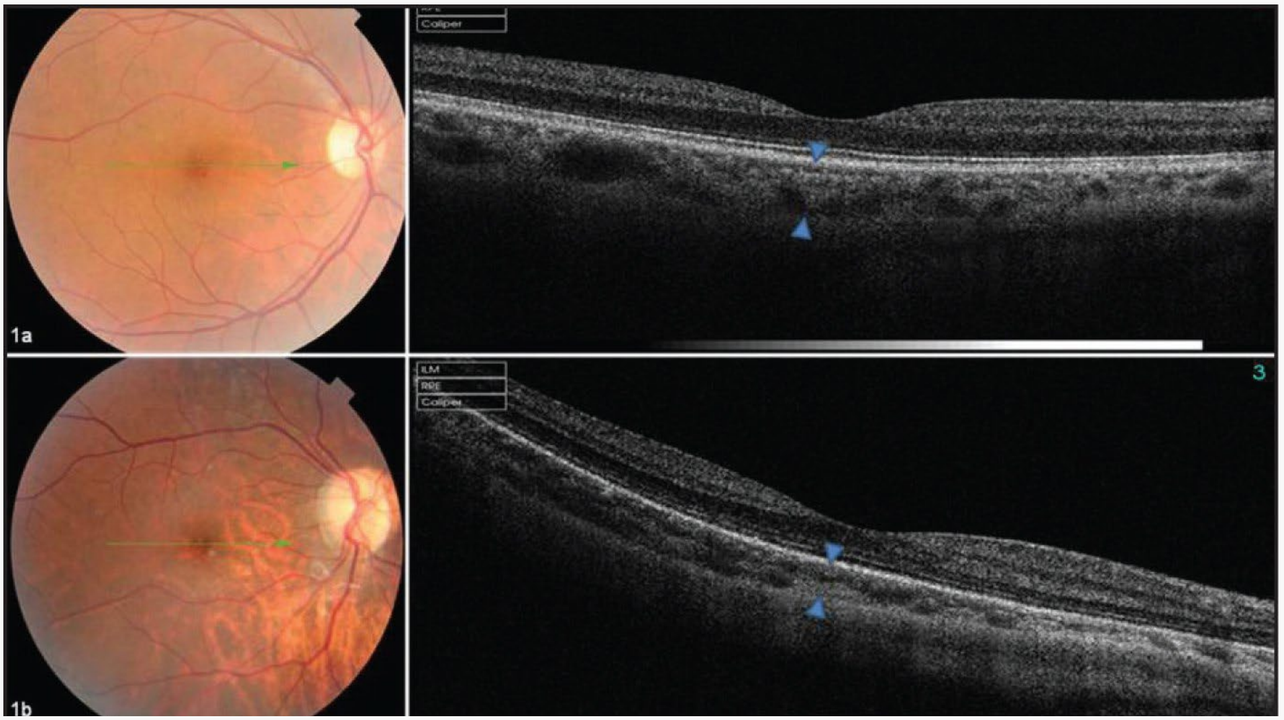
Refractive Error	-1.00 D to -3.00 D	-3.00 D to -6.00 D	Over -6.00 D
MMD	2x	10x	41x

