DOI: 10.16835/j.cnki.1000-9817.2026252

·述　评·

健全 6 岁以下儿童近视防控全链条研究与实践体系

何鲜桂

上海市眼病防治中心/上海市眼科医院/同济大学附属眼科医院/眼和视光疾病国家临床医学研究中心/
上海市视觉健康中心(儿童青少年近视防治技术中心),上海 200040

【摘要】 6 岁以下儿童是落实国家 2030 年近视防控战略目标的关键人群,也是实现近视发病率下降的“源头”阵地。当前,中国低龄儿童近视问题不容乐观,且面临屏幕暴露增加、户外活动不足等多重挑战。本研究系统梳理了当前 6 岁以下儿童近视及近视前期患病现状,厘清低龄儿童屈光发育规律及远视储备参考值的应用价值,发现 3~5 岁儿童屈光发育以+1.00 D轻度远视为优选状态,提出一套针对低龄儿童远视储备的梯次监测服务路径,并探讨了影响因素、干预措施及“多病同防”的实践策略,旨在为构建科学、高效的 6 岁以下儿童近视防控全链条体系提供依据,助力更快实现国家近视防控战略目标。

【关键词】 近视;远视储备;健康促进;儿童,学龄前

【中图分类号】 R 179　R 778.1^{+1}　G 479　【文献标识码】 A　【文章编号】 1000-9817(2026)08-1075-06

Establishing a comprehensive research and practice system for myopia prevention and control in children under 6 years of age

HE Xiangui

Shanghai Eye Disease Prevention and Treatment Center/Shanghai Eye Hospital/Eye Hospital of Tongji University/ National Clinical Research Center for Eye Diseases/Shanghai Vision Health Center (Children and Adolescents Myopia Prevention and Control Technology Center), Shanghai 200040, *China*

【Abstract】 Children under 6 years of age are the key population for achieving China's 2030 strategic goal of myopia prevention and control, and constitute the "source" frontline for reducing myopia incidence. Currently, myopia among young children in China remains a serious concern, and faces multiple challenges such as increased screen exposure and insufficient outdoor activities. The study systematically reviews the current prevalence of myopia and pre-myopia in children under 6 years of age, clarifies the patterns of refractive development and the application of hyperopia reserve reference values in young children, and identifies that a refractive state of approximately +1.00 D mild hyperopia represents the preferred developmental status for children aged 3-5 years. Furthermore, it proposes a tiered monitoring and service pathway targeting hyperopia reserve in young children, and discusses influencing factors, intervention measures, and "multi-disease co-prevention" strategies. The purpose of the study is to provide an evidence base for establishing a scientific and efficient full-chain system of myopia prevention and control for children under 6 years of age, so as to accelerate the achievement of the national strategic goals for myopia prevention and control.

【Keywords】 Myopia; Hyperopic reserve; Health promotion; Child, preschool

6 岁以下低龄儿童是国家 2030 年近视防控战略的“源头”和重点人群[1]。2018 年教育部等八部委提出,至 2030 年 6 岁儿童近视率控制在 3%左右,小学、初中、高中学生分别降至 38%(后调整为 32%),60%和 70%以下[1]。2024 和 2025 年,教育部等三部委先后印发《关于切实抓牢幼儿园和小学近视防控关键阶段防控工作的通知》《关于科学保护儿童远视储备量的通知》,系统部署将保护远视储备作为幼儿园和小学防控关口前移的核心抓手[2-3]。当前,儿童屏幕暴露增多、户外活动不足、早期教育“小学化”等问题加剧了近视低龄化趋势。抓住这一源头阶段,是实现中小学生及总体近视率下降的关键。因此,亟需全面梳理低龄儿童近视防控的知识与技术储备,为未来 5 年近视防控的研究与实践工作指引方向。

1　把握我国 6 岁以下儿童近视及近视前期流行特征

最新全国调查数据显示,6 岁儿童筛查性近视率高达 14.5%[4],距 2030 年 3%的目标差距显著。Pan 等[5]汇总全国 336 608 名 3~6 岁儿童数据,筛查性近视率为 8.2%,上海(12.8%)、深圳(11.9%)等东部发达地区高于中西部地区。依据《中小学生屈光不正筛查规范》[6]和国家疾病预防控制局《儿童青少年近视防控适宜技术指南(更新版)》[7],筛查性近视定义为裸眼视力<5.0 且非睫状肌麻痹等效球镜(spherical

【基金项目】 上海市卫生健康学科带头人人才计划项目(2022XD032);国家自然科学基金资助项目(82574119)

【作者简介】 何鲜桂(1982-),女,广西人,博士,教授,主要研究方向为儿童青少年近视防控。

equivalent, SE)<−0.50 D, 此界定标准存在高估低龄儿童近视率的局限。有研究显示, 3~6 岁儿童“假性近视率”为 8.29%, 非睫状肌麻痹下近视检出率(10.06%)远高于睫状肌麻痹后(1.90%)[8]。

