

# FISIOPATOLOGIA DELLA PROGRESSIONE DELLA MIOPIA



Alberto Morelli



# Prevalenza: nel mondo

**Miopi**

1.95 Miliardi (28.3%)

5 Miliardi (50%)



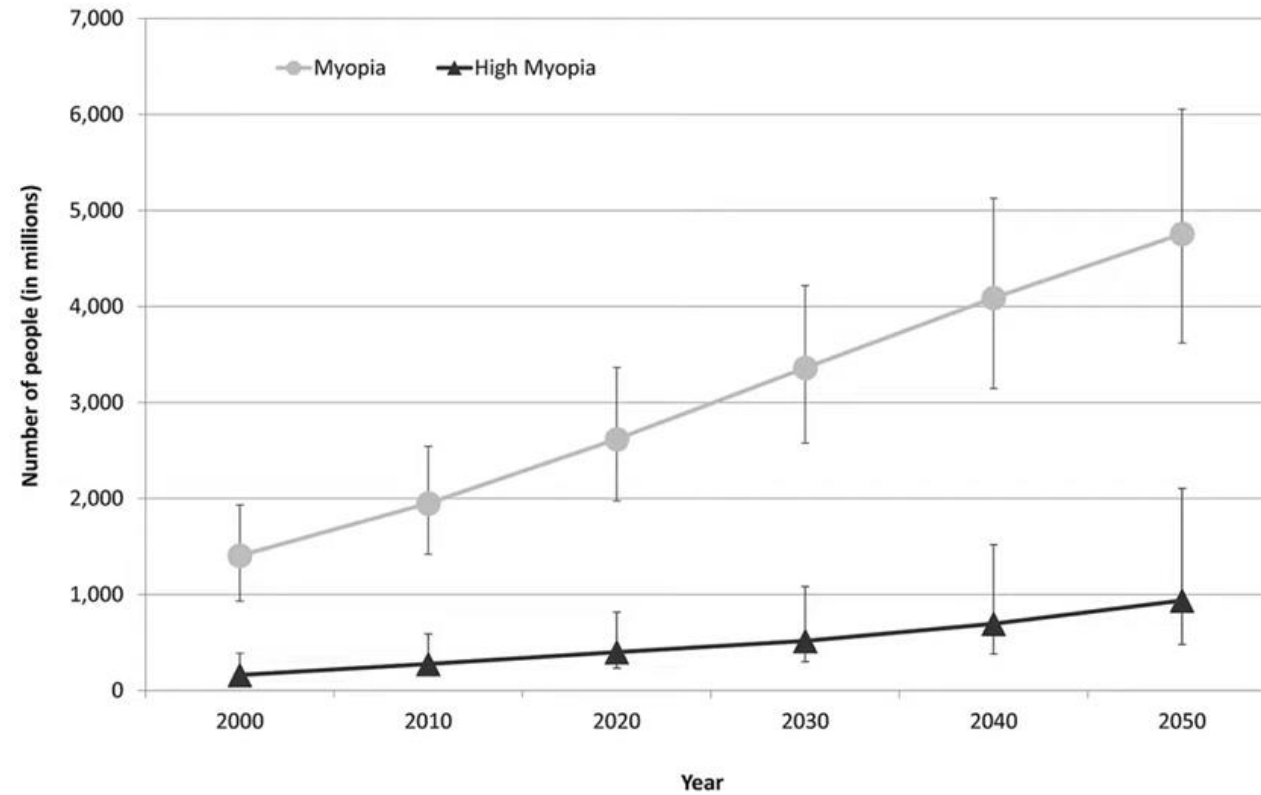
**Miopi elevati**

227 Milioni (4%)

930 Milioni (10%)



# Prevalenza: nel mondo





Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

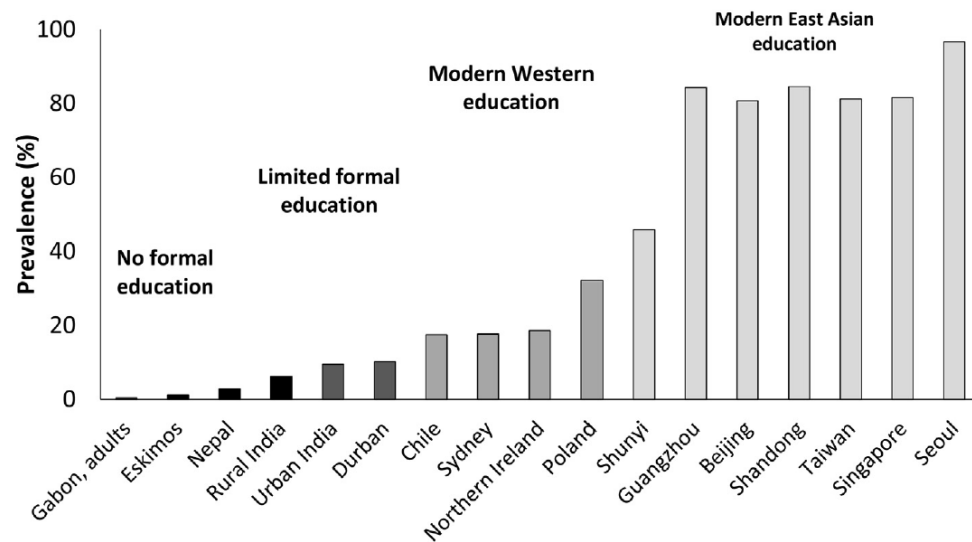
## Progress in Retinal and Eye Research

journal homepage: [www.elsevier.com/locate/prer](http://www.elsevier.com/locate/prer)



### The epidemics of myopia: Aetiology and prevention

Ian G. Morgan <sup>a, b, \*</sup>, Amanda N. French <sup>c</sup>, Regan S. Ashby <sup>d</sup>, Xinxing Guo <sup>b, e</sup>, Xiaohu Ding <sup>b</sup>, Mingguang He <sup>b, f</sup>, Kathryn A. Rose <sup>c</sup>