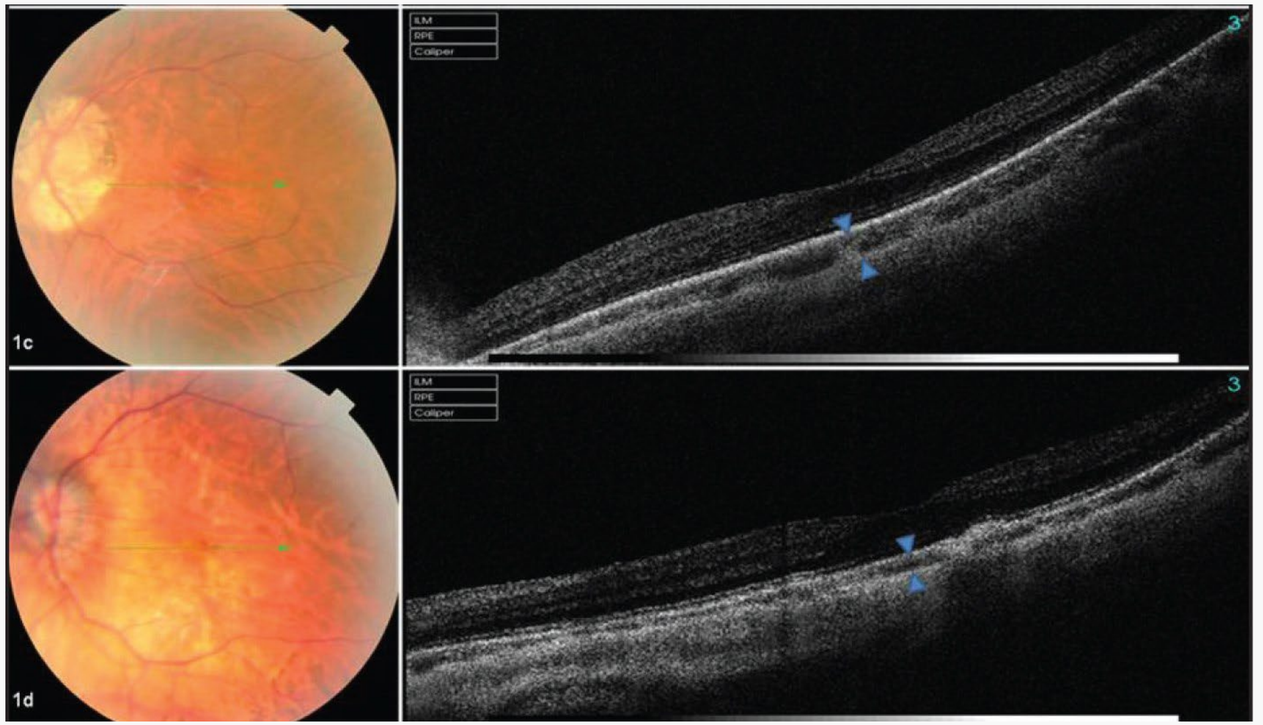
Possible mechanism

Axial elongation, resulting in stretching of the retinal tissue

Annechien, et al. Invest. Ophth. Vis. Sci 2020.

Myopic Macular Degeneration





Myopic Macular Degeneration

	2010	2050
Visually Impaired	10 million	55.7 million
Blind	3.3 million	18.5 million

Myopes of < -5.00 D = 43% of cases

Bullimore, et al. Opt and Vis. Sci 2019.

Myopic Macular Degeneration

Definition: Myopia with any posterior myopia -specific pathology from axial elongation

- **Category 1** – Tessellated fundus only
- **Category 2** – Diffuse chorioretinal atrophy
- **Category 3** – Patchy chorioretinal atrophy
- **Category 4** – Macular atrophy

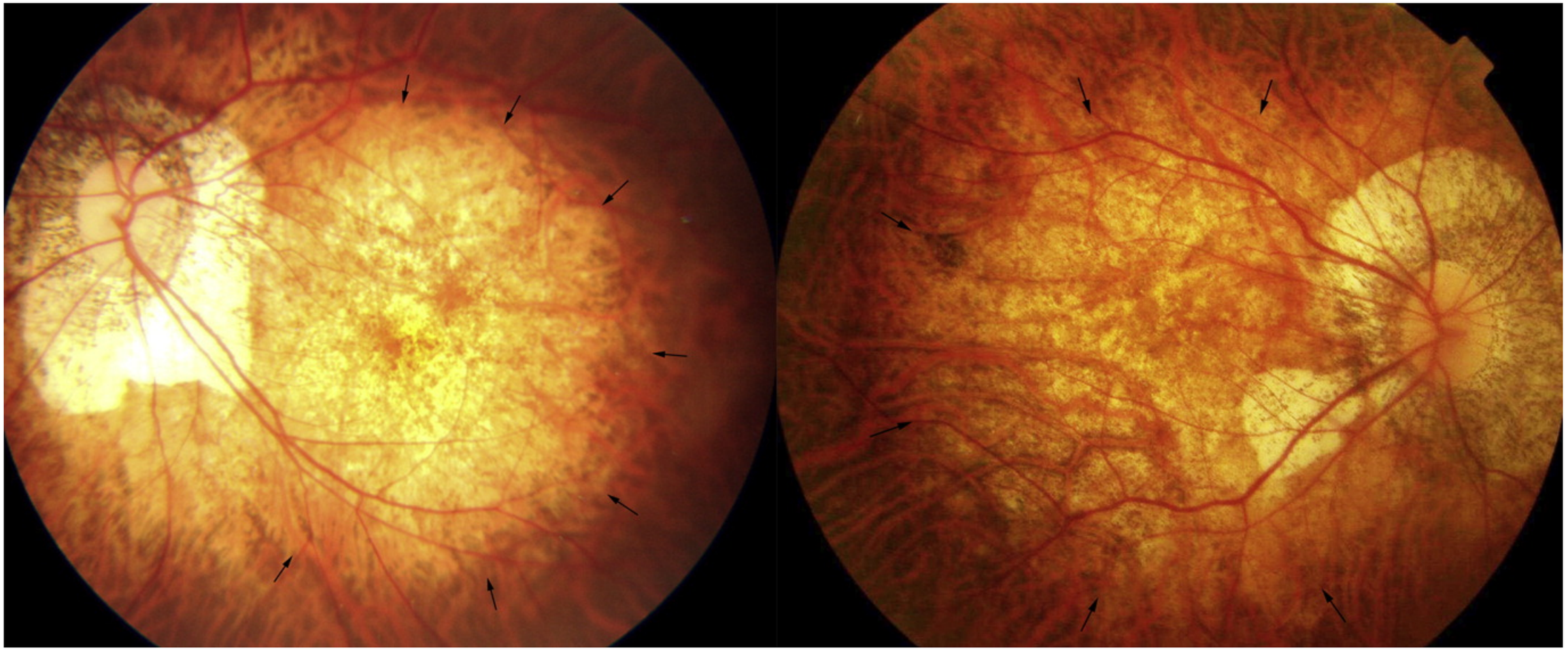
+++ – Lacquer cracks
Choroidal neovascularization
Fuch's spot

Ohno-Matsui, et al. Am. J. of Ophth.,2015.

