# Efficacy of Light Therapy for Myopia Prevention in School-Aged Children: A Systematic Review and Meta-analysis of Randomized Controlled Trials

Isaac Tang Jing Wen MBChB[1], Mavendra Ravindran[1], Akkhash Sivakumar MBChB[1], Roshan Pillai[1], Baljean Dhillon BMed Sci(Hons), BM BS(Nottingham), FRCPS (Glasg), FRCS(Ed) FRCOphth, FRCPE[2,3]

## INTRODUCTION

**Background**

- Myopia is caused by axial elongation, leading to blurred distance vision and increasing global prevalence (~30% in 2020 → ~50% by 2050)
- High burden in East/Southeast Asia (up to 80% of adolescents affected)
- Associated with long-term complications: myopic maculopathy, retinal detachment, glaucoma
- Slowing childhood progression can significantly reduce lifetime visual morbidity
- Current treatment modalities include low-dose atropine eye drops, orthokeratology and maximizing time outdoors

**Aim**

- Provide more reliable estimates of changes in spherical equivalent refraction (SER) and axial length (AL) by only including randomised controlled trials
- Direct comparison with other light-based therapies
- Evaluate the safety of light-based strategies to slow myopia progression in children

## METHODOLOGY

**Design**

- Systematic review & meta-analysis following PRISMA 2020
- Registration: PROSPERO (CRD420251048146)

**Databases**

- **CENTRAL, PubMed, Embase, Scopus** (inception → April 2025)

**Framework**

**P:** Children (6–17 years) with myopia/premyopia
**I:** Light-based therapies (e.g. RLRL, outdoor light)
**C:** Standard care / placebo / no treatment
**O:** Axial length (AL) & spherical equivalent refraction (SER)

**Inclusion Criteria**

- Randomised controlled trials (RCTs)
- ≥6 months follow-up
- Reported AL and/or SER

**Exclusion Criteria**

- Combination therapies (unless separable)
- Non-RCTs (observational, reviews, case reports)
- Missing primary outcomes

**Study Selection & Data Extraction**

- Duplicate removal & screening via **Rayyan**
- Independent dual-reviewer screening (third reviewer for conflicts)
- Data extraction using **Covidence**

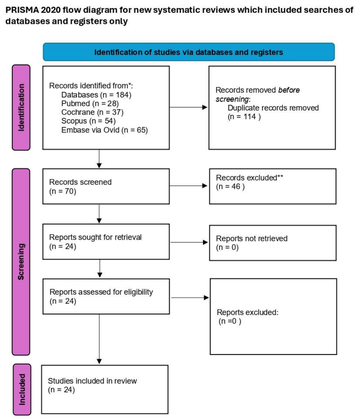
**Outcomes**

**Primary:**
Change in Axial Length (mm)
Change in SER (dioptres)

**Secondary:**
Myopia incidence, choroidal thickness
Adverse effects, visual acuity

**Analysis**

- Meta-analysis performed using **RStudio**
- **Random-effects model**
- Results presented with **forest plots, 95% CI, and heterogeneity**




## RESULTS AND META-ANALYSIS

**Outcomes**

- 24 RCTs (n = 10,717 children) aged 6–17 years
- Follow-up: 6–24 months
- Interventions: RLRL, outdoor light, violet light
- Most compared RLRL + SVS vs SVS alone
- Cochrane Risk of Bias 2.0 tool showed 25% low risk and 54% of RCTs had some concerns due to lack of blinding
- No clear evidence of publication bias (symmetrical funnel plots)

**Key Findings (12 months)**

**RLRL (strongest effect):**

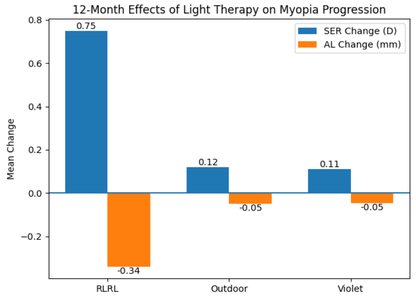
- AL Mean Difference: −0.34 mm (95% CI −0.45 to −0.23)
- SER Mean Difference: +0.75 D (95% CI +0.45 to +1.06)
- AL Mean Difference (24 months): −0.48 mm
- SER Mean Difference (24 months): 0.93 D

**Outdoor light:**

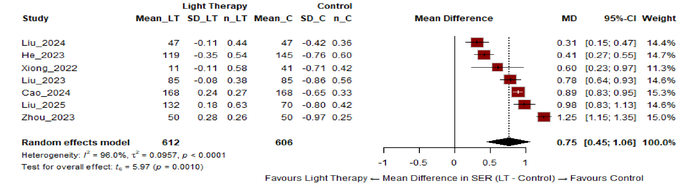
- AL Mean Difference: −0.05 mm
- SER Mean Difference: +0.12 D

**Violet light:**

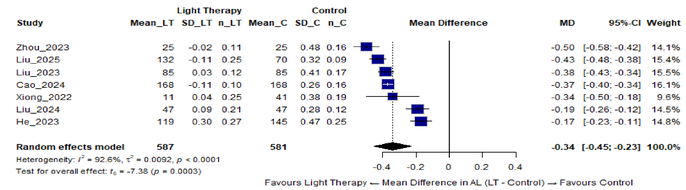
- AL Mean Difference: −0.046 mm
- SER Mean Difference: +0.11 D




**Forest Plot (AL)**



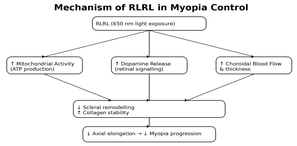

**Forest Plot (SER)**




## DISCUSSION AND CONCLUSION

**RLRL (Red Light Therapy)**

- Dopamine release
- Photobiomodulation
- Nitric oxide vasodilation
- Increased choroidal perfusion
- Choroidal thickening




**Violet Light**

- OPN5 activation
- EGR1 gene expression
- Dopamine release
- Gene-level growth regulation

**Outdoor Light**

- High illuminance exposure
- Dopamine release
- Broad-spectrum light stimulation

**Limitations**

- Predominantly East Asian studies → limited generalisability
- Incomplete data & variable follow-up → challenges in pooled analysis
- Few studies on non-RLRL therapies → limited comparisons
- Lack of head-to-head RCTs → unclear relative efficacy
- Heterogeneity in light dose, duration, and delivery
- Compliance variability, especially for outdoor exposure (no objective measurement)
- English-only inclusion → potential language bias

**Safety**

- Generally well tolerated
- No serious ocular adverse events (clinical exam/OCT)
- Minor effects: transient photic phenomena, occasional dizziness
- Short-term safety reassuring, long-term data lacking

**Implications for Future Research**

**High-quality RCTs**
Larger, multi-centre trials with standardised protocols across diverse populations with head-to-head comparisons

**Population diversity**
Inclusion of non-Asian cohorts to improve generalisability

**Standardisation**
Optimisation of light therapy parameters (dose, duration, wavelength)

**Long-term evaluation**
Assessment of safety, cost-effectiveness, and real-world scalability

## CONCLUSION

This meta-analysis shows that RLRL slows myopia progression compared with single vision spectacles, based on AL and SER changes, supporting light-based interventions for myopia control. Certainty was moderate due to geographic homogeneity, variable follow-up, and small samples.

Future trials should include non-Asian populations and standardise light therapy protocols, with health-economic and real-world studies needed to assess large-scale effectiveness and sustainability.

Corresponding Author: Dr Isaac Tang Jing Wen | Email: isaactjw@gmail.com | ORCID: 0009-0009-3007-0310