# Prevalenza miopia in Italia



**ANSA**<sub>it</sub>

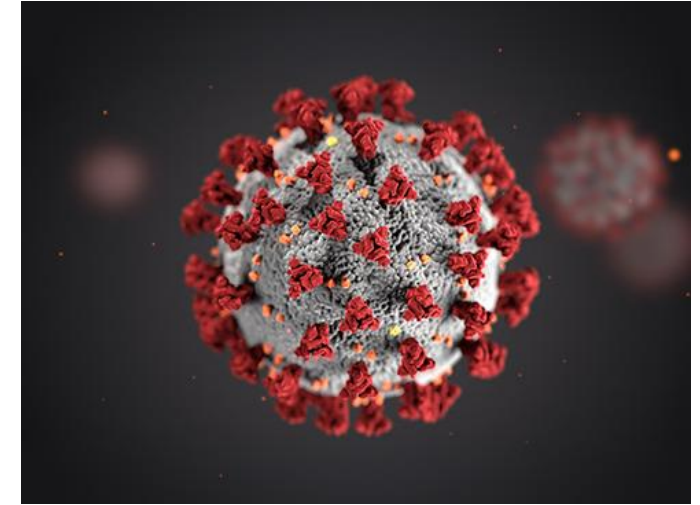
In Italia 18 milioni di miopi, la Dad la peggiora nei bimbi

Piovella (Soi), anche occhi adulti stanno peggio con lavoro smart

JAMA Ophthalmology | **Original Investigation**

# Progression of Myopia in School-Aged Children After COVID-19 Home Confinement

Jiaxing Wang, MD, PhD; Ying Li, MD, PhD; David C. Musch, PhD, MPH; Nan Wei, MD; Xiaoli Qi, MD; Gang Ding, MD; Xue Li, MD; Jing Li, MD; Linlin Song, MD; Ying Zhang, MD; Yuxian Ning, MD; Xiaoyu Zeng, MD; Ning Hua, MD; Shuo Li, MD, PhD; Xuehan Qian, MD, PhD



**Findings** In this cross-sectional study that included 194 904 photoscreening tests conducted in 123 535 children, a substantial myopic shift (-0.3 diopters) was noted after home confinement due to coronavirus disease 2019 for children aged 6 to 8 years. The prevalence of myopia increased 1.4 to 3 times in 2020 compared with the previous 5 years.

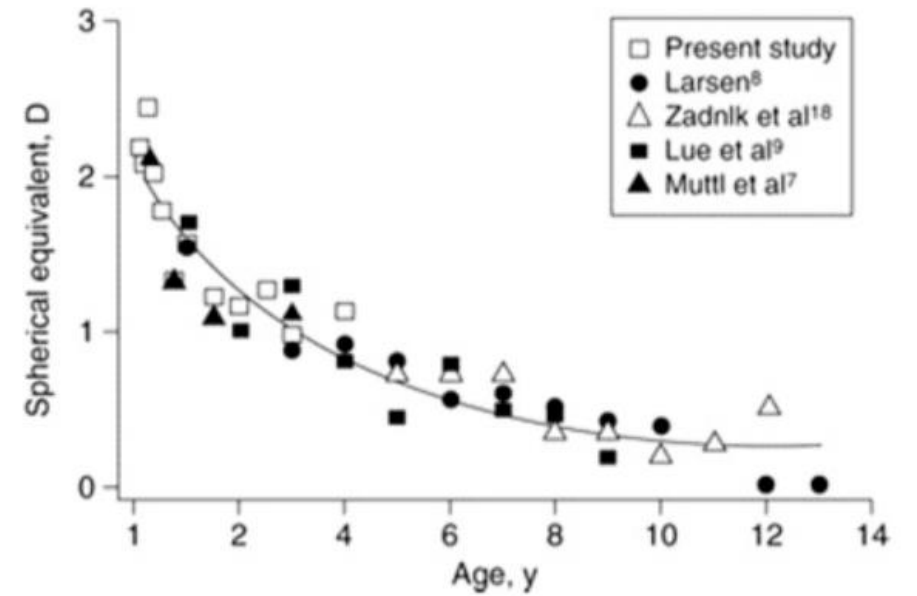
**Meaning** Home confinement due to coronavirus disease 2019 appeared to be associated with a substantial myopic shift in children; younger (aged 6-8 years) children's refractive status may be more sensitive to environmental changes than older children, given that they are in an important period for the development of myopia.

*JAMA Ophthalmol.* 2021;139(3):293-300. doi:[10.1001/jamaophthalmol.2020.6239](https://doi.org/10.1001/jamaophthalmol.2020.6239)  
Published online January 14, 2021.

# Emmetropizzazione

Normale processo fisiologico:

- Potere corneale
- Lunghezza assiale (+)



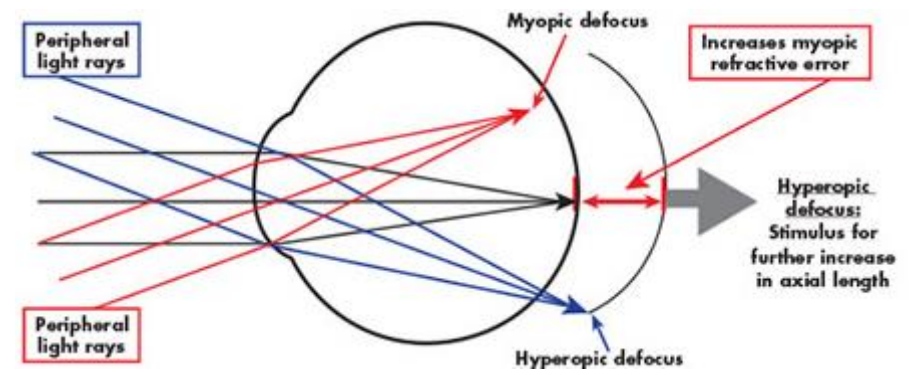


# Eziopatogenesi: Teorie

## Accommodative Lag Theory



## Peripheral Refraction Theory







# Accommodative Lag Theory

Minore accomodazione nel lavoro da vicino

Immagine focalizzata posteriormente rispetto al piano retinico a **livello foveale**

