Literature review: Light and colour in myopia control

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Background

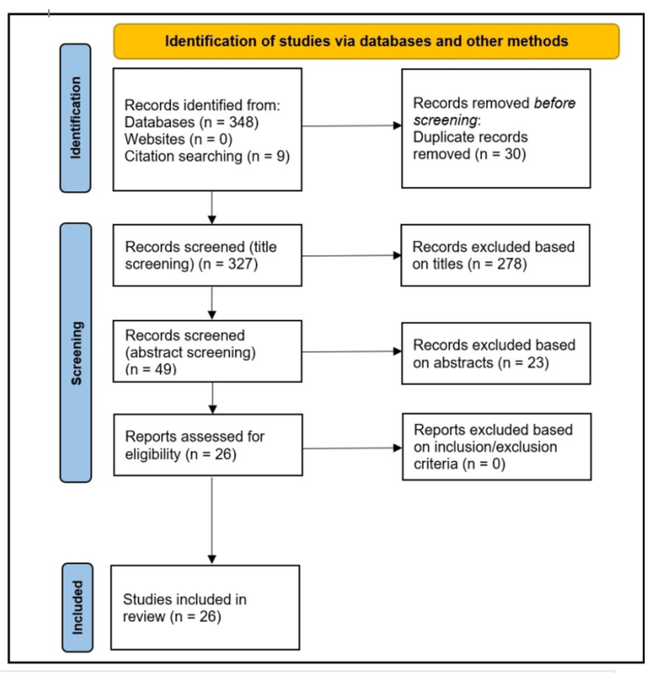
Increasing time outdoors reduces the risk of developing myopia. Likely mechanisms (Lingham et al., 2020) relate to outdoors having higher illuminance, a broader chromatic spectrum, a different effect on circadian rhythms, and different spatial frequency characteristics. Flicker may also be relevant. Myopia control interventions have been proposed based on manipulating exposure to light of different chromaticities, involving repeated low-level red-light stimulation (RLRL), blue light (BL), and violet light (VL).

Purpose: To review evidence on the effectivity, effectiveness, and safety of coloured light interventions for myopia control. The review considers a diversity of interventions (RLRL, BL, VL) and adopts a narrative format, considering diverse approaches in a holistic way, to highlight synergies or contradictions.

Method

PubMed and Embase searches:
(myopia+control OR myopia+management) AND (red+light OR blue+light OR violet)

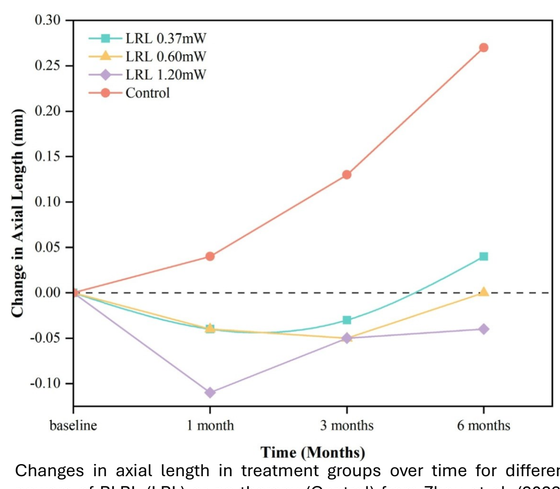
The review prioritises RCTs, but also includes relevant observational studies, case studies, and laboratory research, when relevant to illustrate safety and potential mechanisms. Previous reviews were also considered.



Results

- 26 relevant investigations. Studies with follow-up of at least one year were tabulated, comprising 3 studies on VL and 10 on RLRL.
- Literature on VL and myopia progression is mostly retrospective and suggestive of a possible benefit from VL.
    - VL-emitting spectacles described by Torii and colleagues (2022) await validation in long-term RCTs.
- Research on blue light is limited. Interventions are yet to be reported.
- Evidence for RLRL is more substantial, with several RCTs continuing for at least one year, producing significant treatment effects.
- For all RLRL studies except Dong et al. (2023) and Zhou et al. (2023), the control group received no control intervention. Zhou et al. (2023) report little difference between three doses (intensities) of RLRL.

- Lack of long-term follow-up data. Most treatment effect occurs in the first six months.
- Insufficient exploration of rebound effect.
- Mechanism(s) uncertain.
- Ostrin and Schill (2024) show ANSI maximum permissible exposure (MPE) is exceeded by some RLRL instruments.
    - ANSI states no repeat exposure for ≥48 h.



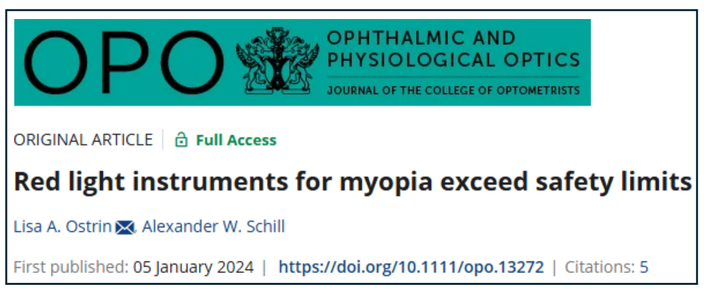
Changes in axial length in treatment groups over time for different powers of RLRL (LRL) or no therapy (Control) from Zhou et al. (2023). Reproduced from Efficacy of Different Powers of Low-Level Red Light in Children for Myopia Control by Zhou et al. (2023) under Creative Commons License.

Discussion

- Intuitively unlikely that claims of effectivity for interventions that stimulate opposite ends of the spectrum (VL and RLRL) are valid.
    - If the narrow spectrum of artificial lighting is a factor in increasing myopia, then "stretching the spectrum" by stimulation of either end may be helpful.
- More research is needed on VL, and especially BL. Careful assessment of light levels and safety will be important, especially in view of issues raised about RLRL.
- Safety concerns raised about RLRL are profound and raise serious issues. In some studies, a significant adverse event was children reporting after-images that persist for 6 minutes or more after RLRL treatment.
- Children are particularly vulnerable to over-exposure to light, owing to larger pupil sizes and clearer media than adults.
    - Risks are likely to be greater for Western population who typically have less ocular pigmentation than Eastern populations.
- Even considering natural daylight, there is a lack of clear consensus, for young children, on the minimum recommended exposure to reduce the risk of myopia and the maximum recommended exposure to reduce the risk of light-induced ocular pathology in later life.
- In RLRL, the effects of narrow wavelength bands of intense stimulation on ocular health are poorly understood and therefore this intervention cannot be endorsed at present.

Conclusions

- Mechanisms for a benefit from daylight in myopia prevention are not fully understood but may include breadth of spectrum.
- Evidence for VL and especially BL in myopia control is limited.
- Several RCTs confirm short-term myopia control benefits from RLRL, but long-term effects are unknown.
- Important safety concerns have been raised about RLRL that mean that RLRL cannot be endorsed at present.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Red light instruments for myopia exceed safety limits

Lisa A. Ostrin | Alexander W. Schill

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