WHY EVERY DIOPTRE COUNTS

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ECLSO Meeting, Paris

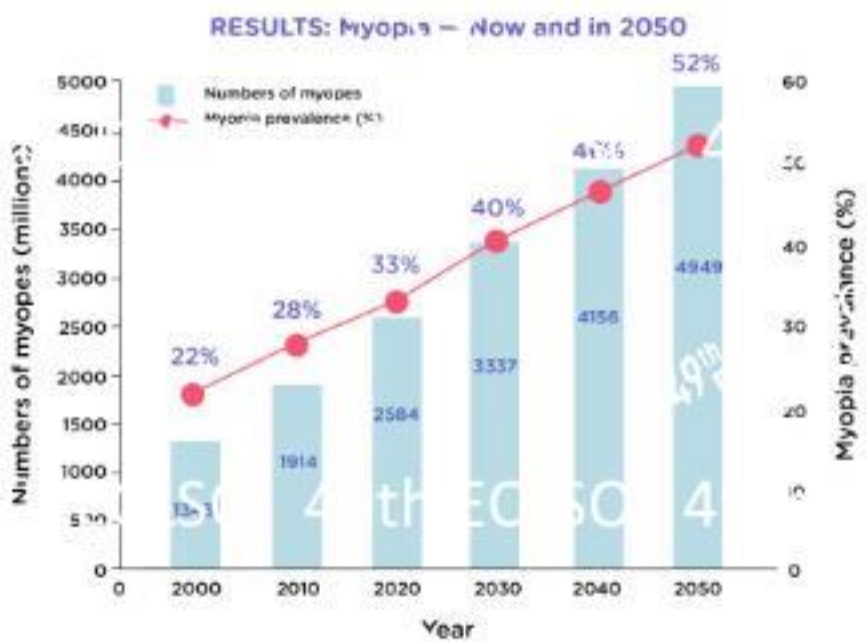
SEP 2 TO 3, 2022

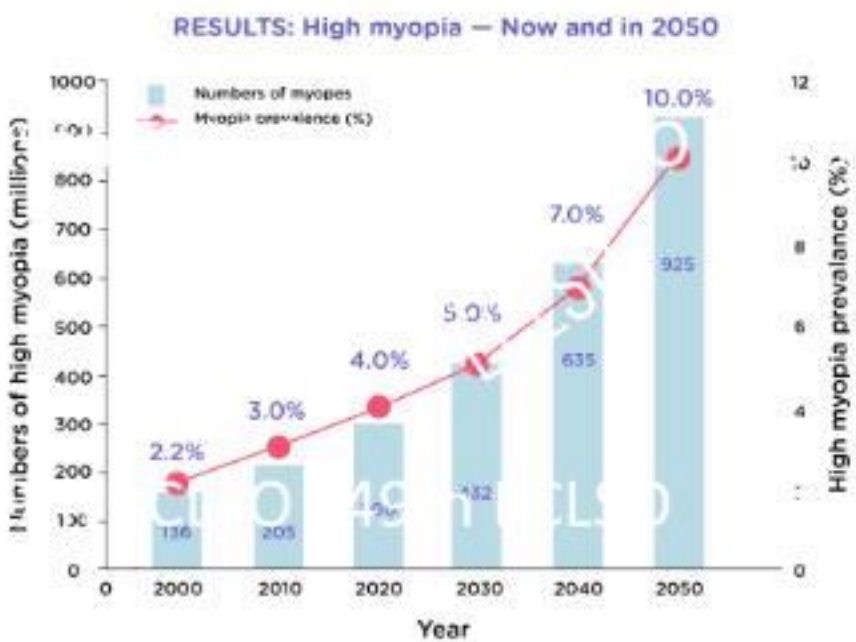
MYOPIA: THE BIGGEST EYE HEALTH THREAT OF THE 21ST CENTURY

By 2050, half of the world's population is projected to be myopic (5 billion) and 1 billion are expected to have high myopia[1]

The rate of high myopia prevalence has ~ doubled over the past 20 years.


Myopia – A 21st Century Public Health Issue



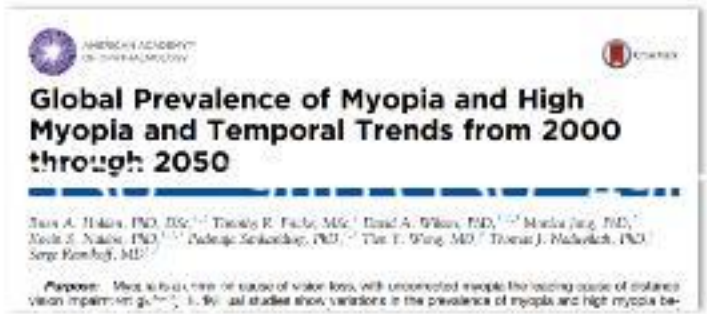


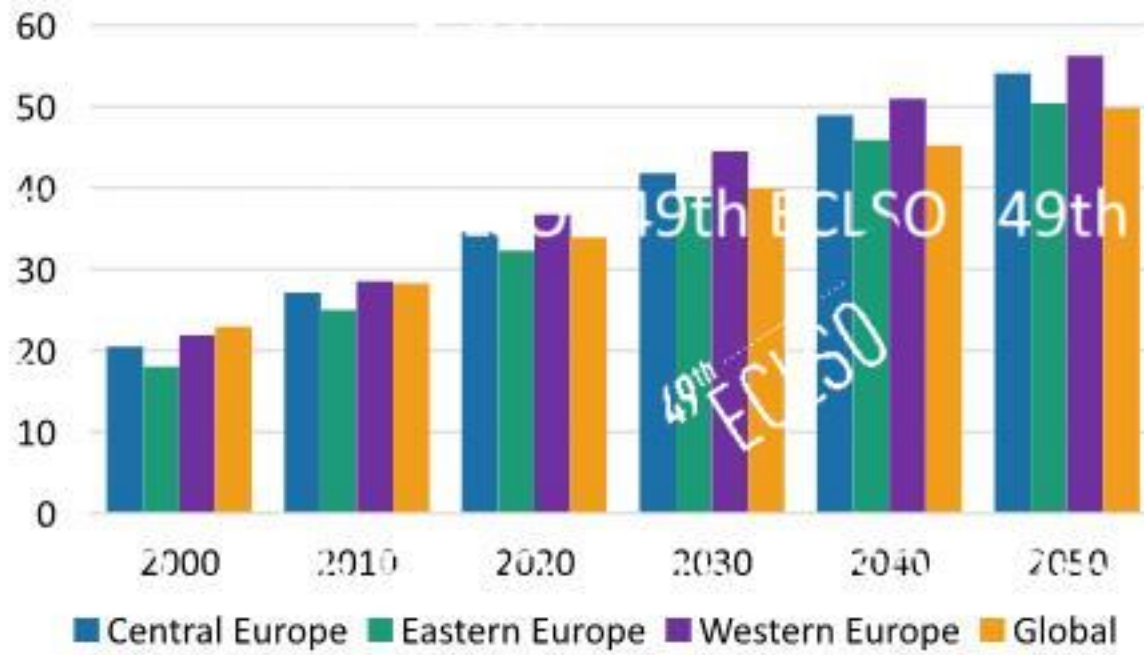
1. Holden BA, Fricke TR, Wilson DA, et al. Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050. Ophthalmology. 2016;123(5):1036-1042. doi:10.1016/j.ophtha.2016.01.006