Ipermetropia relativa che stimola la crescita assiale del bulbo

# Accommodative Lag Theory

## ARTICLES

### Do Progressing Myopes Show Reduced Accommodative Responses?

ROSENFELD, MARK MCOptom, PhD, FAAO; DESAI, ROSHNI BA; PORTELLO, and JOAN K. OD, MPH, FAAO

Author Information 

Optometry and Vision Science: April 2002 - Volume 79 - Issue 4 - p 268-273

BUY

#### Abstract

Refractive error and accommodative responsivity were monitored at 4-month intervals over a 1-year period to determine whether an increased lag of accommodation either precedes or accompanies the development of myopia. Accommodation was measured for stimulus levels of 2.5, 3, 4, and 5 D, and both the slope of the stimulus-response function and accommodative error were computed. Almost all subjects exhibited accommodative stimulus-response gradients close to unity, although a lower gradient was observed in subjects who were myopic upon entry into the study and whose ametropia remained stable. These stable myopes also exhibited the largest lag of accommodation. These findings do not support the proposal that the development of myopia in young adults is accompanied by a reduced accommodative response during nearwork.





Vision Research

Volume 51, Issue 9, 11 May 2011, Pages 1039-1046



### Accommodative lag and juvenile-onset myopia progression in children wearing refractive correction

David A. Berntsen <sup>a</sup>, Loraine T. Sinnott <sup>b</sup>, Donald O. Mutti <sup>b</sup>, Karla Zadnik <sup>b</sup>  , The CLEERE Study Group <sup>1</sup>

#### Abstract

The relationship between accommodative lag and annual myopia progression was investigated using linear models in 592 myopic children wearing a full refractive correction in the Collaborative Longitudinal Evaluation of Ethnicity and Refractive Error (CLEERE) Study. The mean ( $\pm$  SD) age and spherical equivalent refractive error at baseline were  $10.4 \pm 1.8$  years and  $-2.13 \pm 1.24$  D, respectively. The mean annual progression of myopia was  $-0.45 \pm 0.32$  D, and the mean accommodative lag (for a 4-D Badal stimulus) was  $1.59 \pm 0.63$  D. Neither lag at the beginning nor at the end of a yearly progression interval was associated with annual myopia progression (all  $p \geq 0.12$ ). These data suggest that foveal hyperopic retinal blur during near viewing may not drive juvenile-onset myopia progression.



# Accommodative Lag Theory

## A Randomized Trial Using Progressive Addition Lenses to Evaluate Theories of Myopia Progression in Children with a High Lag of Accommodation

David A. Berntsen; Loraine T. Sinnott; Donald O. Mutti; Karla Zadnik

Investigative Ophthalmology & Visual Science February 2012, Vol.53, 640-649.

doi:<https://doi.org/10.1167/iovs.11-7769>

### 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.

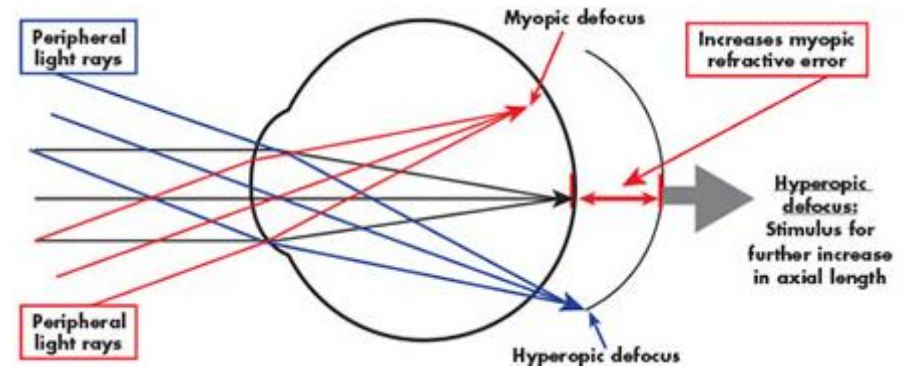
**Results.:** When the children were randomly assigned to SVLs or PALs, the adjusted 1-year changes in SE were  $-0.52$  D (SVL group) and  $-0.35$  D (PAL group; treatment effect =  $0.18$  D;  $P = 0.01$ ). When all children wore SVLs the second year, there was no difference in myopia progression between 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 association between accommodative lag and myopia progression is inconsistent with the PAL effect being due to decreased foveal blur during near work. (Clinical Trials.gov number, NCT00335049.)

