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Efficacy of 0.01% Atropine for Myopia Control in Children: An Artificial Intelligence-Assisted Multivariate Bayesian Meta-analysis

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ADMINISTRATIVE INFORMATION

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Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 19 May 2026 and was last updated on 19 May 2026.

INTRODUCTION

Review question / Objective An artificial intelligence (AI)-assisted systematic review and Bayesian multivariate meta-analysis of randomised controlled trials (RCTs) was performed to evaluate 0.01% atropine (a low-concentration atropine formulation) for myopia control in children. The objective is to synthesize effects on spherical equivalent refraction (SER) and axial length (AL) outcomes jointly within a Bayesian framework and assess the probability of achieving clinically meaningful thresholds.

Condition being studied Myopia is a public health concern, especially in East Asia where prevalence in schoolchildren can exceed 70%. Progressive myopia increases the risk of irreversible, vision-threatening complications such as retinal detachment, glaucoma, and myopic maculopathy. The review focuses on controlling or slowing the progression of myopia in children.

METHODS

Participant or population The review addresses children or adolescents diagnosed with myopia. The included studies involved participants with a mean age ranging from 8.6 to 10.3 years.

Intervention The intervention evaluated was the nightly instillation of 0.01% atropine, either alone or in combination with single-vision spectacles. A subset of studies also evaluated a combination of 0.01% atropine with orthokeratology lenses.

Comparator The comparator interventions were placebo, spectacles alone, or orthokeratology (OK) alone.

Study designs to be included The study design included in this review were Randomised Controlled Trials (RCTs). Animal studies and non-randomised studies were excluded.

Eligibility criteria Inclusion criteria required that outcomes include annualised changes in SER and/or AL.
Exclusion criteria included: (1) animal studies, (2) non-randomised studies, (3) trials using atropine doses other than 0.01% (unless 0.01% arm data could be isolated), and (4) duplicate publications.

Information sources Electronic databases searched included PubMed, Embase (Ovid), Cochrane CENTRAL, Web of Science Core Collection, ClinicalTrials.gov, Chinese Clinical Trial Registry, and China National Knowledge Infrastructure (CNKI). Searches covered records from inception to 24 September 2025. No language restrictions were applied.

Main outcome(s) The primary outcomes of the review were the annualised changes in Spherical Equivalent Refraction (SER, measured in diopters per year, D/year) and the annualised changes in Axial Length (AL, measured in millimeters per year, mm/year).

Quality assessment / Risk of bias analysis The risk of bias in primary studies was assessed using the Cochrane RoB 2.0 tool across five domains (randomisation process, deviations from intended interventions, missing outcome data, measurement of the outcome, and selective reporting). Two reviewers independently conducted the assessment, and an overall judgement was generated following the Cochrane algorithm.

Strategy of data synthesis Data analysis employed a Bayesian multivariate random-effects meta-analysis to jointly model the effects on SER and AL. Between-study heterogeneity was modeled, and meta-regression was used to explore sources of heterogeneity. Posterior probabilities of exceeding clinically meaningful thresholds were calculated. Sensitivity analyses and subgroup analyses (by follow-up duration, geographic region, sample size) were also performed.

Subgroup analysis Subgroup analyses were conducted based on:
Follow-up duration (≤12 months, 13–24 months, >24 months).
Geographic region (East Asian populations, South Asian studies, Western countries).
Sample size (large studies: ≥100 participants; small studies: <100 participants).

Sensitivity analysis Leave-one-out sensitivity analysis was performed to examine the influence of individual studies on the pooled estimates for SER and AL.
Cumulative sensitivity analysis was conducted to assess the temporal stability of effect estimates as studies were added sequentially over time (by publication year).
Publication bias and small-study effects were assessed using Bayesian Egger regression and funnel plot asymmetry analyses.

Country(ies) involved China - Hebei Eye Hospital.

Keywords myopia control; atropine; eye axial length; spherical equivalentrefraction.

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