ESTIMATED MYOPIA PREVALENCE IN EUROPE

Region	Prevalence (%) in Each Decade					
	2000	2010	2020	2030	2040	2050
Andean Latin America	15.2	20.5	28.1	36.7	44.3	50.7
Asia-Pacific, high income	46.1	48.8	53.4	58.1	62.5	66.4
Australasia	19.7	27.3	36.0	43.8	50.2	55.1
Caribbean	15.7	21.6	29.0	37.4	45.0	51.7
Central Africa	5.1	7.6	11.8	16.1	20.4	23.9
Central Asia	11.2	17.0	24.3	32.9	41.1	47.4
Central Europe	20.5	27.1	34.6	41.8	48.9	54.1
Central Latin America	22.1	27.3	34.2	41.6	48.9	54.9
East Africa	3.2	4.9	8.4	12.5	17.1	22.7
East Asia	38.8	47.0	51.5	58.9	61.4	65.3
Eastern Europe	18.0	25.0	32.2	38.9	45.9	50.4
North Africa and Middle East	14.6	23.3	30.5	38.8	46.3	52.2
North America, high income	28.3	34.5	42.1	48.5	54.0	58.4
Oceania	5.0	6.7	9.1	12.5	17.4	23.8
South Asia	14.4	20.2	28.6	38.0	46.2	53.0
Southeast Asia	33.8	39.3	46.1	52.4	57.6	62.0
Southern Africa	5.1	8.0	12.1	17.5	23.4	30.2
Southern Latin America	15.6	22.9	32.4	40.7	47.7	53.4
Tropical Latin America	14.5	20.1	27.7	35.9	43.9	50.7
West Africa	5.2	7.0	9.6	13.6	19.7	26.8
Western Europe	21.9	28.5	36.7	44.5	51.0	56.2
Global	22.9	28.3	33.9	39.9	45.2	49.8

Numbers and uncertainty are provided in the Supplemental Material (available at www.aaojournal.org).


Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050



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

SNAPSHOT PREVALENCE OF MYOPIA

Germany 47% <-0.5
35-44y 2007-12 N = 1,474[2]

UK 49% <-0.75D
45y 2002 N = 2,487[6]

Japan 95% ≤-0.50D
12-14y 2019 N = 727[4]

France 24% <-0.50D
0-17 y 2018 N = 613,306[11]

3X
Increase in myopia prevalence in Chinese school children during COVID-19[1]
6-8 y, 2020 N= 194, 904

S. Korea 97% <-0.5
19y 2010 N = 23,616[6]

USA 50% <-0.50D
20-59y 1999-04 N = 8,429[9]

Taiwan 87% ≤-0.50D
13-24y 2010-11 N = 5048[5]

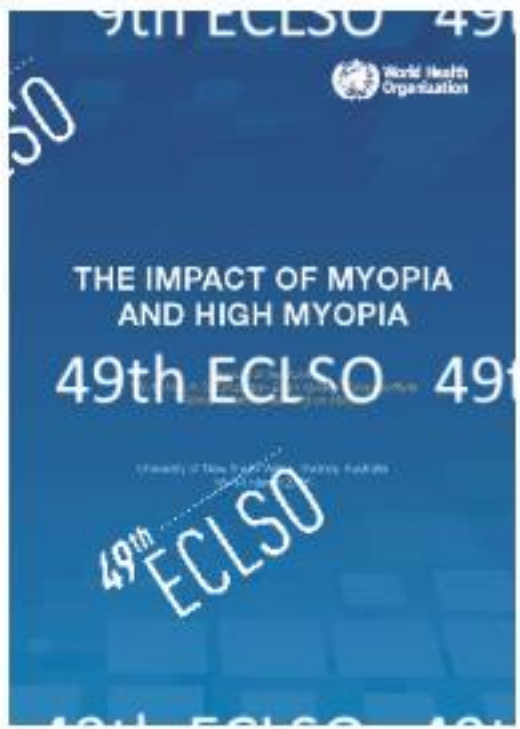
China 80%
18y 2000-14 N = 2,275[10]

Singapore 82% <-0.50
17-29y 2009-10 N = 28,908M[7]

Hong Kong 88% VA <0.1
15y 2001 N = 117[3]