# Peripheral Refraction Theory

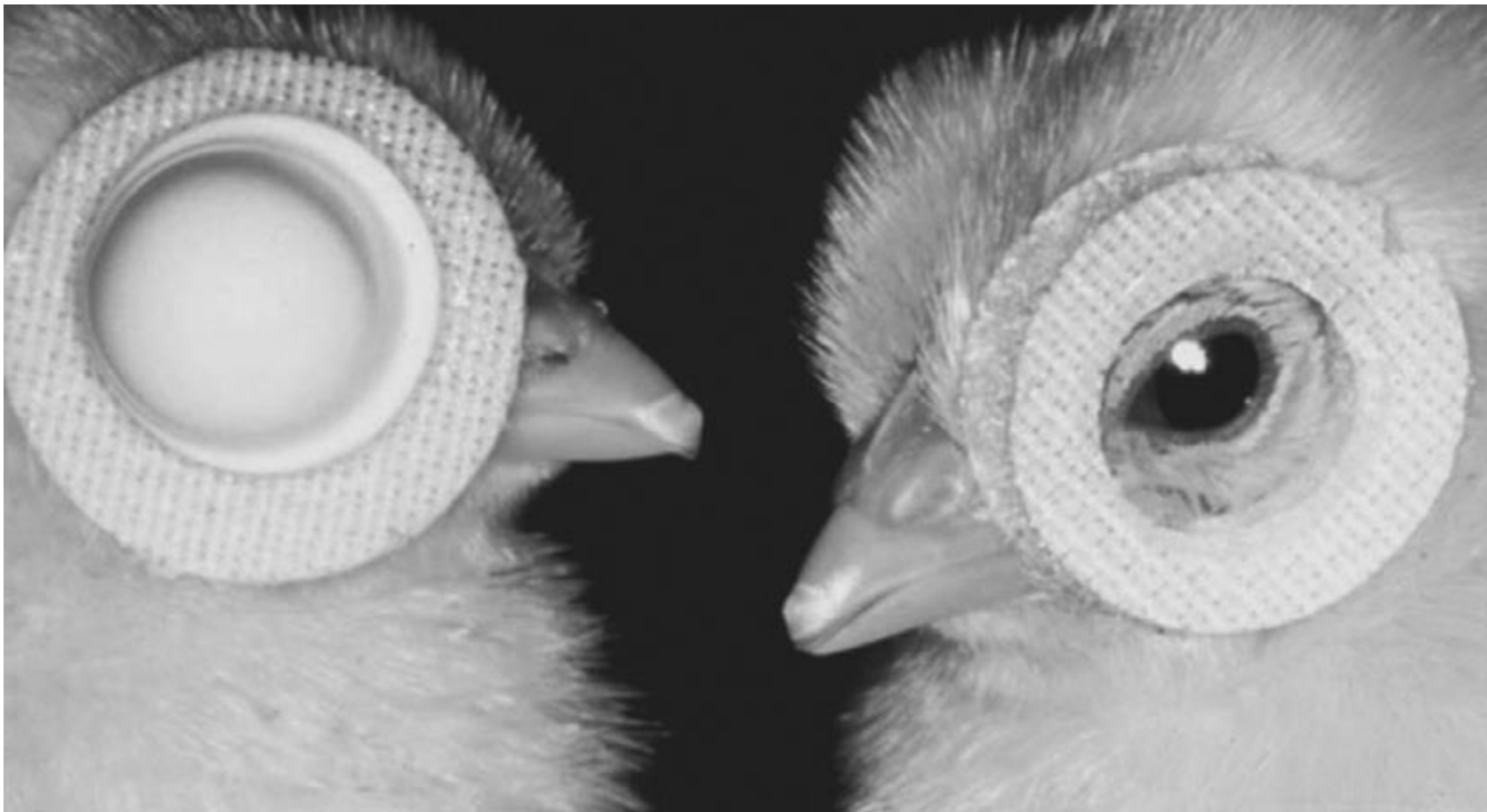
L'immagine è focalizzata posteriormente alla retina in periferia