近年采用 1%盐酸环喷托酯麻痹睫状肌的流行病学调查显示, 上海、深圳、广州和北京等地 3~6 岁儿童总体近视率为 1.0%~3.6%, 6 岁组为 1.6%~5.2%[9-13]。国际比较中, 美国“多族裔儿童眼病研究”显示, 6~72 月龄非西班牙裔白人近视率为 1.2%[14]; 新加坡“幼儿斜视、弱视和屈光不正研究”报道 6 岁华裔儿童近视率为 6.4%[15]。强效麻痹剂检测所得近视率偏低, 弱效则偏高: 唐孟利等[16]用 0.5%托吡卡胺(弱效剂)获得十省 5~6 岁近视率为 5.5%; Wu 等[17]用 1%阿托品(强效剂)获得 5~6 岁近视率仅为 0.4%。持续收集或适时启动全国性学龄前儿童睫状肌麻痹验光调查, 是客观评估该年龄段真实近视率及其动态变化的关键。

虽然学龄前儿童近视率尚低, 但其远视储备消耗加快, 虽未普遍达近视程度, 却致近视前期比例增加及近视发病年龄前移。2019 年国际近视学会(Internation Myopia Institute, IMI)将近视前期界定为睫状肌麻痹下 SE 为>−0.50~+0.75 D。采用 0.5%托吡卡胺睫状肌麻痹, 中国台湾地区 5~6 岁儿童近视前期比例达 52.0%[18], 大陆十省为38.9%[16]。有研究在上海通过 1%盐酸环喷托酯(中效剂)测得 6 岁儿童近视前期比例约 20%[17,19], 如无有效干预, 近视前期儿童 1 年 31.5%、2 年 62.0%将发生近视[19]。时间轴上, Chen 等[20]基于上海三甲医院样本发现, 4~6 岁儿童近视前期占比从 2005 年的 19.0%升至 2021 年的 26.5%, 平均近视发病年龄由 10.6 岁提前至 7.6 岁。提示低龄儿童远视储备消耗问题严峻, 发病年龄持续前移已成为我国近视防控的核心挑战。

2 厘清低龄儿童屈光发育规律与远视储备参考值

新生儿眼球通常处于+2.50~+3.00 D 远视状态, 为发育预留“安全空间”即远视储备。传统认为远视度数随生长线性递减, 至 12~15 岁趋于正视(−0.50~+0.50 D)。但近年多地调查显示, 经 1%盐酸环喷托酯麻痹睫状肌验光, 3~5 岁儿童屈光和脉络膜厚度均值基本稳定, 6 岁轻微下降, 屈光均值为+1.13~+1.49 D[9-13]; 采用 1%阿托品麻痹睫状肌验光, 3~6 岁儿童屈光均值分别为+1.91, +1.87, +1.74, +1.67 D[17]。学龄前女童远视储备高于男童, 8 岁后该性别差异方向发生改变[9]。随访发现, 屈光度和脉络膜厚度 1 年间基本无变化, 而眼轴长度(axial length, AL)明显增长[21], 提示“正视化”并非线性下降, AL 增长可通过晶状体屈光力(lens power, LP)下降代偿, 构成“油门”与“刹车”系统。

有研究在 3~5 岁儿童中发现屈光发育存在约+1.00 D的“吸引点”: 高于+1.00 D 时, LP 下降相对 AL 增长稍弱, 不完全代偿, 推动向正视发展; 低于+1.00 D时, LP 下降幅度超过 AL 近视化效应, 屈光向远视回漂; 晶状体代偿使整体屈光度与脉络膜厚度保持稳定[21]。这解释了屈光发育以轻度远视为优选状态, 而非传统 0 D 或 IMI 的+0.75 D。但 6 岁及以上儿童一旦低于+1.00 D, 代偿不足则加速近视漂移[22]。因此, 干预窗口应前移至+1.00 D 以上, 核心是减缓远视储备消耗, 延长稳态区间, 避免跌入高风险区。

基于 3~16 岁的 1 年随访研究(1%盐酸环喷托酯麻痹睫状肌验光), 采用倒推法估计[23], 并经专家讨论, 暂定远视储备参考值下限为推荐值: 即 3~5 岁+2.05 D(约 200 度), 6 岁+1.72 D(约 175 度), 7 岁+1.48 D(约 150 度), 之后每年消耗约 25 度, 低于此即远视储备不足。近视前期是最严重亚阶段, 介于其与推荐值之间为相对不足。该方案已列入国家卫生行业标准[24]。需强调的是 6 岁以下儿童准确测量须依赖睫状肌麻痹验光, 不同麻痹剂结果有差异, 未来仍需更多证据优化该参考值及应用。