1. Wang J, Li Y, Musch DC, Wei N, Qi X, Ding G, Li X, Li J, Song L, Zhang Y, Ning Y, Zeng X, Hua N, Li S, Qian X. Progression of Myopia in School-Aged Children After COVID-19 Home Confinement. JAMA Ophthalmol. 2021 Mar 1;139(3):293-300. doi: 10.1001/jamaophthalmol.2020.6239. PMID: 33443542; PMCID: PMC7809617; 2. Germany, Wolfram, et al. 2014 Br J Ophthalmol; 3. Hong Kong Lam, et al., 2001; 4. Japan,Yotsukura, et al., JAMA Ophthalmol 2019 ; 5. Taiwan, Lee IOVS 13; 6. S. Korea, Jung, et al. IOVS 2012; 7. Singapore, Koh 2014 Ophthalmol ; 8. UK, Rahi, et al., 2011 Ophthalmol;9. USA, Vitale, et al., 2008 Arch Ophthalmol; California Theophanous C, Modjtahedi BS, Batech M, Marlin DS, Luong TQ, Fong DS. Myopia prevalence and risk factors in children. Clin Ophthalmol. 2018;12:1581-1587. Published 2018 Aug 29. doi:10.2147/OPTH.S164641; 10. China, combined data taken from Wang, et al., 2009 Eye; Sun, et al., 2012 IOVS; Shandong, Wu, et al., 2013 PLoS1; Gobi Desert, Guo, et al., 2015 IOVS; Beijing, Yan, et al. 2015 Acta Oph; Guangzhou, He et al 2004, IOVS and Guo et al 2016 Eye; [11]B, date of data collection uncertain for Guo et al 2015 and You et al 2015. Data were digitized from the published papers for Lin, et al., 2008 and You et al., 2015; 11. Dorian TRICARD, Quentin Dufour, Simon Marillet, Pierre Ingrand, Alexandre DUCLOUX, Nicolas Leveziel; Myopia in children : multicentric national data from French opticians. Invest. Ophthalmol. Vis. Sci. 2020;61(7):71.

WHO-BHVI MEETING SYDNEY MARCH 2015

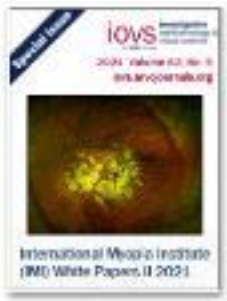


- Recommendations for definitions of myopia, high myopia, MMD; research and clinical management

IMI WHITE PAPERS IN IOVS – AUTHORED BY 150 EXPERTS

EDITORIAL: MYOPIA – A 21ST CENTURY PUBLIC HEALTH ISSUE	IMI MYOPIA CONTROL REPORTS OVERVIEW AND INTRODUCTION	IMI DEFINING AND CLASSIFYING MYOPIA: A PROPOSED SET OF STANDARDS FOR CLINICAL AND EPIDEMIOLOGIC STUDIES	IMI ACCOMMODATION AND BINOCULAR VISION IN MYOPIA DEVELOPMENT AND PROGRESSION	IMI PATHOLOGIC MYOPIA	UPDATE AND GUIDANCE ON MANAGEMENT OF MYOPIA
IMI REPORT ON EXPERIMENTAL MODELS OF EMMETROPIZATION AND MYOPIA	IMI MYOPIA GENETICS REPORT	IMI INTERVENTIONS FOR CONTROLLING MYOPIA ONSET AND PROGRESSION REPORT	IMI 2021 YEARLY DIGEST	IMI PREVENTION OF MYOPIA AND ITS PROGRESSION	IMI 2021 REPORTS AND DIGEST – REFLECTION ON THE IMPLICATIONS FOR CLINICAL PRACTICE
IMI CLINICAL MYOPIA CONTROL TRIALS AND INSTRUMENTATION REPORT	IMI INDUSTRY GUIDELINES AND ETHICAL CONSIDERATIONS FOR MYOPIA CONTROL	IMI CLINICAL MANAGEMENT MYOPIA GUIDELINES REPORT	IMI PREVENTION OF MYOPIA AND ITS PROGRESSION	IMI RISK FACTORS FOR MYOPIA	IMI IMPACT OF MYOPIA

INTERNATIONAL MYOPIA INSTITUTE




Ian Flitcroft


Christine Wildsoet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Monica Jong