Una ipermetropia relativa stimola la crescita assiale del bulbo

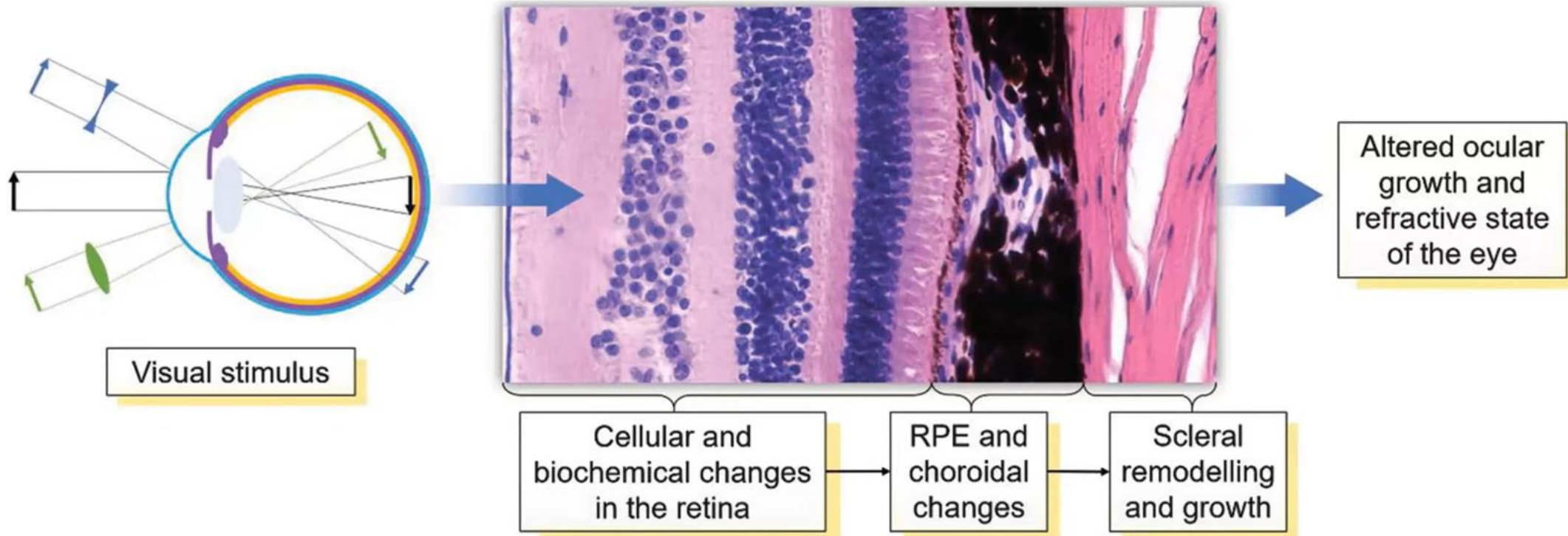




# Eziopatogenesi

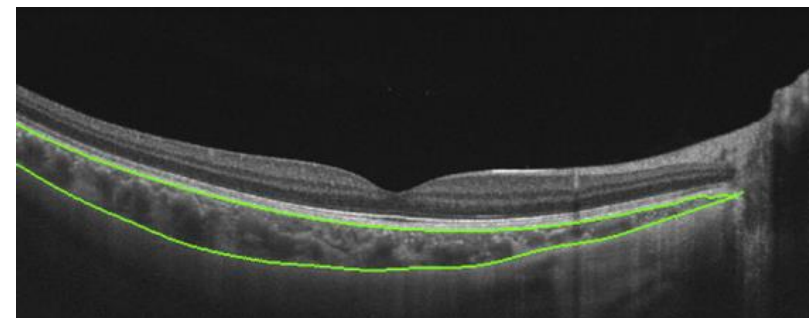
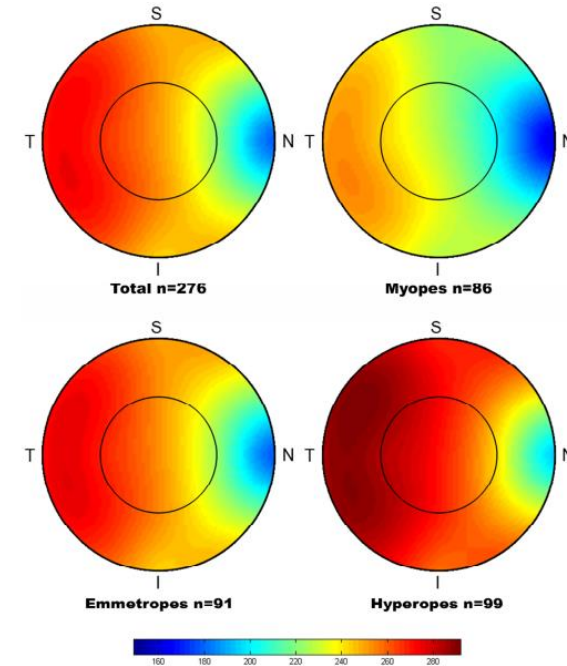
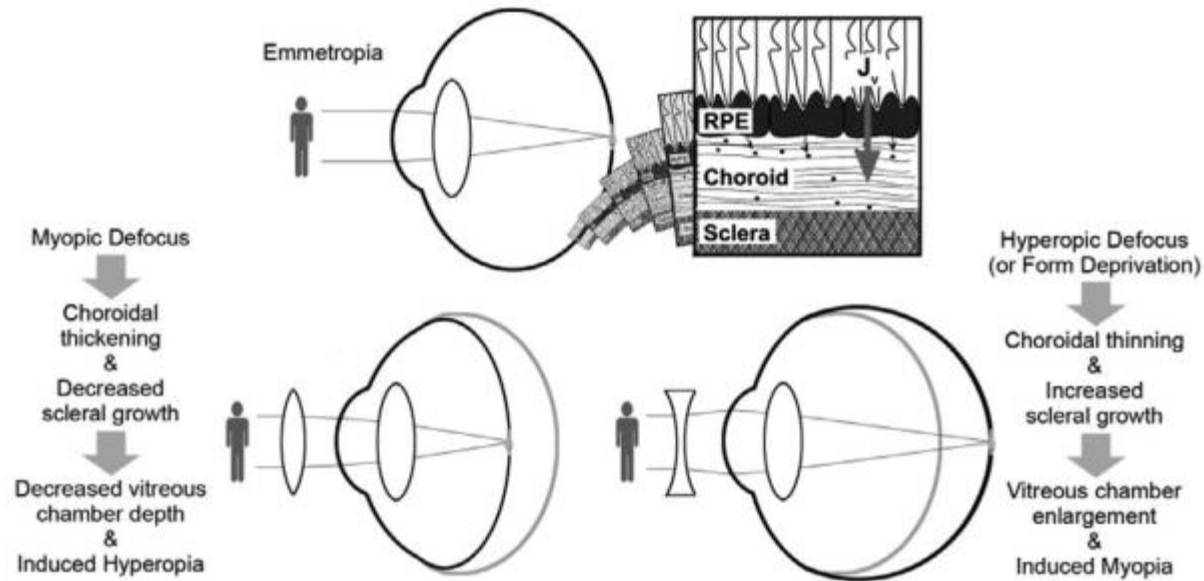


# Eziopatogenesi





# Eziopatogenesi







# Fattori di rischio

Errore refrattivo →  
fattore predittivo per lo sviluppo di  
ulteriore miopia

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



# Fattori di rischio

## Fattori Genetici

- Rischio doppio con un genitore affetto
- Rischio quintuplicato con entrambi i genitori affetti

Gli errori di refrazione elevati hanno maggiore aggregazione familiare rispetto a quelli di entità lieve



# Fattori di rischio

## Fattori Genetici

- Associazioni con geni coinvolti nel controllo della matrice extracellulare e nel rimodellamento del tessuto connettivo sclerale.
- I casi di miopia associata ad anomalie sistemiche si rinvengono nei disordini ereditari del tessuto connettivo come la Sindrome di Marfan.



# Fattori di rischio

Fattori Genetici ?





# Fattori di rischio

## Fattori Ambientali

- **LUCE AMBIENTALE:** maggiore esposizione alla luce solare in età adolescenziale è associata a regressione della miopia
- Il tempo trascorso all'aperto può ridurre il rischio di sviluppo di miopia



# Fattori di rischio

## Aree Urbane

- Il Refractive Error Study in Children (RESC): i bambini cinesi ed indiani che vivono nelle aree urbane abbiano un tasso di miopia maggiore rispetto ai bambini della stessa etnia provenienti dalle regioni rurali.
- Ruolo protettivo dell'esposizione alla luce solare sembra legato alla **dopamina** → capace di inibire l'allungamento assiale in modelli di miopia sperimentale



# Fattori di rischio

## Lavoro da vicino

- Maggiore prevalenza della miopia nei ragazzi ebrei ortodossi con più intensa scolarizzazione
- SMS study (Sydney Myopia Study): correlazione tra ore spese in una continua e ravvicinata lettura (per un tempo >30 minuti ad una distanza < 30cm) con l' aumento della miopia
- Studio OLMS (Orinda Longitudinal Study of Myopia): la più forte associazione fra miopia e lavoro da vicino riguarda lo studio/lettura