3 构建低龄儿童远视储备监测与视力健康管理梯次服务路径

根据《中国儿童睫状肌麻痹验光及安全用药专家共识(2019 年)》[25], 6 岁以下儿童首次验光应采用 1%阿托品眼膏强效麻痹睫状肌。研究在 3~6 岁儿童中比较发现, 强效剂与中效剂检出的近视和近视前期比例差异可达 12.9%[17]。鉴于阿托品操作耗时长、低龄儿童配合度差, 资源有限时可先采用视力和非睫状肌麻痹验光, 筛出疑似远视储备不足者(裸眼视力正常且非睫状肌麻痹下 SE<0 D)[24], 再转诊用 1%盐酸环喷托酯(操作 40~60 min, 恢复 1~3 d)检查, 对疑似近视前期者进一步用 1%阿托品(操作 3 d, 恢复 2~3 周)确诊[17], 确诊后提前实施强化综合预防干预。这一梯次策略兼顾了诊断准确性与基层可操作性。

6 岁以下儿童裸眼视力正常范围: 3 岁不低于4.7, 4~6 岁不低于 4.8[24,26]。视力表方面, 笔者团队发现 E 字视力表优于儿童图形视力表[27], HOTV 视力表优于 E 字视力表[28], 故鼓励探索应用 HOTV 视力表或类似检查表, 图形视力表可作为备用。AL 方面, 轴率比在 6 岁以下儿童中与屈光度相关度较低, 筛检近视准确度不足, 联合裸眼视力虽可改善, 但整体效能不及裸眼视力联合非睫状肌麻痹验光, 因此, AL 更宜作为监测远视储备消耗的便捷指标。6~10 岁儿童中以 0.2 mm为 AL 年增长安全界值[29], 已被纳入国家指南和行业白皮书。6 岁以下儿童尚无 AL 安全增长参考值, 考虑该年龄段晶状体代偿能力更强, 理论允许值更大, 结合临床经验, 建议试行以 0.3 mm 左右作为判

断低龄儿童远视储备消耗快慢的界值。

《近视防治指南(2026 年版)》[30] 明确儿童自 24 月龄起进行屈光筛查,建立屈光发育档案,定期监测视力、屈光度、AL 和角膜曲率,结合年龄评估远视储备,对实现早发现、早预警、早干预具有重要价值。

4　探明影响低龄儿童屈光发育的主要因素

遗传因素是学龄前儿童近视证据一致性最强的影响因素,父母近视与远视储备消耗相关且呈剂量效应[31-32],提示遗传易感性可能为 6 岁前儿童屈光发育设定初始"阈值"或"轨道"。遗传背景虽无法改变,但对双亲有近视的儿童,应积极给予干预。

行为与环境因素中,户外活动、屏幕暴露、近距离用眼和睡眠均与儿童近视相关[31]。针对学龄前儿童的研究则未发现户外活动与远视储备存在关联,但发现学习日电子产品使用≥2 h/d 可使近视前期风险增加 2.83 倍(参照<1 h/d)[33],超过半数儿童学习日电子产品≥1 h/d 且户外活动<2 h/d,风险暴露远超安全阈值。另一项调查显示,3~4 岁儿童日均屏幕时间 2.8 h,53.0%超过 2 h/d[34]。提示低龄防控可将屏幕管理作为优先风险因素,虽未发现户外活动与远视储备的关联,但不否定其保护意义。

新型环境风险因素研究拓展了新视野,包括室内空间频率、夜间光暴露、绿地面积、建筑密度及空气污染等,其中前两者有潜力成为个体干预补充方向[35-39]。总体而言,当前基于睫状肌麻痹验光系统研究 6 岁以下儿童屈光影响因素文献不足,仍有待更多证据积累。

5　加快低龄儿童视力干预措施的研究与实施

目前,绝大多数近视循证干预研究集中于学龄儿童[40],针对学龄前儿童的随机对照试验证据十分有限。群体普遍性行为干预方面,已有多项高质量研究证实增加户外活动的有效性。上海的"增加户外活动减少近视研究"采用可穿戴手环客观监测,证实儿童每日户外 120~170 min、光照≥5 000 lx 可降低近视风险,最低起效模式为单次≥15 min 且光照≥2 000 lx[41]。虽针对 6 岁以上儿童,但为学龄前儿童干预提供了方向:幼儿园倡导每日至少 3 h 户外活动具有可行性和必要性;2025 年教育部将中小学课间延长至 15 min,也为幼儿园优化户外活动提供了政策参照。台湾"宜兰近视预防与视力改善计划项目"针对 5~6 岁儿童以增加户外活动为主,2 年内近视发病率从 15.5%下降至 8.3%[42]。近距离用眼与屏幕暴露干预成为新兴方向。山东使用用眼监测仪实时反馈用眼行为,近视发病率从 27.8%下降至 13.3%[43];马来西亚"停止屏幕、开始游戏(Stop and Play)"家长教育干预使儿童屏幕时间减少约 200 min/d[44]。但远像技术等新技术在低龄儿童中的实际应用效果仍需验证。