Lyndon Jones


Kate Gifford


Earl Smith


Jost Jonas

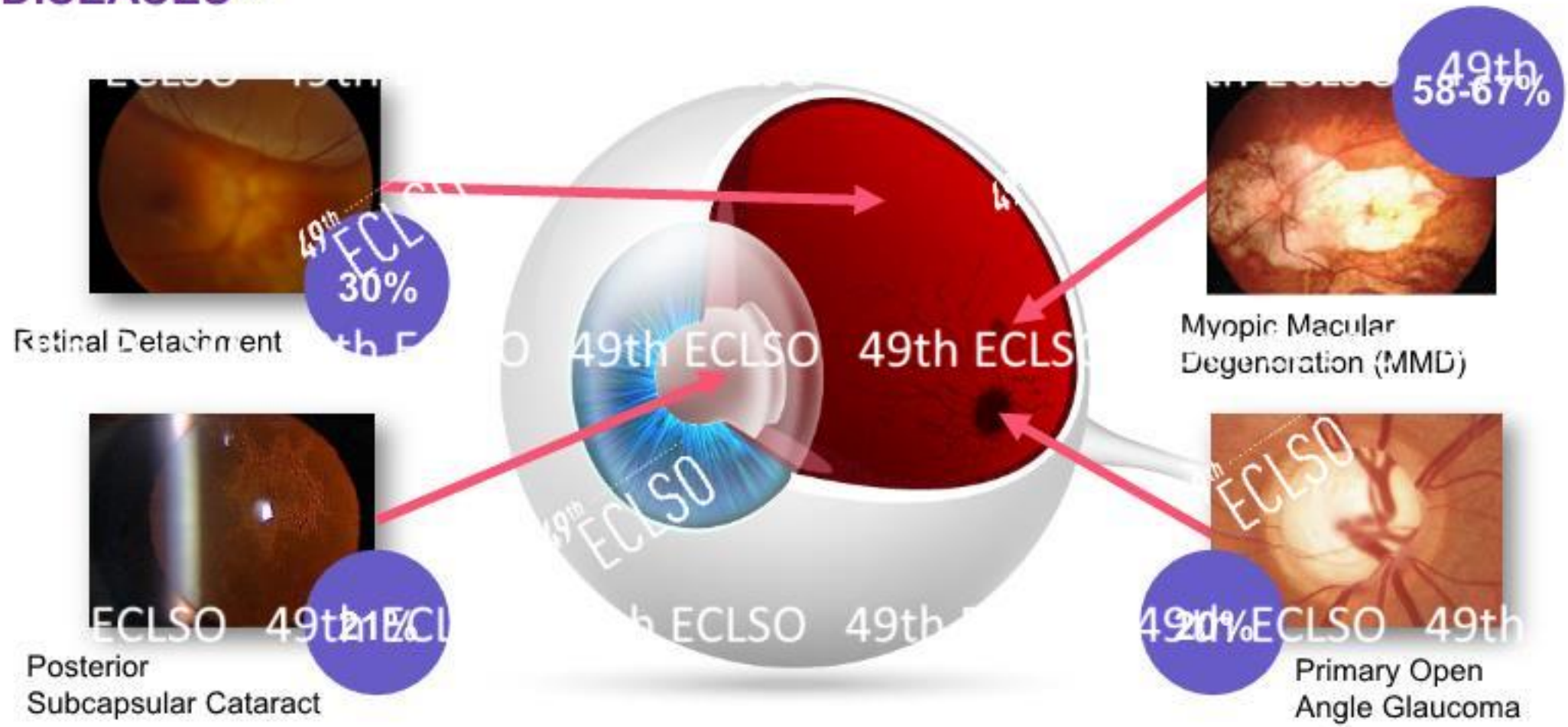

Ian Morgan


Kyoko Ohno-Matsui


Caroline Klaver

WWW.MYOPIAINSTITUTE.ORG

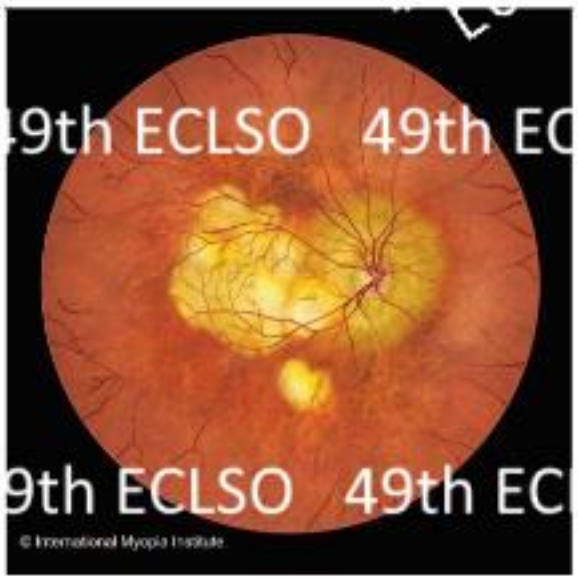
EVERY DIOPTER OF MYOPIA INCREASES RISK OF OCULAR DISEASES[1,2]

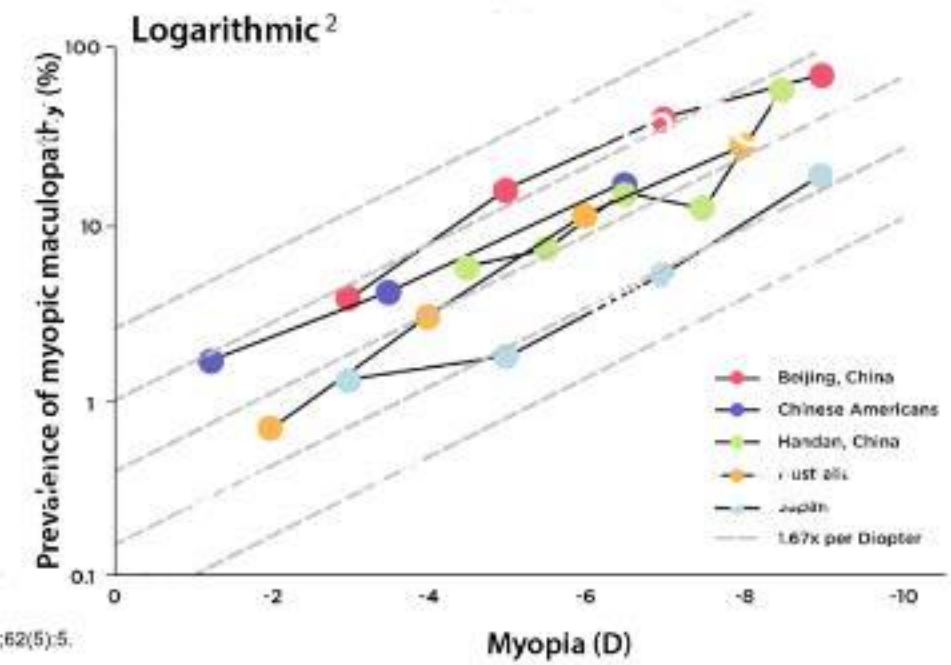


1. Bullimore MA, Brennan NA. Myopia Control: Why Each Diopter Matters. Optom Vis Sci 2019;96:463-5; 2. Bullimore MA, Fitchey EA, Shah S, et al. The Risks and Benefits of Myopia Control. Ophthalmology 2021;128:1561-79

MMD IS A LEADING CAUSE OF PERMANENT VISION LOSS

- **Myopic macular degeneration** is the:
  - **# 1** cause of cause of blindness in Taiwan, Japan, and China[1]
  - **# 3** cause of blindness in Netherlands, Denmark, and Los Angeles, USA[1]





1. Ohno-Matsui K, Wu P-C, Yamashiro K, et al. IM' Pathologic myopia. Invest Ophthalmol Vis Sci. 2021;62(5):5.
2. Bullimore MA, Ritchey EP, Sheh S, et al. The Risks and Benefits of Myopia Control. Ophthalmology 2021;128(11):1561-79.

MYOPIA INCREASES RISK OF OCULAR PATHOLOGY[1]

	DEGREE OF MYOPIA		
	-0.50 to -3.00 D	-3.00 to -6.00 D	-6.00 D or more myopic
MMD	13.6	73	846
RETINAL DETACHMENT	3.2	8.8	12.6
VISUAL IMPAIRMENT†	0.9	1.7	5.5

*Applies only to myopia of -6.00 to -10.00 D. Odds ratios are 7.8 for myopia of -10.00 to -15.00 D and 88 for myopia more than -15.00 D.
†Decimal visual acuity of 0.30 to 0.05 (approx 20/60 to 20/400).