Zylbermann R et al. 1993  
Saw SM et al 2008  
Mutti DO et al 2002





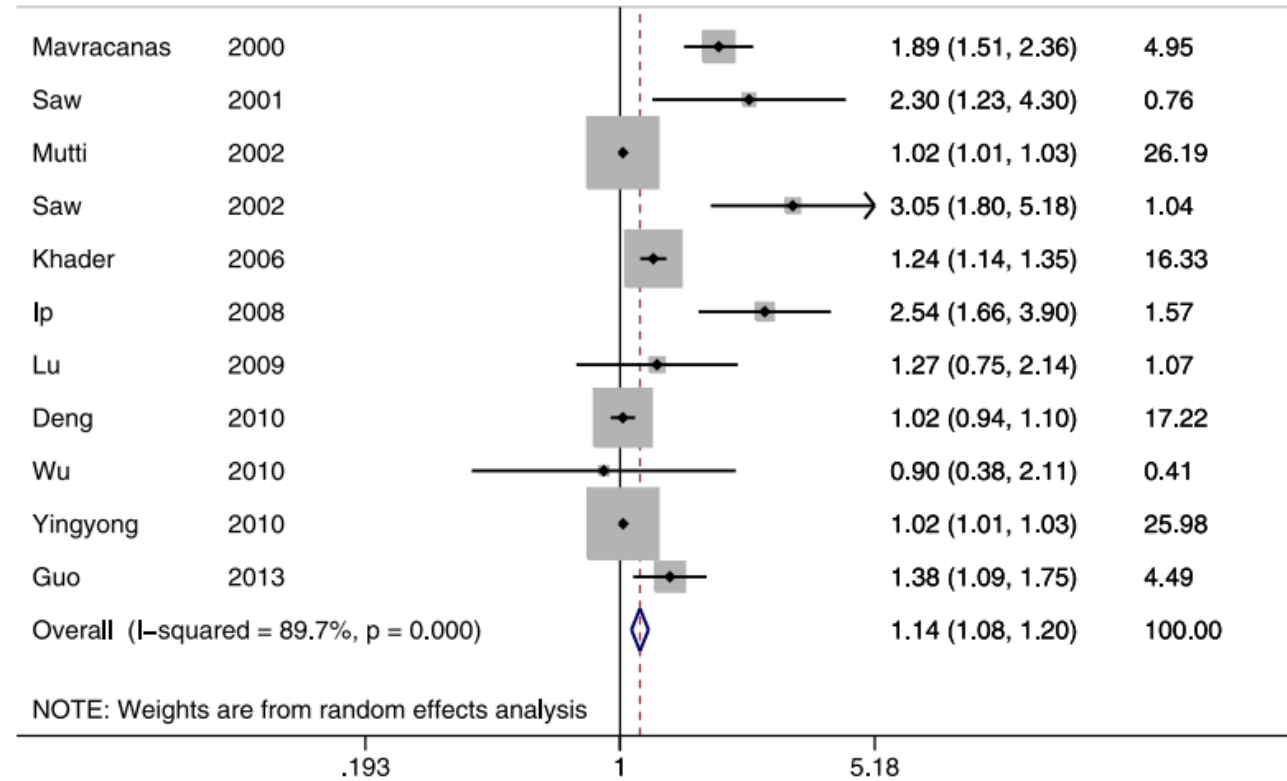
# Near Activity

RESEARCH ARTICLE

## The Association between Near Work Activities and Myopia in Children—A Systematic Review and Meta-Analysis

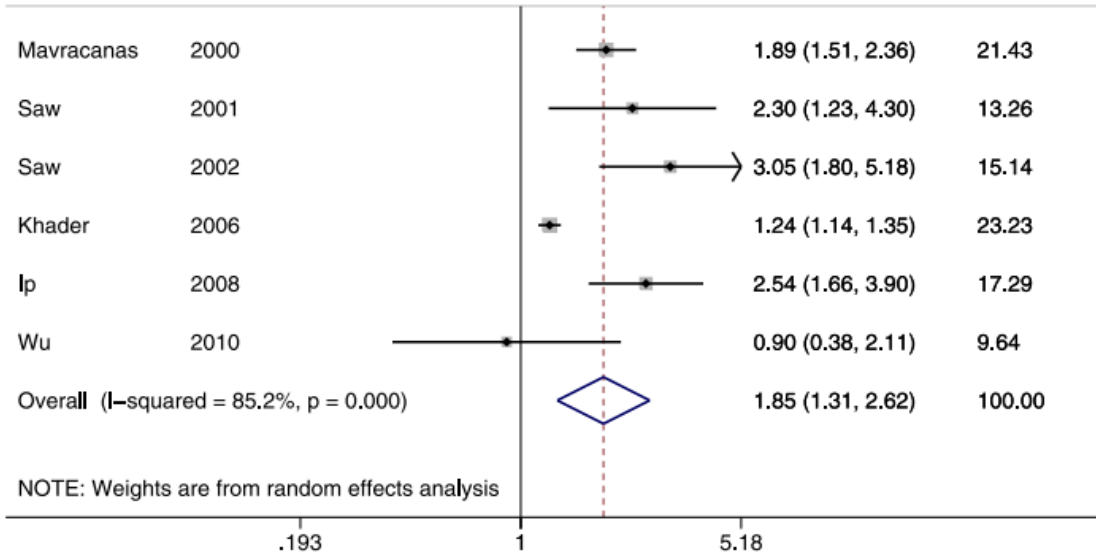
Hsiu-Mei Huang<sup>1</sup>, Dolly Shuo-Teh Chang<sup>2</sup>, Pei-Chang Wu<sup>1\*</sup>