Myopic Macular Degeneration

Ohno-Matsui, et al. Am. J. of Ophth.,2015.

Myopic Macular Degeneration



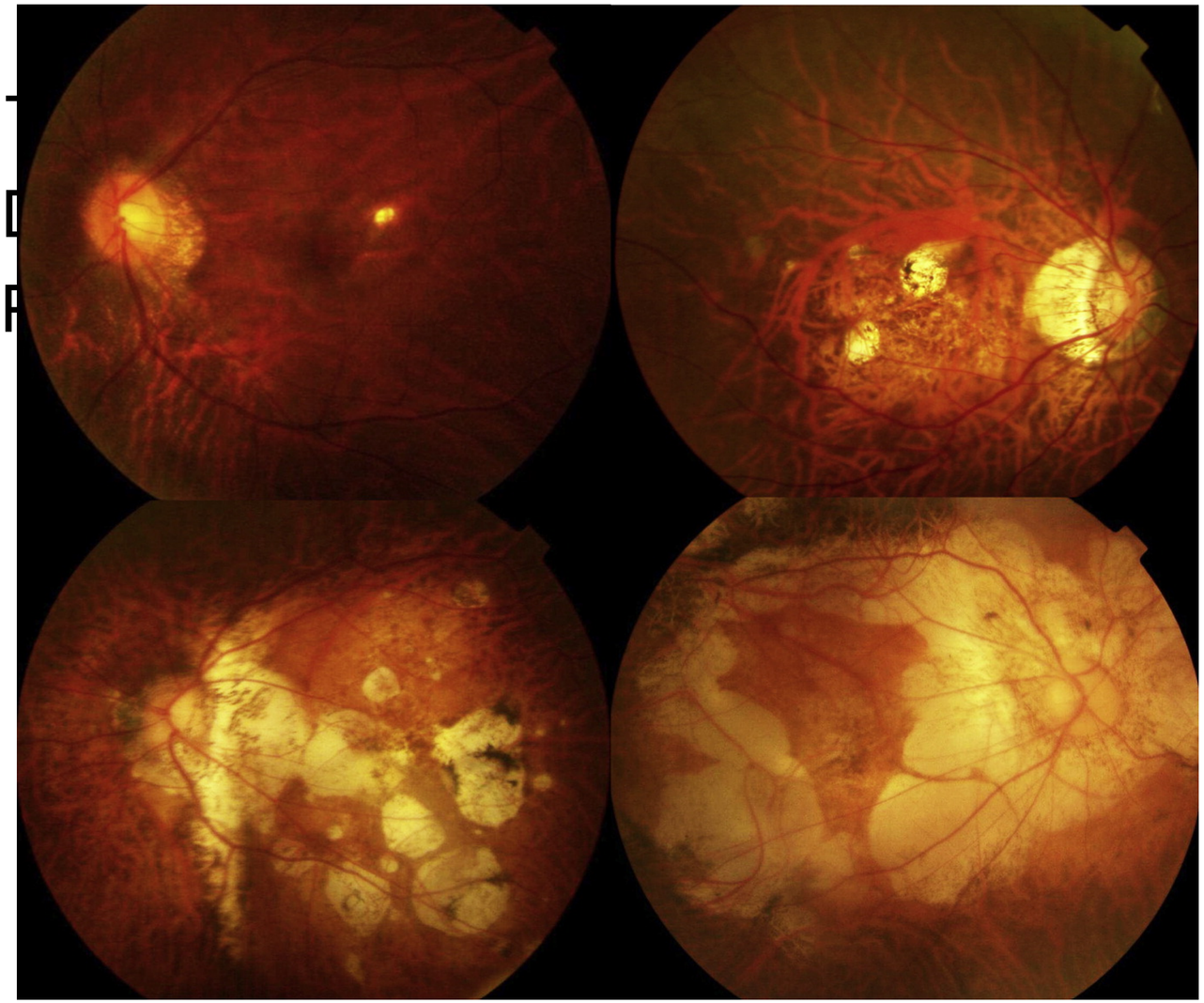
Ohno-Matsui, et al. Am. J. of Ophth.,2015.