The cumulative incidence of visual impairment = 90% for > 75 years old with an AL > 30 mm.[2]

1. Adapted from Haarman AEG, Enthoven CA, Tideman JWL, Tedja MS, Verhoeven VJM, Klaver CCW. The Complications of Myopia: A Review and Meta-Analysis. Invest Ophthalmol Vis Sci. 2020;61(4):49. doi:10.1167/iovs.61.4.49
2. Tideman JW, Snabel MC, Tedja MS, et al. Association of Axial Length With Risk of Uncorrectable Visual Impairment for Europeans With Myopia. JAMA Ophthalmol. 2016;134(12):1355-1363. doi:10.1001/jamaophthalmol.2016.4039

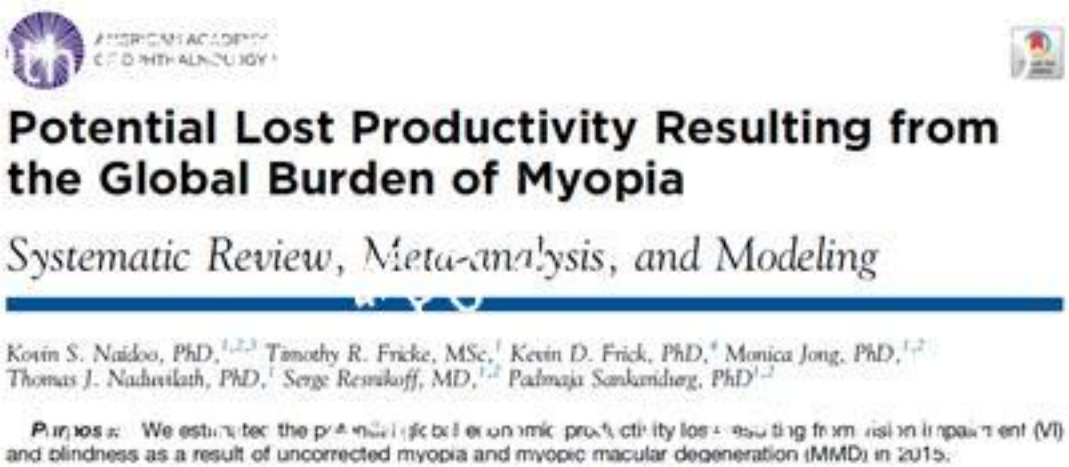
VISION IMPAIRMENT IN CHILDREN CAUSED BY MYOPIA LINKED TO DEPRESSION AND ANXIETY

- Systematic review and analysis
- 36 studies
- Examined causes of vision impairment in children & association with depression & anxiety
- Mix of low, middle, high income countries

- **Children with myopia experienced significantly higher scores of depression than normally sighted children**
- **The importance and potential impact of early detection & treatment of childhood vision problems is critical**

Li D, Chan VF, Virgili G, Piyasena P, Negash H, Whitestone N, O'Connor S, Xiao B, Clarke M, Cherwek DH, Singh MK, She X, Wang L, Boswell M, Prakalapakorn SG, Patnaik JL, Congdon N, Impact of vision impairment and ocular morbidity and their treatment on depression and anxiety in children: A systematic review, *Ophthalmology* (2022), doi: https://doi.org/10.1016/j.ophtha.2022.05.020.

GLOBAL BURDEN OF MYOPIA



AMERICAN ACADEMY OF OPHTHALMOLOGY

Potential Lost Productivity Resulting from the Global Burden of Myopia

Systematic Review, Meta-analysis, and Modeling

Kovin S. Naidoo, PhD,[1,2,3] Timothy R. Fricke, MSc,[1] Kevin D. Frick, PhD,[4] Monica Jong, PhD,[1,2] Thomas J. Naduvilath, PhD,[1] Serge Resnikoff, MD,[1,2] Padmaja Sankaridurg, PhD[1,2]

Purpose: We estimated the potential economic productivity loss resulting from vision impairment (VI) and blindness as a result of uncorrected myopia and myopic macular degeneration (MMD) in 2015.

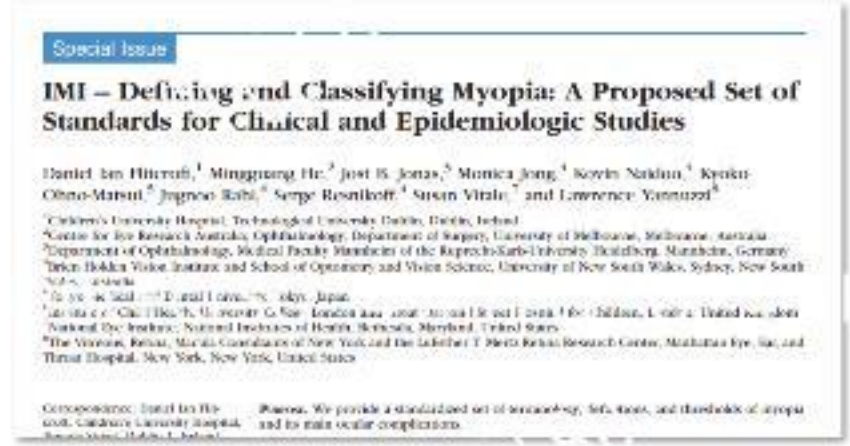
- Huge potential lost productivity estimated at **US$250 billion** (2015)
  - US$244 billion from **uncorrected refractive error** & US$6 billion from **MMD**
- Higher magnitudes of myopia result in greater costs later in life due to complications
- These costs are expected to rise significantly in the future.

Naidoo KS, Fricke TR, Frick KD, Jong M, Naduvilath TJ, Resnikoff S, Sankaridurg P. Potential Lost Productivity Resulting from the Global Burden of Myopia: Systematic Review, Meta-analysis, and Modeling. Ophthalmology. 2019 Mar;126(3):338-346. doi: 10.1016/j.ophtha.2018.10.029. Epub 2018 Oct 17. PMID: 30342076.

MYOPIA MANAGEMENT

PRE-MYOPIA[1]

"A refractive state of an eye of ≤ +0.75 D and > −0.50 D in children where a combination of baseline refraction, age, and other quantifiable risk factors provide a sufficient likelihood of the future development of myopia to merit preventative interventions."