各国指南对用低龄儿童屏幕管理日趋严格:世界卫生组织建议 1 岁以下零屏幕,2~5 岁≤1 h/d 且越少越好[45];美国儿科学会建议 18 个月以下除视频聊天外避免屏幕,2~5 岁≤1 h/d 且需家长陪同[46];我国建议 0~3 岁禁用电子产品,3~6 岁尽量避免使用[3],学龄前儿童每日白天户外活动≥3 h[30]。倡导用更积极的游戏和高质量的亲子互动(如阅读、讲故事)来替代屏幕前的久坐时间,对 6 岁以下近视前期或近视者,研究发现户外活动作用已有限[41],需叠加其他措施。国家批准的低浓度阿托品适用≥6 岁,香港"低浓度阿托品近视预防研究"则覆盖 4~9 岁儿童,显示0.05%阿托品 1 年近视发生率相对下降 68.5%[47]。重复低强度红光可有效预防小学生近视(1 年相对下降 54.1%)[48],但专家共识[49]指明 6 岁以下儿童使用须谨慎,尚无该年龄段研究报告。离焦框架眼镜理论上更安全,对学龄近视前期对象的预防有效性也出现高质量证据[50],但有待在低龄儿童中验证特别是配戴依从性。中医药技术如穴位电刺激已被国家卫生健康委员会新版指南纳入[30],但低龄儿童证据仍薄弱。可见,现有研究在随机对照试验证据、联合干预、监测设备适配性和特殊人群策略上均存在明显空白,亟需在实践应用中加快积累高质量证据。

6　践行"五健"行动,推进低龄儿童眼病多病同防

儿童近视并非孤立健康问题,其行为风险因素——户外活动不足、屏幕过度使用和久坐生活方式同样关联肥胖、心理健康、骨骼健康和龋齿等。STORM 研究显示,增加户外活动可降低超重儿童近视发生风险[51]。天津 41 654 名中小学生筛查数据显示,近视与脊柱侧弯共患检出率为 2.65%,不良读写姿势是重要可调控因素[52]。一项纳入近 70 万名儿童青少年的 Meta 分析发现,近视儿童抑郁和焦虑评分高于视力正常儿童[53]。重叠的决定因素提示,针对共同行为干预可能产生协同健康收益。

眼病内部共防同样重要。国家卫生健康委员会发布的《0~6 岁儿童眼保健及视力检查服务规范》[54],将先天性致盲性眼病与屈光不正、斜视、弱视等常见眼病纳入同一筛查体系。中山眼科中心智能手机筛诊系统,3 min 视频即可智能识别婴幼儿超 16 种常见致盲眼病,包括先天性白内障、先天性上睑下垂、先天性青光眼等,平均准确率超 85%[55]。学龄前儿童的近视防控体系可作为基础平台,实现和其他常见眼病或罕见眼病的"一筛多防"高效整合。

政策层面,我国已启动向统一多病同防框架的战略性政策转型。2024 年国家疾病预防控制局发布的《学生常见病多病共防技术指南》[56];2025 年 13 部门

印发的《儿童青少年“五健”促进行动计划(2026—2030 年)》[57],将视力、体重、心理、骨骼、口腔 5 个健康维度整合为统一框架,要求学龄前儿童每天 3 h 身体活动,幼儿园每半年 1 次视力检测。未来应验证多病联合干预协同效应,探索眼健康档案与全健康档案整合路径,关注人工智能辅助筛查在基层落地的可行性以及成本效益。

综上所述,实现儿童青少年总体近视率更快下降,亟需抓住源头人群,即 6 岁以下学龄前儿童,构建一套贯穿“防-筛-诊-管”全链条的医防融合工作体系。当前,国家层面的方案和标准已为大规模筛查与预警提供了统一“标尺”,也初步明确了危险因素和干预方向。然而,仍存在关键瓶颈亟待突破:缺乏适用于大规模低龄人群的快捷且精准的远视储备量化监测方法;基于睫状肌麻痹验光的影响因素研究证据尚不充足;针对 6 岁以下儿童的防控干预技术亟需更多高质量临床试验支撑;多病同防框架的协同效应仍有待实证检验。未来,应着力研发适宜技术,建设低龄儿童屈光发育动态监测的智能化平台,并建立“家庭-学校-社区-医院”四方联动的长效机制,将科学证据切实转化为行动。依托多病同防框架整合近视防控与儿童全面健康促进,力争到 2030 年实现 6 岁儿童近视率控制在 3%左右及各学段防控战略目标,为健康中国建设筑牢视觉健康根基。

利益冲突声明 所有作者声明无利益冲突。

参考文献

[1] 中华人民共和国教育部等八部门关于印发《综合防控儿童青少年近视实施方案》的通知[EB/OL].(2018-08-30)[2026-08-13].http://www.moe.gov.cn/srcsite/A17/moe_943/s3285/201808/t20180830_346672.html.