Published: October 20, 2015

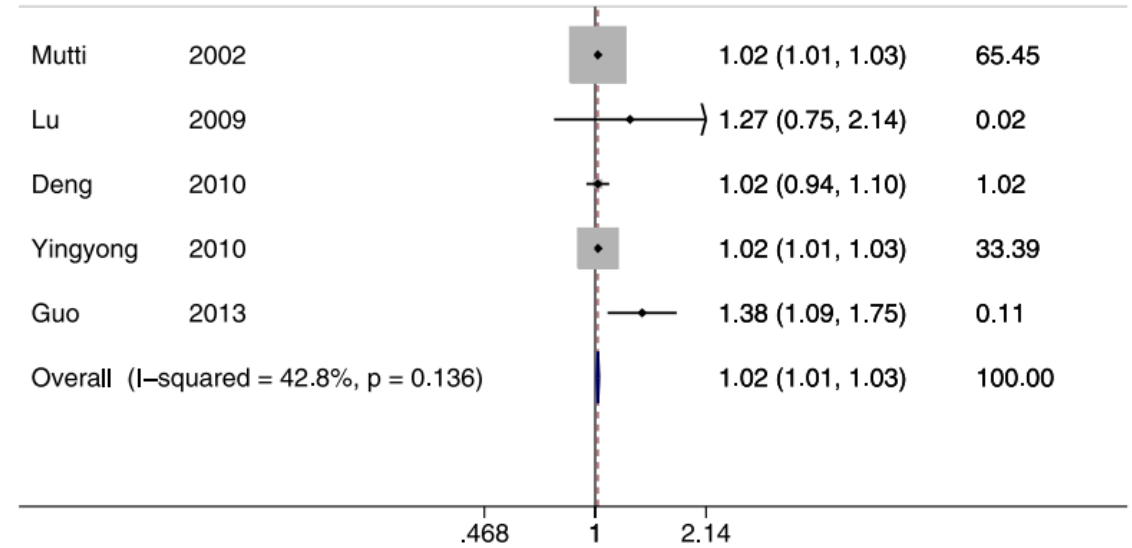




# Near Activity



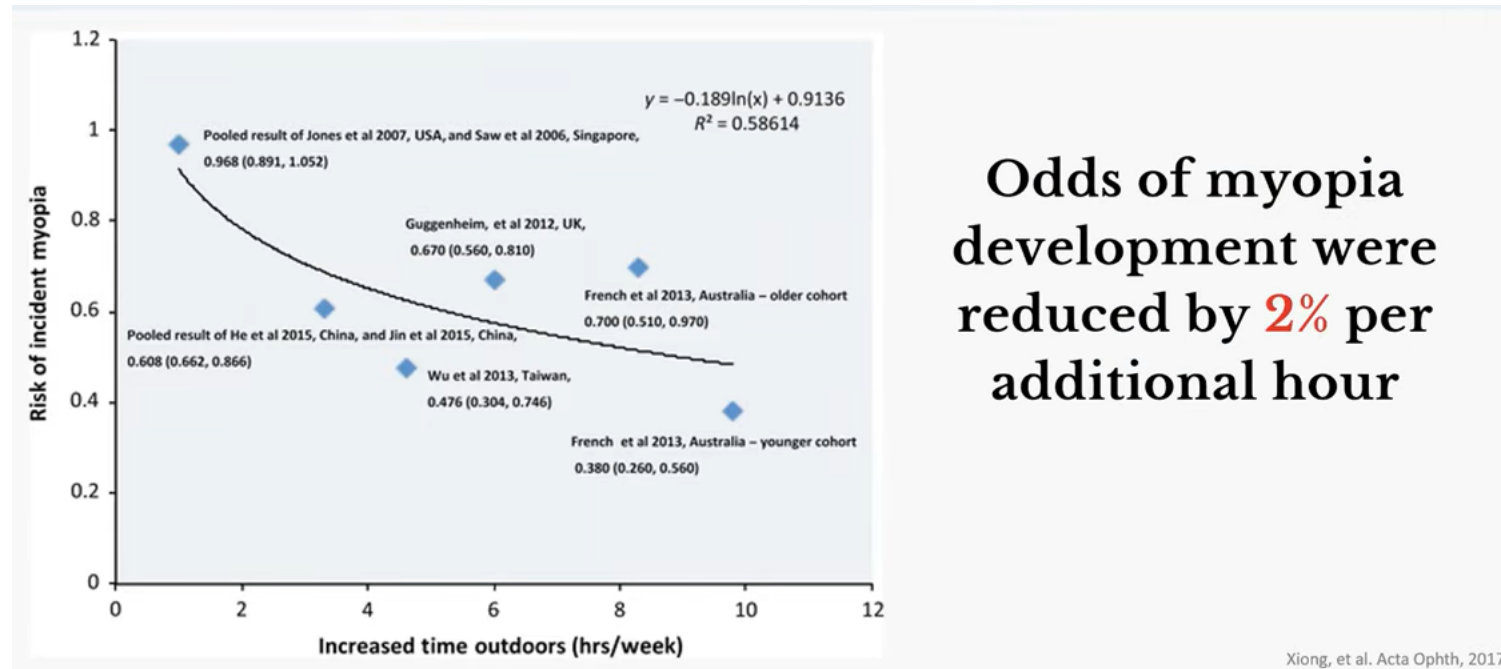
Children who performed more near work were more likely to be myopic