Myopic Macular Degeneration

Category 1 – T

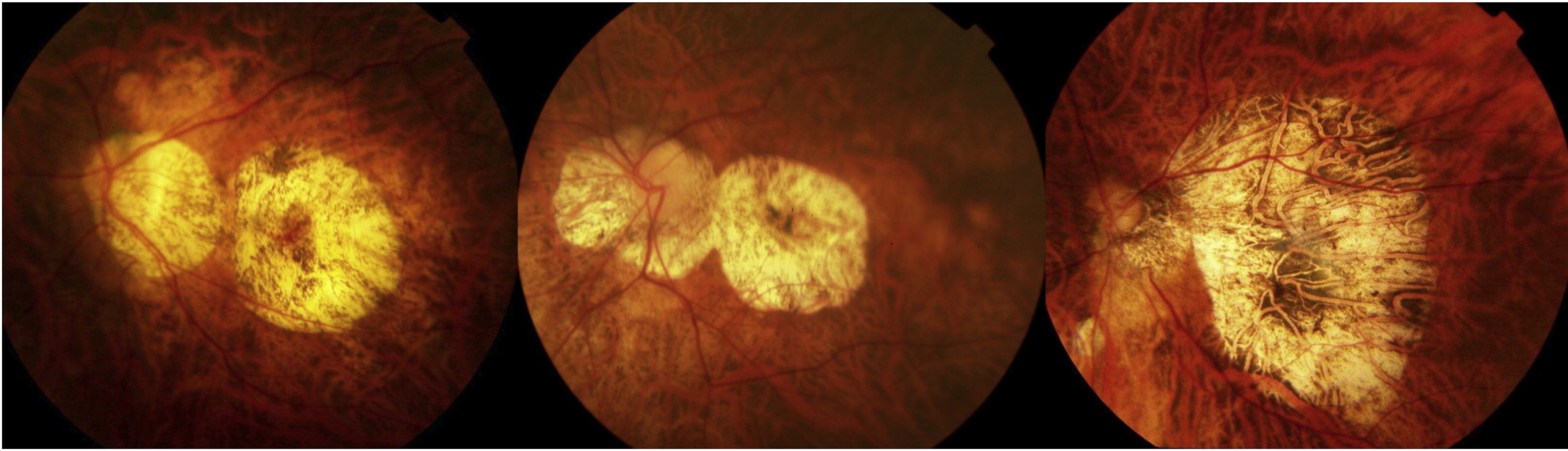
Category 2 – D

Category 3 – F



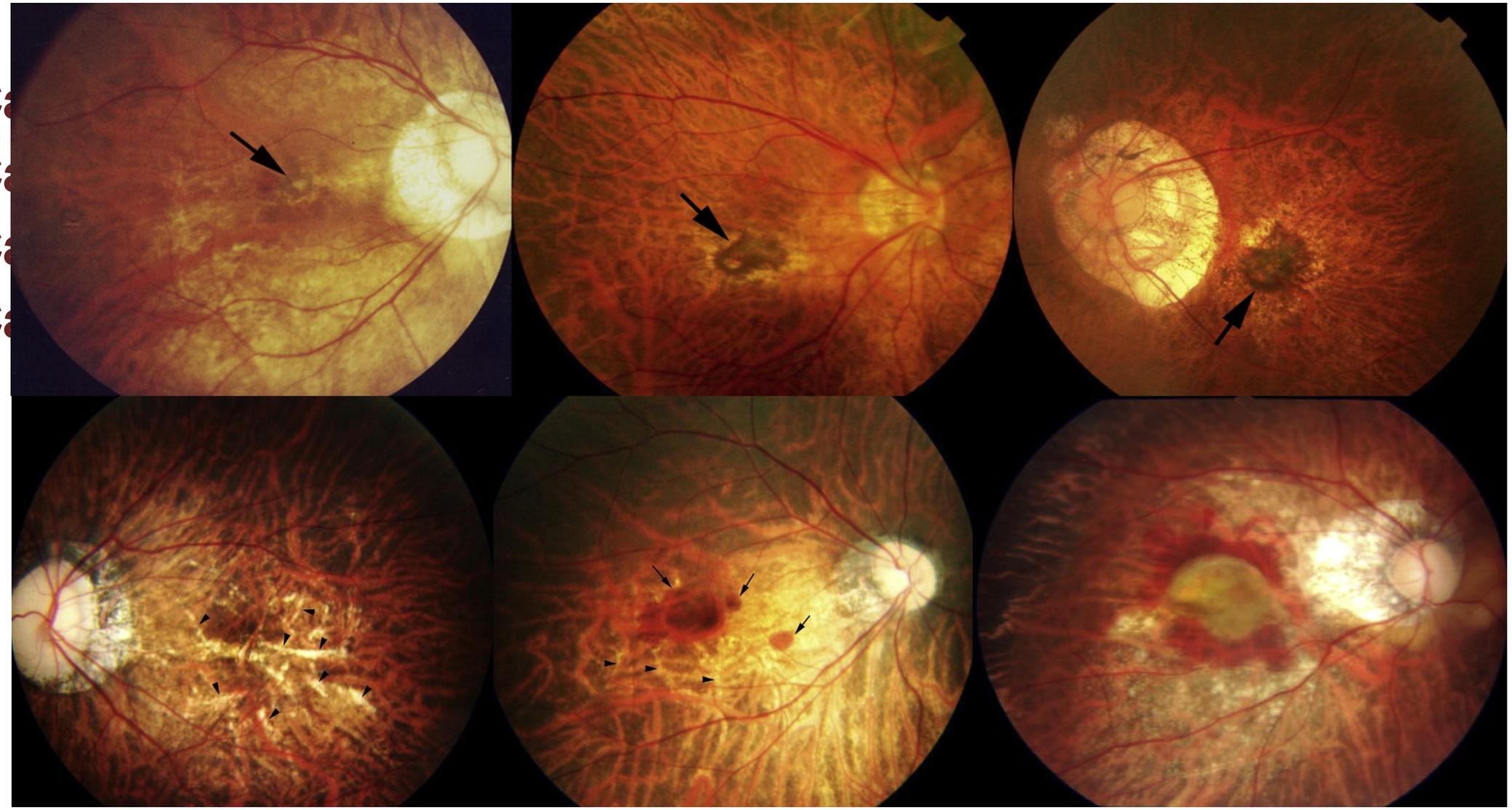
Ohno-Matsui, et al. Am. J. of Ophth.,2015.