[2] 中华人民共和国教育部办公厅, 中华人民共和国国家卫生健康委办公厅, 国家疾控局综合司关于切实抓牢幼儿园和小学近视防控关键阶段防控工作的通知[EB/OL].(2024-10-22)[2026-08-13]. http://www.moe.gov.cn/srcsite/A17/moe_943/s3285/202411/t20241111_1162337.html.

[3] 中华人民共和国教育部办公厅 中华人民共和国国家卫生健康委办公厅 国家疾控局综合司关于科学保护儿童远视储备量的通知[EB/OL].(2025-10-31)[2026-08-13].http://www.moe.gov.cn/srcsite/A17/moe_943/s3285/202511/t20251107_1419599.html.

[4] 中华人民共和国国家卫生健康委员会.2022 年全国儿童青少年近视筛查情况。2024 年 5 月新闻发布会[EB/OL].(2024-05-31)[2026-08-13].https://www.nhc.gov.cn/xcs/c100122/202405/25a749fe72aa47359b7efd7ce5e0719c.shtml.

[5] Pan Z, Wang Z Y, Wang Y X, et al. Prevalence and time trends in myopia among preschool children in China[J]. Invest Ophthalmol Vis Sci, 2023;64(8):2790.

[6] WS/T 663—2020 中小学生屈光不正筛查规范[S].
WS/T 663-2020 Specification for screening of refractive error in primary and secondary school students[S].(in Chinese)

[7] 中华人民共和国国家卫生健康委员会疾病预防控制局.《儿童青少年近视防控适宜技术指南(更新版)》及解读[EB/OL].(2021-10-11)[2026-08-13].http://www.nhc.gov.cn/jkj/c100062/202110/a05ccaf5773a436486d2d79b59c0a5e9.shtml.

[8] Liu P, Zhu B, Fu J, et al. A clearer vision: unveiling the importance of cycloplegic refraction and the pseudomyopia prevalence in Chinese preschoolers[J]. BMC Ophthalmol, 2024, 24(1): 338.

[9] Ma Y, Qu X, Zhu X, et al. Age-specific prevalence of visual impairment and refractive error in children aged 3-10 years in Shanghai, China[J]. Invest Ophthalmol Vis Sci, 2016, 57(14): 6188-6196.

[10] Guo X, Fu M, Ding X, et al. Significant axial elongation with minimal change in refraction in 3- to 6-year-old Chinese preschoolers: the Shenzhen kindergarten eye study[J]. Ophthalmology, 2017, 124(12): 1826-1838.

[11] Lan W, Zhao F, Lin L, et al. Refractive errors in 3-6 year-old Chinese children: a very low prevalence of myopia?[J]. PLoS One, 2013, 8(10): e78003.

[12] Zhu B, Sun Y, Wang S, et al. Refraction and ocular biometric parameters of preschool children in the Beijing whole childhood eye study: the first-year report[J]. BMC Ophthalmol, 2023, 23(1): 366.

[13] Zhu L, Xu Q, Yuan J, et al. Associations between refraction and ocular biometry in Chinese preschoolers aged 3-6 years: a cross-sectional study in Shunyi, Beijing[J]. BMJ Open, 2025, 15(4): e094342.

[14] Wen G, Tarczy-Hornoch K, McKean-Cowdin R, et al. Prevalence of myopia, hyperopia, and astigmatism in non-Hispanic white and Asian children: multi-ethnic pediatric eye disease study[J]. Ophthalmology, 2013, 120(10): 2109-2116.

[15] Dirani M, Chan Y H, Gazzard G, et al. Prevalence of refractive error in Singaporean Chinese children: the strabismus, amblyopia, and refractive error in young Singaporean children (STARS) study[J]. Invest Ophthalmol Vis Sci, 2010, 51(3): 1348.

[16] 唐孟利, 刘扬, 秦然, 等.我国 10 省幼儿园 5~6 岁儿童近视和近视前期流行特征[J].北京大学学报(医学版),2025,57(3):442-448.
Tang M L, Liu Y, Qin R, et al. Epidemiological characteristics of myopia and pre-myopia among preschool children aged 5-6 years in ten provinces of China[J]. J Peking Univ (Health Sci), 2025, 57(3):442-448. (in Chinese)

[17] Wu H, Wang Y, Lu Q, et al. Atropine or cyclopentolate to diagnose premyopia in preschool children[J]. JAMA Ophthalmol, 2025, 143(11): 904-913.

[18] Wang C Y, Hsu N W, Yang Y C, et al. Premyopia at preschool age population-based evidence of prevalence and risk factors from a serial survey in Taiwan[J]. Ophthalmology, 2022, 129(8): 880-889.