Special Issue

IMI – Defining and Classifying Myopia: A Proposed Set of Standards for Clinical and Epidemiologic Studies

Daniel Ian Flitcroft,[1] Mingguang He,[2] Jost B. Jonas,[3] Monica Jong,[4] Kovin Naidoo,[5] Kyoko Ohno-Matsui,[6] Jugnoo Rahi,[7,8] Serge Resnikoff,[9] Susan Vitale,[10] and Lawrence Yannuzzi[11]

[1]Children's University Hospital, Technological University Dublin, Dublin, Ireland
[2]Centre for Eye Research Australia, Ophthalmology, Department of Surgery, University of Melbourne, Melbourne, Australia
[3]Department of Ophthalmology, Medical Faculty Mannheim of the Ruprecht-Karls-University Heidelberg, Mannheim, Germany
[4]Brien Holden Vision Institute and School of Optometry and Vision Science, University of New South Wales, Sydney, New South Wales, Australia
[5]Singapore Eye Research Institute, Singapore National Eye Centre, Singapore
[6]Department of Ophthalmology and Visual Sciences, Nagoya City University Graduate School of Medical Sciences, Nagoya, Japan
[7]Ulverscroft Vision Research Group, UCL Great Ormond Street Institute of Child Health, University College London, London, United Kingdom
[8]Great Ormond Street Hospital for Children, London, United Kingdom
[9]World Health Organization, Universal Eye Health, Geneva, Switzerland
[10]National Eye Institute, National Institutes of Health, Bethesda, Maryland, United States
[11]The Vitreous, Retina, Macula Consultants of New York and the Isabelle T. Ellis Retina Research Center, Manhattan Eye, Ear, and Throat Hospital, New York, New York, United States

Correspondence: Daniel Ian Flitcroft, Children's University Hospital, [illegible], Dublin 1, Ireland.

Purpose. We provide a standardized set of terminology, [illegible] and thresholds of myopia and its main ocular complications.

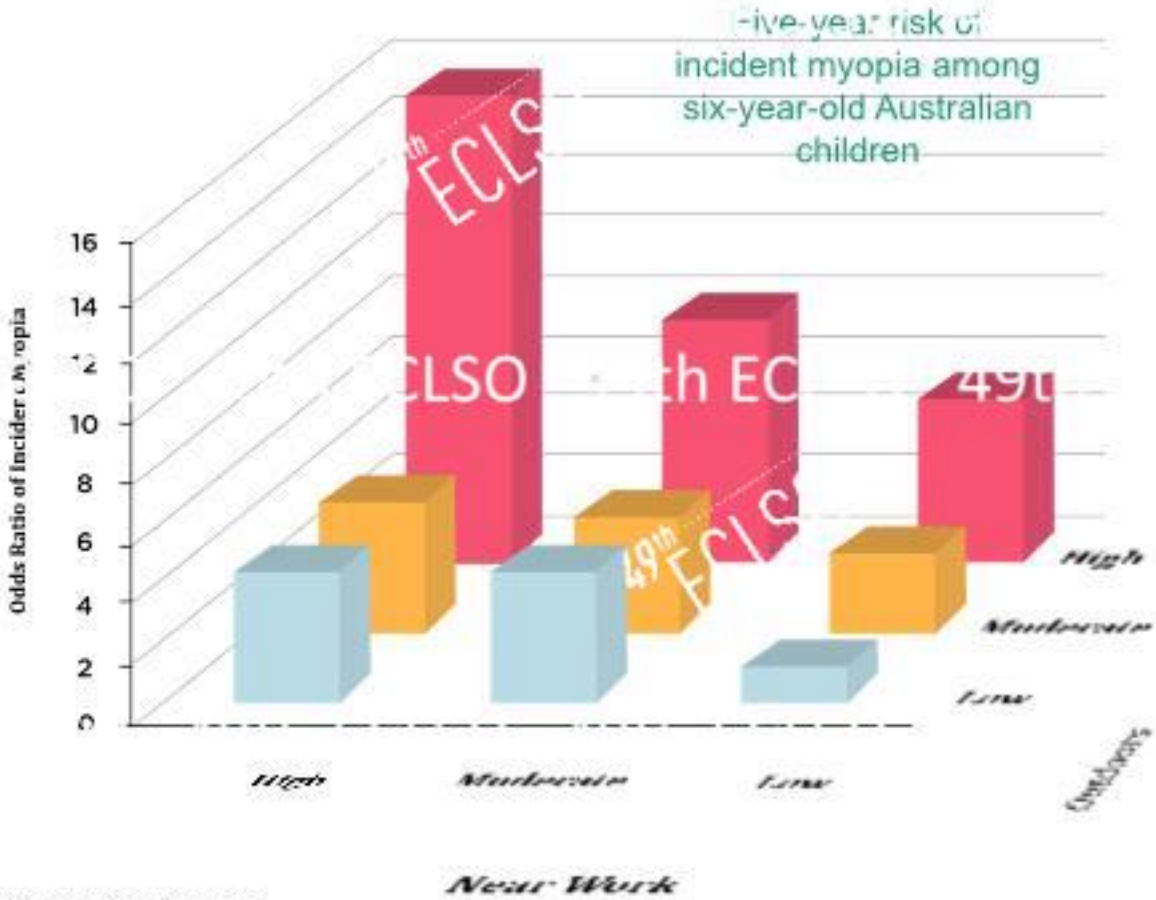
MYOPIA[1]

"A condition in which the spherical equivalent refractive error of an eye is ≤ −0.50 D when ocular accommodation is relaxed."