Myopic Macular Degeneration



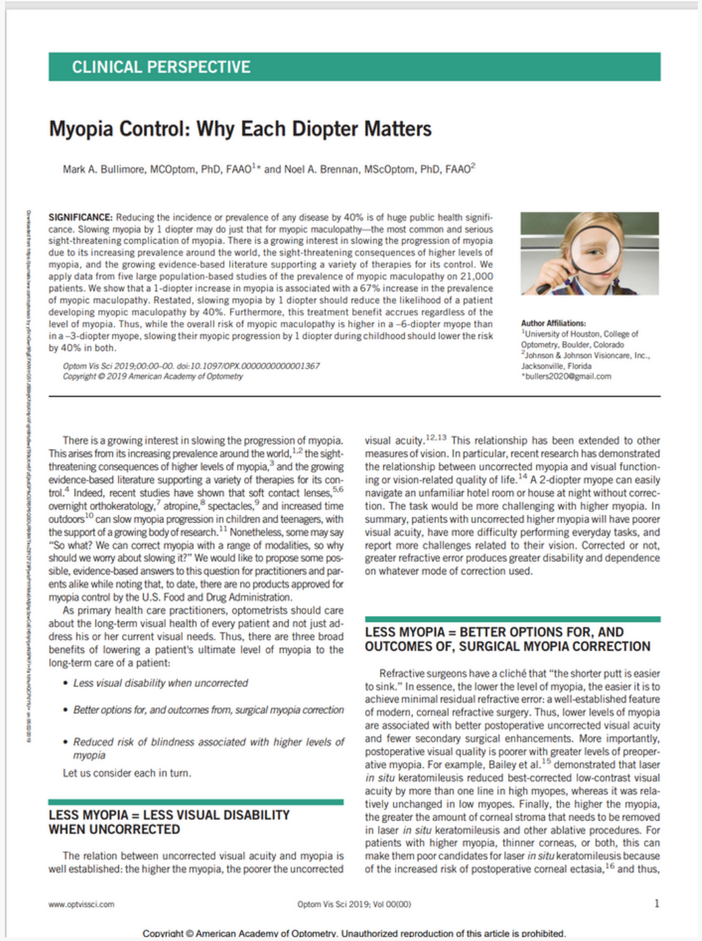
Ohno-Matsui, et al. Am. J. of Ophth.,2015.

Myopic Macular Degeneration



Ohno-Matsui, et al. Am. J. of Ophth.,2015.

Myopic Macular Degeneration



CLINICAL PERSPECTIVE

Myopia Control: Why Each Diopter Matters

Mark A. Bullimore, MCOptom, PhD, FAAO[1]* and Noel A. Brennan, MScOptom, PhD, FAAO[2]

SIGNIFICANCE: Reducing the incidence or prevalence of any disease by 40% is of huge public health significance. Slowing myopia by 1 diopter may do just that for myopic maculopathy—the most common and serious sight-threatening complication of myopia. There is a growing interest in slowing the progression of myopia due to its increasing prevalence around the world, the sight-threatening consequences of higher levels of myopia, and the growing evidence-based literature supporting a variety of therapies for its control. We apply data from five large population-based studies of the prevalence of myopic maculopathy on 21,000 patients. We show that a 1-diopter increase in myopia is associated with a 67% increase in the prevalence of myopic maculopathy. Restated, slowing myopia by 1 diopter should reduce the likelihood of a patient developing myopic maculopathy by 40%. Furthermore, this treatment benefit accrues regardless of the level of myopia. Thus, while the overall risk of myopic maculopathy is higher in a –6-diopter myope than in a –3-diopter myope, slowing their myopic progression by 1 diopter during childhood should lower the risk by 40% in both.

Optom Vis Sci 2019;00:00-00. doi:10.1097/OPX.0000000000001367

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There is a growing interest in slowing the progression of myopia. This arises from its increasing prevalence around the world,[1,2] the sight-threatening consequences of higher levels of myopia,[3] and the growing evidence-based literature supporting a variety of therapies for its control.[4] Indeed, recent studies have shown that soft contact lenses,[5,6] overnight orthokeratology,[7] atropine,[8] spectacles,[9] and increased time outdoors[10] can slow myopia progression in children and teenagers, with the support of a growing body of research.[11] Nonetheless, some may say "So what? We can correct myopia with a range of modalities, so why should we worry about slowing it?" We would like to propose some possible, evidence-based answers to this question for practitioners and parents alike while noting that, to date, there are no products approved for myopia control by the U.S. Food and Drug Administration.