[19] 戚紫怡, 何鲜桂, 潘臣炜, 等. 上海地区 6~8 岁儿童近视前期流行病学调查[J]. 中国学校卫生, 2022,43(9):1314-1318.
Qi Z Y, He X G, Pan C W, et al. Epidemiology of premyopia among children aged 6-8 in Shanghai[J]. Chin J Sch Health, 2022, 43(9):1314-1318. (in Chinese)

[20] Chen Z, Gu D, Wang B, et al. Significant myopic shift over time: sixteen-year trends in overall refraction and age of myopia onset among Chinese children, with a focus on ages 4-6 years[J]. J Glob Health, 2023, 13: 04144.

[21] Ma Y, Lin S, Morgan I G, et al. Eyes grow towards mild hyperopia rather than emmetropia in Chinese preschool children[J]. Acta Ophthalmol, 2021, 99(8): e1274-e1280.

[22] Chen J, Qi Z, Zhang X, et al. Myopic shift accelerates at refractive

diopter below +1.0 in children aged 6 to 9 years old[J]. Am J Ophthalmol, 2025, 279: 110-117.

[23] Wang J, Qi Z, Feng Y, et al. Normative value of hyperopia reserve and myopic shift in Chinese children and adolescents aged 3-16 years[J]. Br J Ophthalmol, 2024, 108(7): 1024-1029.

[24] WS/T 10039—2025　儿童青少年裸眼视力和屈光状态评价规范[S].
WS/T 10039-2025　Specification for evaluation of uncorrected distant visual acuity and refractive status in children and adolescents[S]. (in Chinese)

[25] 中华医学会眼科学分会斜视与小儿眼科科学组, 张伟. 中国儿童睫状肌麻痹验光及安全用药专家共识(2019 年)[J]. 中华眼科杂志, 2019, 55(1): 7-12.
Strabismus and Pediatric Ophthalmology Group, Chinese Medical Association Ophthalmology Branch, Zhang W. Chinese expert consensus on cycloplegic refraction and safe medication use in children (2019)[J]. Chin J Ophthalmol, 2019, 55(1): 7-12. (in Chinese)

[26] 王菁菁,杜林琳,谢辉,等.屈光相对安全儿童青少年裸眼视力生长曲线研究[J].中国学校卫生,2021,42(6):893-897.
Wang J J, Du L L, Xie H, et al. Study on the growth curves of uncorrected visual acuity of children and adolescents with relative safe refractive range[J]. Chin J Sch Health, 2021, 42(6): 893-897. (in Chinese)

[27] 何鲜桂, 朱剑锋, 陆丽娜, 等. 两种视力表在学龄前儿童视力筛查中的对比分析[J]. 中国儿童保健杂志, 2010, 18(12): 951-953.
He X G, Zhu J F, Lu L N, et al. Comparison of the two charts for preschool children vision screening[J]. Chin J Child Health Care, 2010, 18(12): 951-953. (in Chinese)

[28] Wu H, Wang Y, Ni Z, et al. HOTV vision test compared with tumbling e for pediatric vision screening[J]. JAMA Ophthalmol, 2026. DOI: 10.1001/jamaophthalmol.2026.3425.

[29] 《眼轴长度在近视防控管理中的应用专家共识(2023)》专家组. 眼轴长度在近视防控管理中的应用专家共识(2023)[J]. 中华实验眼科杂志, 2024, 42(1): 1-11.
Expert Group on Consensus on the Application of Axial Length in Myopia Prevention and Control Management (2023). Expert consensus on the application of axial length in myopia prevention and control management (2023)[J]. Chin J Exp Ophthalmol, 2024, 42(1): 1-11. (in Chinese)

[30] 中华人民共和国国家卫生健康委办公厅关于印发近视防治指南、斜视和弱视诊疗指南(2026 年版)的通知[EB/OL].(2026-07-23)[2026-08-13]. https://www.nhc.gov.cn/yzygj/c100067/202607/c4a1c6f628fa45c29328db0671b68d57.shtml.

[31] Morgan I G, Wu P C, Ostrin L A, et al. IMI risk factors for myopia[J]. Invest Ophthalmol Vis Sci, 2021, 62(5): 3.

[32] Ma Y, Lin S, Zhu J, et al. Effect of parental myopia on change in refraction in Shanghai preschoolers: a 1-year prospective study[J]. Front Pediatr, 2022, 10: 864233.

[33] 陆秋颖, 张彤, 王艳姣, 等. 上海市嘉定区学龄前儿童远视储备现状及相关因素分析[J].中国学校卫生,2026, 47(7): 1031-1035.
Lu Q Y, Zhang T, Wang Y J, et al. Analysis of hyperopic reserve status and associated factors among preschool children in Jiading District, Shanghai[J]. Chin J Sch Health, 2026, 47(7): 1031-1035. (in Chinese)

[34] Zhao J, Yu Z, Sun X, et al. Association between screen time trajectory and early childhood development in children in China[J]. JAMA Pediatr, 2022, 176(8): 768-775.