OR > 2% for every one diopter-hour more of near work per week

# Outdoor Activity

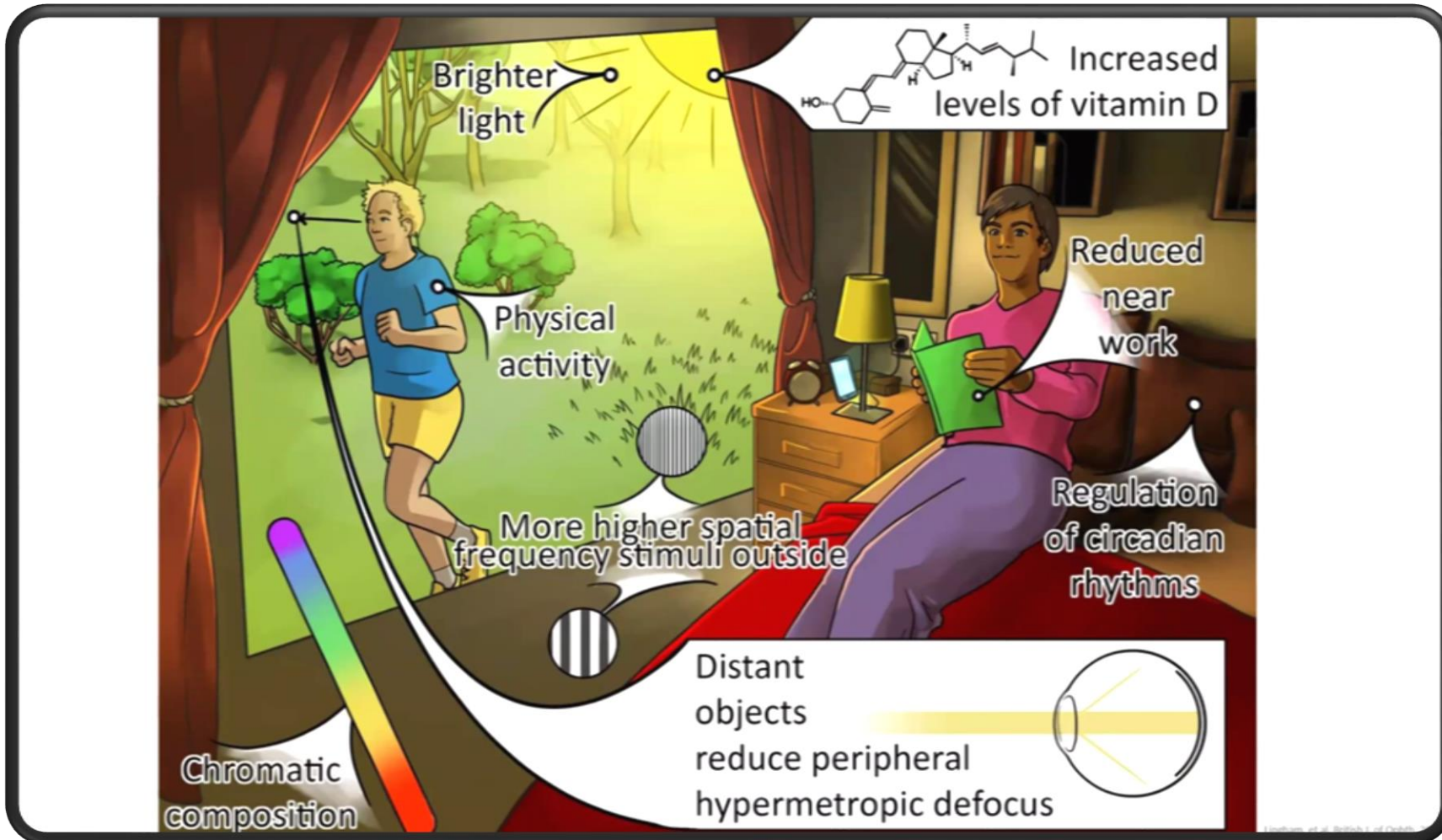
Protettivo contro lo sviluppo di miopia



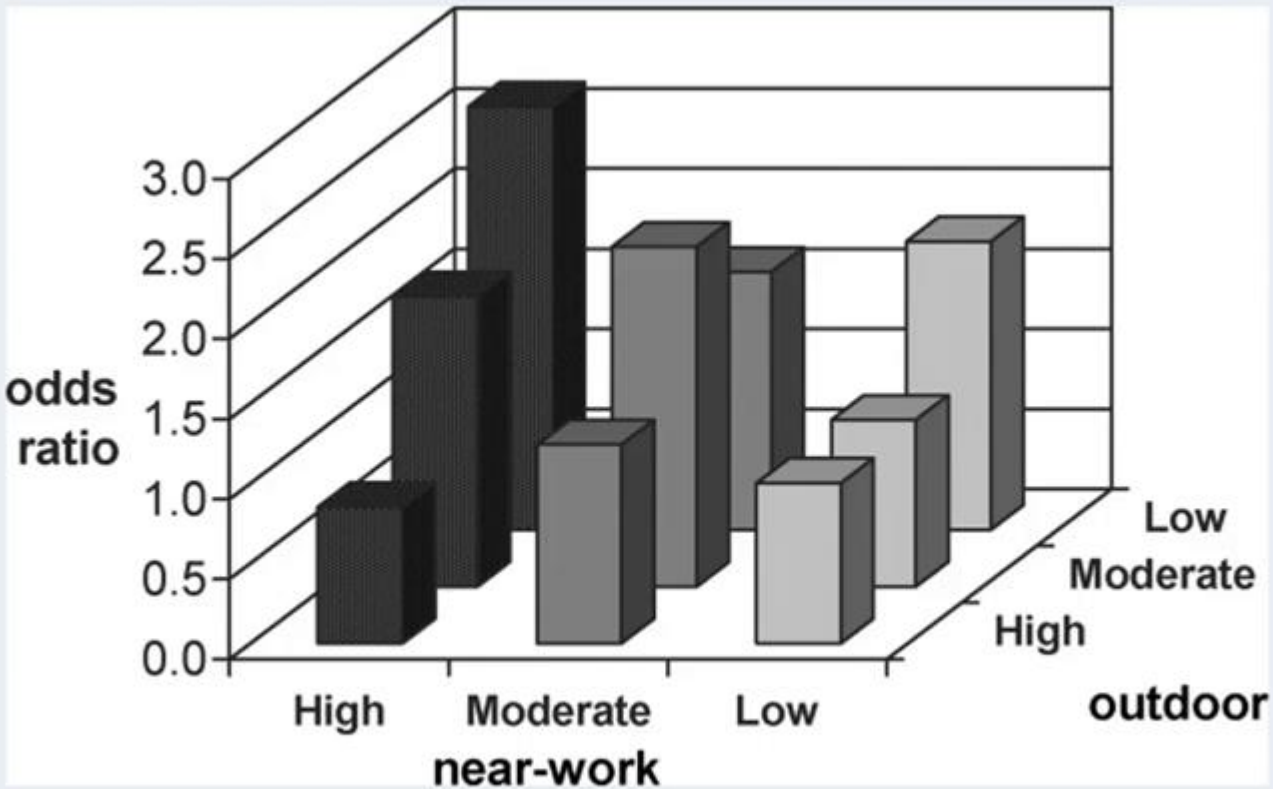
Odds of myopia development were reduced by **2%** per additional hour

< 14 ore alla settimana → Maggiore odds ratio per sviluppo di miopia

# Outdoor Activity



# Outdoor Activity



Rose, et al. Ophthalmology, 2008.



# Conclusioni

**Miopia in aumento in tutto il mondo → Epidemia**

**Non solo fattori genetici, ma anche fattori ambientali**

- **Fattore di rischio attività da vicino, in particolare lettura e utilizzo di smartphone e tablet → recrudescenza con COVID**
- **Ruolo protettivo dell'attività all'aperto**

**Prevenire è sempre meglio di curare!**





Grazie per l'attenzione!