As primary health care practitioners, optometrists should care about the long-term visual health of every patient and not just address his or her current visual needs. Thus, there are three broad benefits of lowering a patient's ultimate level of myopia to the long-term care of a patient:

- *Less visual disability when uncorrected*
- *Better options for, and outcomes from, surgical myopia correction*
- *Reduced risk of blindness associated with higher levels of myopia*

Let us consider each in turn.

LESS MYOPIA = LESS VISUAL DISABILITY WHEN UNCORRECTED

The relation between uncorrected visual acuity and myopia is well established: the higher the myopia, the poorer the uncorrected visual acuity.[12,13] This relationship has been extended to other measures of vision. In particular, recent research has demonstrated the relationship between uncorrected myopia and visual functioning or vision-related quality of life.[14] A 2-diopter myope can easily navigate an unfamiliar hotel room or house at night without correction. The task would be more challenging with higher myopia. In summary, patients with uncorrected higher myopia will have poorer visual acuity, have more difficulty performing everyday tasks, and report more challenges related to their vision. Corrected or not, greater refractive error produces greater disability and dependence on whatever mode of correction used.

LESS MYOPIA = BETTER OPTIONS FOR, AND OUTCOMES OF, SURGICAL MYOPIA CORRECTION

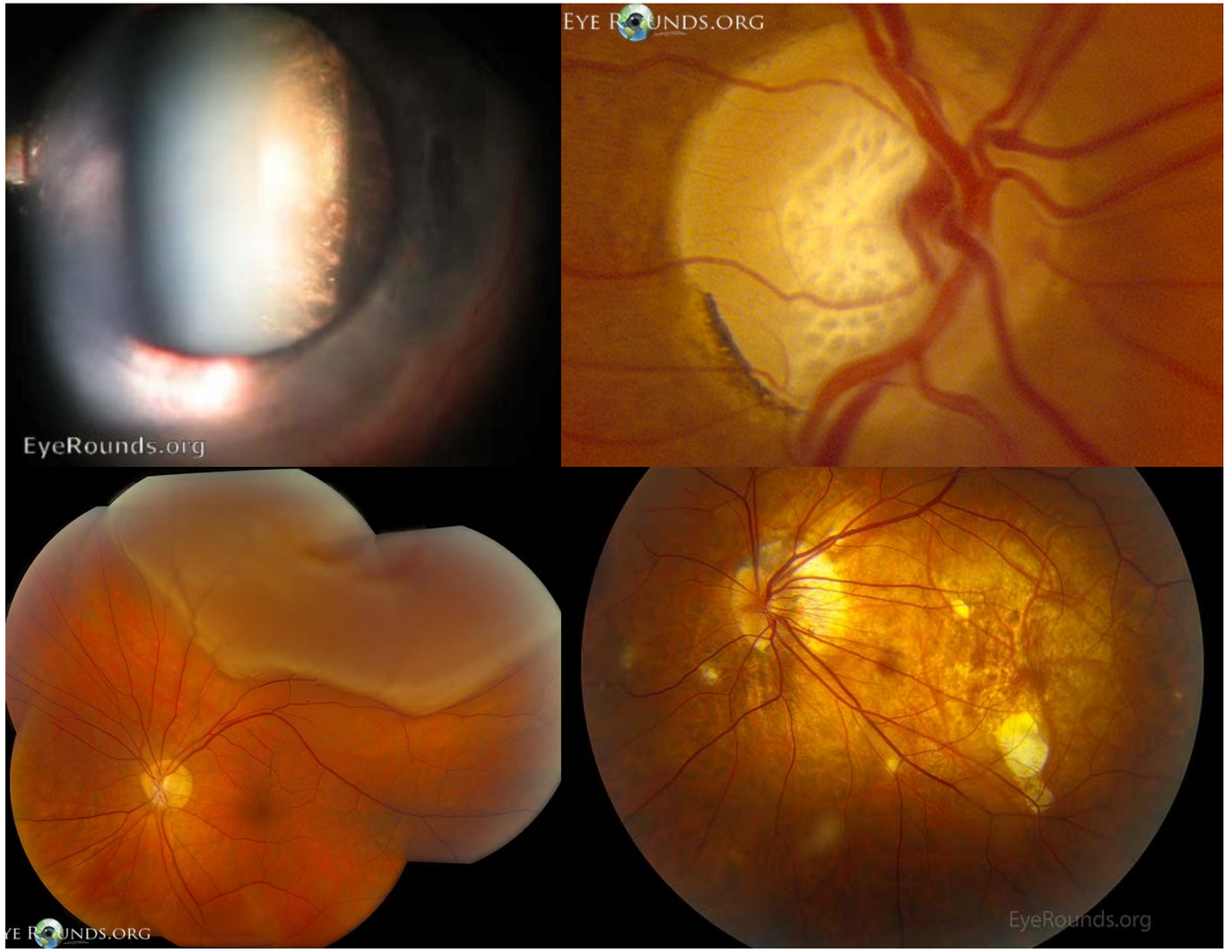
Refractive surgeons have a cliché that "the shorter putt is easier to sink." In essence, the lower the level of myopia, the easier it is to achieve minimal residual refractive error: a well-established feature of modern, corneal refractive surgery. Thus, lower levels of myopia are associated with better postoperative uncorrected visual acuity and fewer secondary surgical enhancements. More importantly, postoperative visual quality is poorer with greater levels of preoperative myopia. For example, Bailey et al.[15] demonstrated that laser *in situ* keratomileusis reduced best-corrected low-contrast visual acuity by more than one line in high myopes, whereas it was relatively unchanged in low myopes. Finally, the higher the myopia, the greater the amount of corneal stroma that needs to be removed in laser *in situ* keratomileusis and other ablative procedures. For patients with higher myopia, thinner corneas, or both, this can make them poor candidates for laser *in situ* keratomileusis because of the increased risk of postoperative corneal ectasia,[16] and thus,