1. Flitcroft DI, He M, Jonas JB, et al. IMI - Defining and Classifying Myopia: A Proposed Set of Standards for Clinical and Epidemiologic Studies. Invest Ophthalmol Vis Sci. 2019;60(3):M20-M30. doi:10.1167/iovs.18-25957

RISK FACTORS FOR MYOPIA [1]

- Minimal time outdoors (< 2 hrs/day)
- Education/Near work
  - Longer duration
  - Shorter working distance
- Myopic parents/genetics
- Ethnicity
- **Reduced expected power of eye with age**



1. 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

Graph adapted from French et al 2013 Ophthalmology

IDENTIFYING CHILDREN AT RISK OF MYOPIA

Research

Original Investigation

Prediction of Juvenile-Onset Myopia

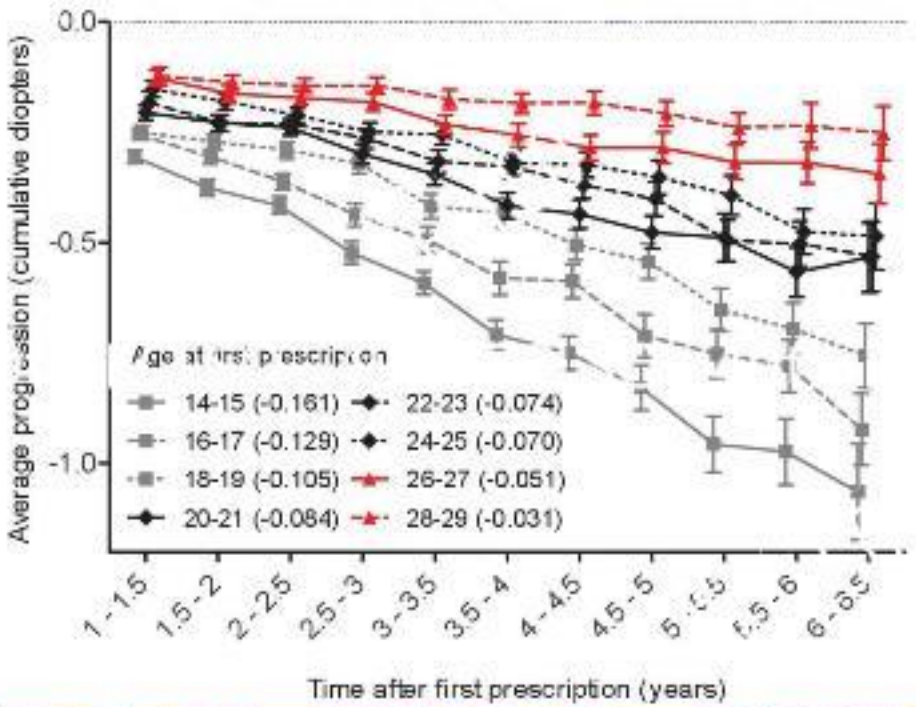
Karla Zadnik, OD, PhD; Loraine T. Sinnott, PhD; Susan A. Cotter, OD, MS; Lisa A. Jones-Jordan, PhD; Robert N. Kleinstein, OD, MPH, PhD; Ruth E. Manny, OD, PhD; J. Daniel Twelker, OD, PhD; Donald O. Mutti, OD, PhD; for the Collaborative Longitudinal Evaluation of Ethnicity and Refractive Error (CLEERE) Study Group

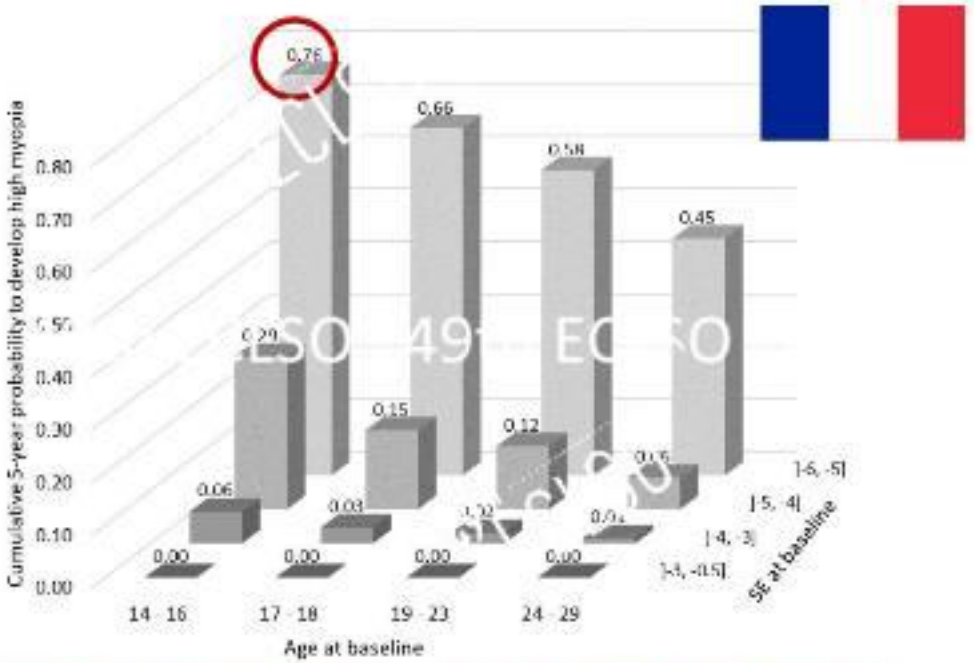
Age (yrs)	6	7-8	9-10	11
Refractive Error	< +0.75D	≤ +0.50D	≤ +0.25D	≤ 0.00D

Cycloplegic spherical equivalent autorefraction threshold by age, for children at high risk of developing myopia by 8th grade

Zadnik K et al. Prediction of Juvenile-Onset Myopia. JAMA Opthalmol 2015;133:683-9.

MYOPIA PROGRESSES FASTER AT YOUNGER AGES





"When combining a **younger age at baseline** and higher myopic status, the **5-year cumulative risk** of development of high myopia reached **76%**."

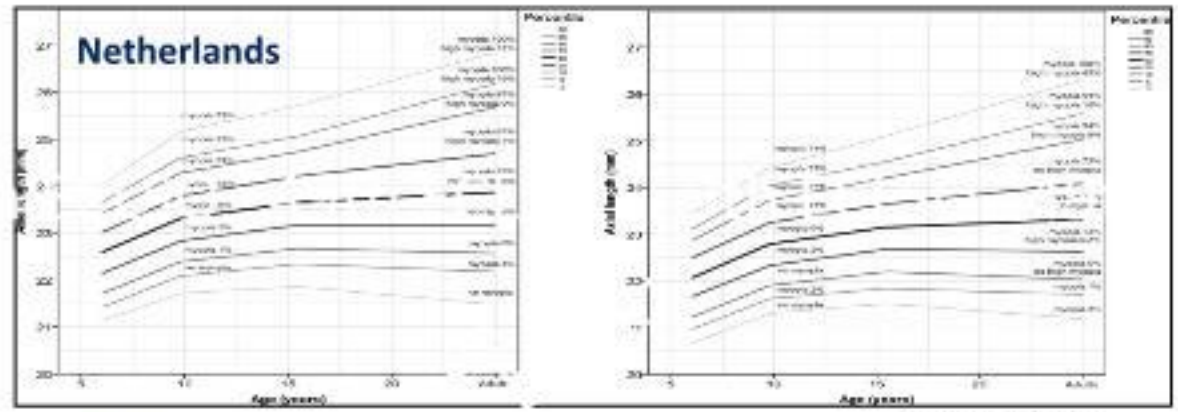
Ducloux A, Marillet S, Ingrand P, Bullimore MA, Bourne RRA, Leveziel N. Progression of myopia in teenagers and adults: a nationwide longitudinal study of a prevalent cohort [published online ahead of print, 2021 Dec 22]. Br J Ophthalmol. 2021;bjophthalmol-2021-319568. doi:10.1136/bjophthalmol-2021-319568