[35] Li D L, Dong X X, Yang J L X, et al. Lower indoor spatial frequency increases the risk of myopia in children[J]. Br J Ophthalmol, 2025, 109(2): 250-256.

[36] Shi D, Li J, Dang J, et al. Dual associations of post-sleep and pre-wake light-at-night (LAN) exposure with myopia in children and adolescents[J]. Environ Res, 2025, 279: 121915.

[37] Yang Y, Liao H, Zhao L, et al. Green space morphology and school myopia in China[J]. JAMA Ophthalmol, 2024, 142(2): 115.

[38] Wang J, Chen J, Gong W, et al. Association between building density and screening myopia in children and adolescents: a 5-year longitudinal study from China[J]. Br J Ophthalmol, 2026, 110(2): 197-203.

[39] Liu K, Luo H, Boran B, et al. Long-term exposure to $PM_{2.5}$ and NO_2 and risk of myopia in Chinese school-aged children: a cross-sectional study[J]. BMC Ophthalmol, 2026, 26(1): 54.

[40] 中华预防医学会儿少卫生分会视觉健康(近视防控)学组. 中国儿童青少年近视防控循证指南(2026 年)[J]. 中华眼科杂志, 2026, 62(6): 406-424.
Visual Health (Myopia Prevention and Control) Group, Child and Adolescent Health Branch of Chinese Preventive Medicine Association. Evidence-based guidelines for myopia prevention and control in Chinese children and adolescents (2026)[J]. Chin J Ophthalmol, 2026, 62(6): 406-424. (in Chinese)

[41] 何鲜桂. 户外活动防控儿童青少年近视: 需更新证据指导实践[J]. 中国校医, 2025, 39(8): 565-568, 582.
He X G. Outdoor activity for myopia prevention in children and adolescents: updating evidence to guide practice[J]. Chin J School Doctor, 2025, 39(8): 565-568, 582. (in Chinese)

[42] Yang Y C, Hsu N W, Wang C Y, et al. Prevalence trend of myopia after promoting eye care in preschoolers: a serial survey in Taiwan before and during the coronavirus disease 2019 pandemic[J]. Ophthalmology, 2022, 129(2): 181-190.

[43] Hu Y, Yu M, Han X, et al. Behavioral intervention with eye-use monitoring to delay myopia onset and progression in children: a cluster randomized trial[J]. Ophthalmology, 2025, 132(6): 701-712.

[44] Raj D, Ahmad N, Mohd Zulkefli N A, et al. Stop and play digital health education intervention for reducing excessive screen time among preschoolers from low socioeconomic families: cluster randomized controlled trial[J]. J Med Internet Res, 2023, 25: e40955.

[45] World Health Organization. Guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age[R]. Geneva: WHO, 2019.

[46] American Academy of Pediatrics. Media and young minds[J]. Pediatrics, 2016, 138(5): e20162591.

[47] Yam J C, Zhang X J, Zhang Y, et al. Effect of low-concentration atropine eyedrops vs placebo on myopia incidence in children: the LAMP2 randomized clinical trial[J]. JAMA, 2023, 329(6): 472-481.

[48] He X, Wang J, Zhu Z, et al. Effect of repeated low-level red light on myopia prevention among children in China with premyopia: a randomized clinical trial[J]. JAMA Netw Open, 2023, 6(4): e239612.

(下转第 1085 页)

http://dg.cnsoc.org/article/04/RMAbPdrjQ6CGWTwmo62hQg.html.

[14] WS/T 663—2020　中小学生屈光不正筛查规范[S].
WS/T 663-2020　Specification for screening of refractive error in primary and secondary school students[S].(in Chinese)

[15] Wang M, Tong J, Zhu D, et al. Sleep duration, sleep habits, and social jetlag from 4 to 6 years their impacts on myopia among school-aged children: the Ma'anshan birth cohort study[J]. Nat Sci Sleep, 2025,17:365-378.

[16] Wen G, Tarczy-Hornoch K, Mckean-Cowdin R, et al. Prevalence of myopia, hyperopia, and astigmatism in non-Hispanic white and Asian children: multi-ethnic pediatric eye disease study[J]. Ophthalmology, 2013,120(10):2109-2116.

[17] Pitt E, Cameron C M, Thornton L, et al. Dietary patterns of Australian children at three and five years of age and their changes over time: a latent class and latent transition analysis[J]. Appetite, 2018,129:207-216.

[18] Liang J, Pu Y, Chen J, et al. Global prevalence, trend and projection of myopia in children and adolescents from 1990 to 2050: a comprehensive systematic review and Meta-analysis[J]. Br J Ophthalmol, 2025,109(3):362-371.

[19] Liu Z, Wang Q, Zhao Q, et al. Association between whole - grain intake and myopia in Chinese children: a cross-sectional epidemiological study[J]. BMC Ophthalmol, 2023,23(1):1.