Slowing myopic progression by 1 diopter reduces risk of myopic maculopathy by 40%

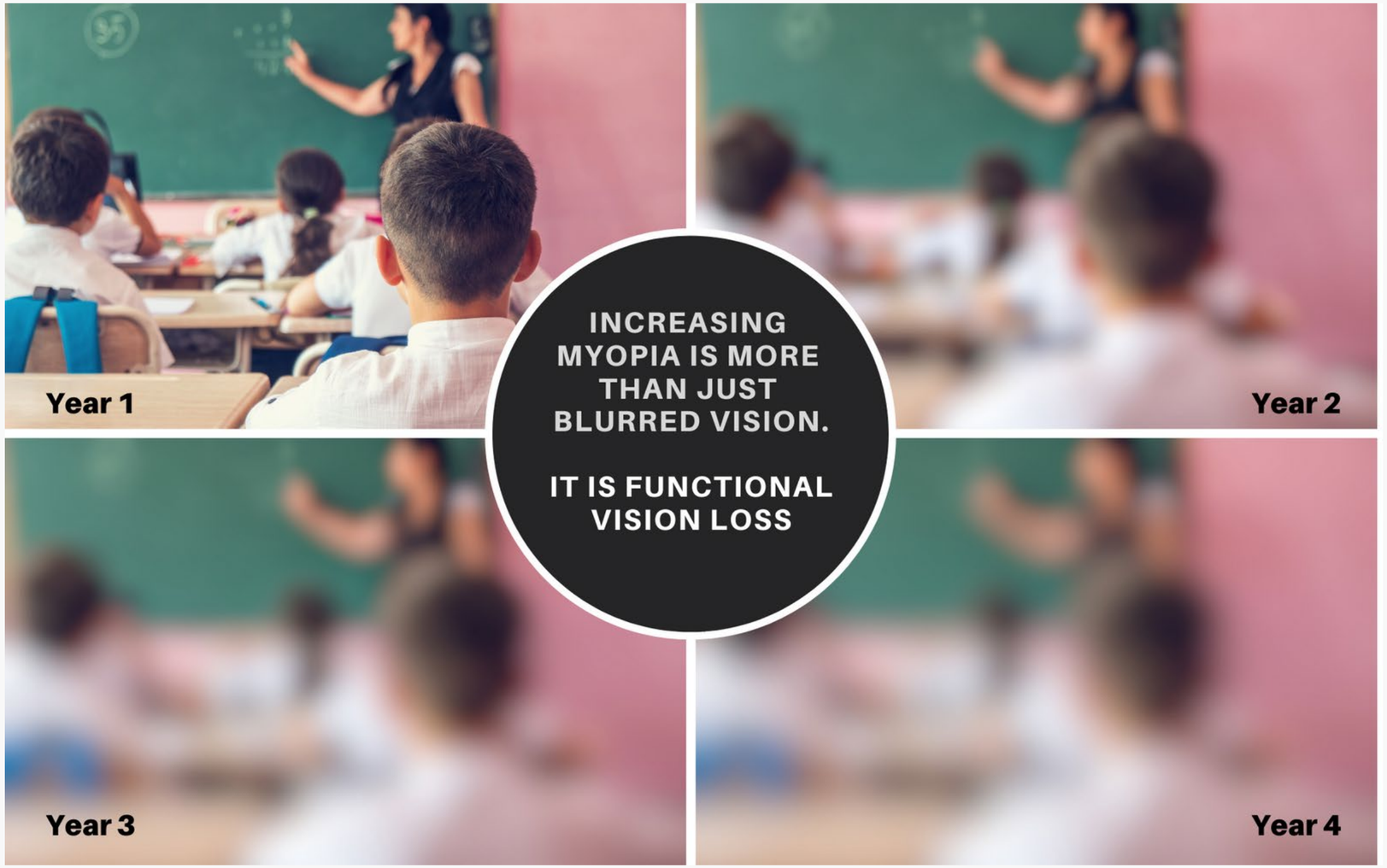
Compared to AREDS: 25% reduced risk for advanced AMD with 6 years of supplementation

Bullimore, et al. Opt and Vis. Sci 2019.