MONITORING MYOPIA

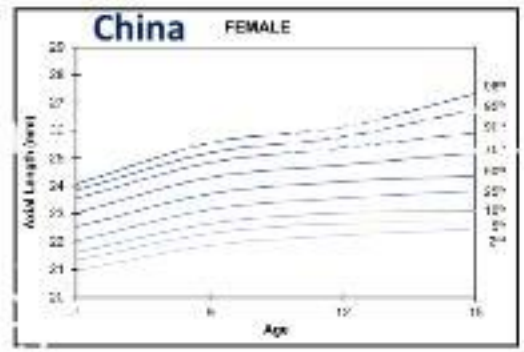
	AGE	7	8	9	10	11	12
AXIAL LENGTH (mm)	Asian	0.52	0.46	0.41	0.36	0.32	0.28
	Non-Asian	0.33	0.31	0.28	0.25	0.22	0.20
REFRACTIVE ERROR (D)	Asian	-1.12	-0.94	-0.78	-0.66	-0.56	-0.50
	Non-Asian	-0.98	-0.82	-0.69	-0.56	-0.45	-0.35

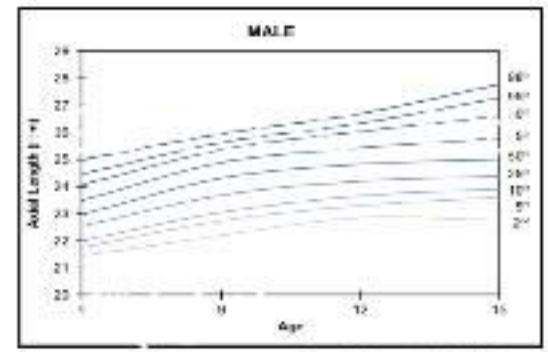
https://www.jnjvisionpro.com/education-center/resource-library/managing-myopia-clinical-response-growing-epidemic

EMERGING: AXIAL LENGTH CENTILE CURVES 1,2,3

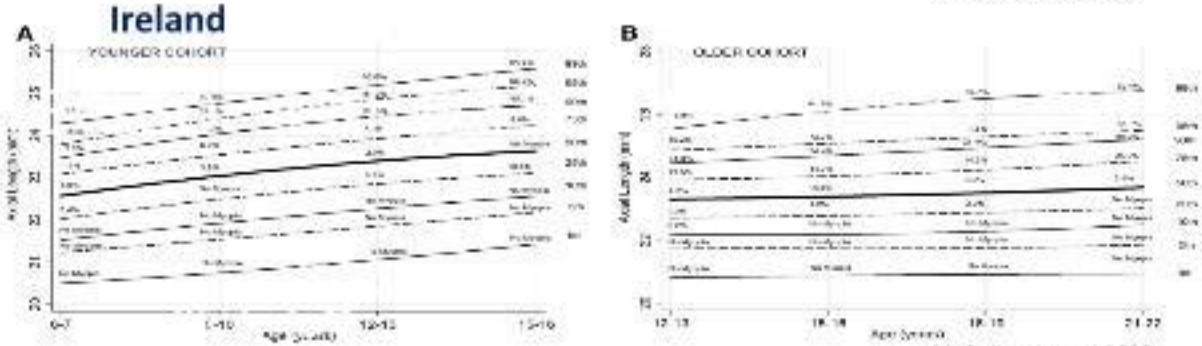


Tideman et al. 2017





San Diez et al. 2019



McCullough et al 2020

1. Jong M, Jansen JB, Wolfram C, et al. 15 year cycloplegic 2021. Invest Ophthalmol Vis Sci. 2021;62(5):7.
Tideman et al. Acta Ophthalmologica, Volume: 96, Issue: 3, Pages: 301-309,2017, DOI: (10.1111/aos.13603)
2. San Diez et al. Graefe's Archive for Clinical and Experimental Ophthalmology. 2019;257:1045 – 1053.
3. McCullough S, Adamson G, Breslin KMM, McClelland JF, Doyle L, Saunders KJ. Axial growth and refractive change in white European children and young adults: predictive factors for myopia. Sci Rep. 2020 Sep 16;10(1):15189. doi: 10.1038/s41598-020-72240-y. PMID: 32938970; PMCID: PMC7494927.

SUMMARY

- Myopia may be considered an ocular disease
- There is no safe level of myopia - **every dioptre matters!**
- Detect and offer treatment to every child that develops myopia **HOLISTICALLY**
- Consistent, objective monitoring of patients is needed
  - Axial length measurement (if available)
- Practitioners play a key role to **change the trajectory of myopia!**

49th ECLSO 49th ECLSO 49th ECLSO 49th ECLSO 49th ECLSO

"Once children become myopic, the myopia continues to progress and the degree of refractive error almost certainly increases." [1]

1. Mutti, Donald O. OD, PhD, FAAO; Sinnott, Loraine T. PhD; Brennan, Noel A. MScOptom, PhD, FAAO; Cheng, Xu MD, PhD; Zadnik, Karla OD, PhD, FAAO for the Collaborative Longitudinal Evaluation of Ethnicity and Refractive Error (CLEERE) Study Group The Limited Value of Prior Change in Predicting Future Progression of Juvenile-onset Myopia. Optometry and Vision Science: February 23, 2022 - Volume - Issue -doi: 10.1097/OPX.0000000000001803