Ocular Disease Associated with Myopia

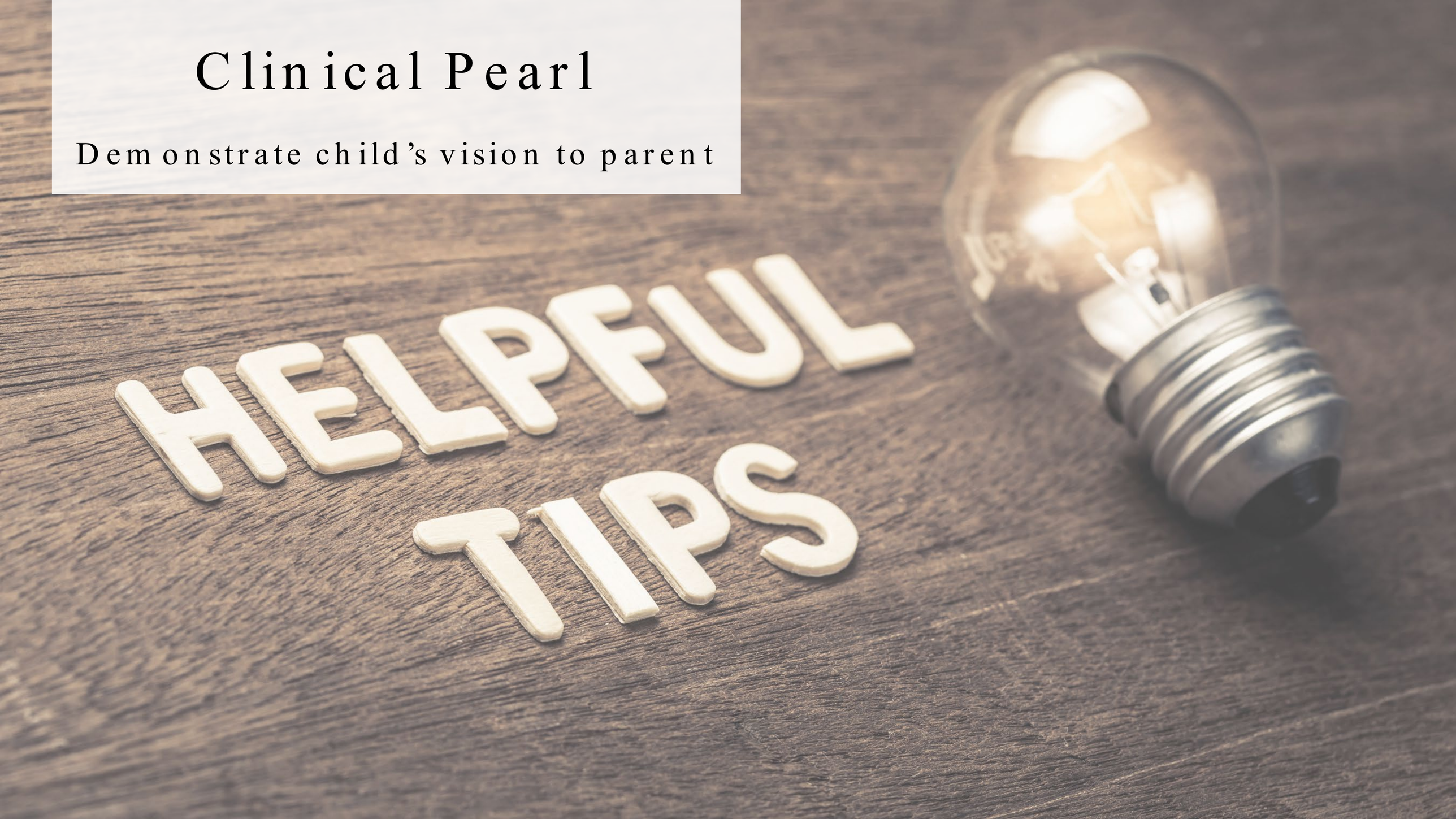


Quality of Life

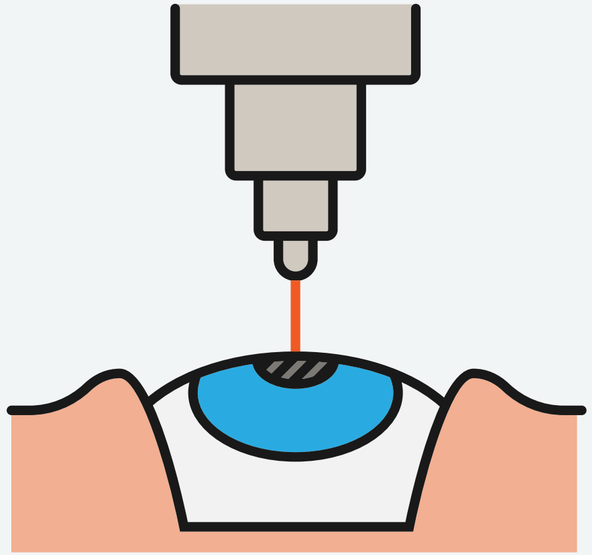


Clinical Pearl

Demonstrate child's vision to parent



Quality of Life



Bullimore, et al. Opt and Vis. Sci 2019.; Lamoureux, et al. Invest. Ophthal Vis Sci. 2009

Thank you

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