[20] 闫艺, 张泳, 王平, 等. 近视病因与发病机制的研究进展[J]. 临床医学进展, 2020,10(11):2561-2566.
Yan Y, Zhang Y, Wang P, et al. Research progress on etiology and pathogenesis of myopia[J]. Adv Clin Med, 2020,10(11):2561-2566.(in Chinese)

[21] Fedor M, Socha K, Urban B, et al. Serum concentration of zinc, copper, selenium, manganese, and Cu/Zn ratio in children and adolescents with myopia[J]. Biol Trace Elem Res, 2017,176(1):1-9.

[22] Huibi X, Kaixun H, Qiuhua G, et al. Prevention of axial elongation in myopia by the trace element zinc[J]. Biol Trace Elem Res, 2001, 79(1):39-47.

[23] Tideman J W L, Polling J R, Vingerling J R, et al. Axial length growth and the risk of developing myopia in European children[J]. Acta Ophthalmol, 2018, 96(3):301-309.

[24] Lin X, Lei Y, Pan M, et al. Augmentation of scleral glycolysis promotes myopia through histone lactylation[J]. Cell Metab, 2024,36(3):511-525.e7.

[25] Berticat C, Mamouni S, Ciais A, et al. Probability of myopia in children with high refined carbohydrates consumption in France[J]. BMC Ophthalmol, 2020,20(1):337.

[26] Terasaki H, Yamashita T, Yoshihara N, et al. Association of lifestyle and body structure to ocular axial length in Japanese elementary school children[J]. BMC Ophthalmol, 2017,17(1):123.

[27] Cordain L, Eaton S B, Brand M J, et al. An evolutionary analysis of the aetiology and pathogenesis of juvenile-onset myopia[J]. Acta Ophthalmol Scand, 2002,80(2):125-135.

[28] Li J. The association between smartphone use and myopia progression in children: a prospective cohort study[J]. BMC Pediatr, 2025,25(1):378.

[29] Cui M, Yang Z, Li S, et al. Prevalence and associated factors of myopia and axial length-related visual impairment in children and adolescents aged 4-18 years[J]. Sci Rep, 2025,15(1):35277.

收稿日期:2026-01-21　**修回日期**:2026-03-01　**本文编辑**:顾璇

(上接第 1079 页)

[49] 《重复低强度红光照射辅助治疗儿童青少年近视专家共识(2022)》专家组. 重复低强度红光照射辅助治疗儿童青少年近视专家共识(2022)[J]. 中华实验眼科杂志, 2022, 40(7): 599-603.
Expert Workgroup of Expert Consensus on Repeated Low-level Red-light as an Alternative Treatment for Childhood Myopia(2022). Expert consensus on repeated low-level red-light as an alternative treatment for childhood myopia (2022)[J]. Chin J Exp Ophthalmol, 2022, 40(7): 599-603. (in Chinese)

[50] Gao M, Hou Y, Lu Y, et al. Efficacy and safety of 0.01% atropine eye drops and novel lenslet-ARray-integrated spectacle lenses for the prevention of myopia progression among children with premyopia: a randomized clinical trial[J]. Ophthalmol Ther, 2025, 14(10): 2481-2496.

[51] Yang J L X, Li D L, Chen J, et al. Effect modification of time spent outdoors on the association between early childhood overweight and myopia: a one-year follow-up study[J]. J Public Health, 2024, 46(1): 107-115.

[52] 张献伟, 陈璐, 刘忠慧, 等. 天津中小学生近视与脊柱侧弯共患现状及学校环境风险因素分析[J]. 中国学校卫生, 2024, 45(5): 626-629, 634.
Zhang X W, Chen L, Liu Z H, et al. Comorbidity of myopia and scoliosis in primary and secondary school students and analysis of risk factors in school environment in Tianjin[J]. Chin J Sch Health, 2024, 45(5): 626-629, 634. (in Chinese)

[53] Li D, Chan V F, Virgili G, et al. Impact of vision impairment and ocular morbidity and their treatment on depression and anxiety in children a systematic review[J]. Ophthalmology, 2022, 129(10): 1152-1170.

[54] 中华人民共和国国家卫生健康委员会办公厅.关于印发 0~6 岁儿童眼保健及视力检查服务规范(试行)的通知[EB/OL].(2021-06-23)[2026-08-13]. https://www.nhc.gov.cn/fys/c100078/202106/eab0d16758a545bb88c2dc84734a e6ee.shtml.

[55] Chen W, Li R, Yu Q, et al. Early detection of visual impairment in young children using a smartphone-based deep learning system[J]. Nat Med, 2023, 29(2): 493-503.

[56] 国家疾病预防控制局综合司.关于印发学生常见病多病共防技术指南的通知[EB/OL].(2024-04-30)[2026-08-13]. https://www.gov.cn/zhengce/zhengceku/202405/content_6949610.htm.

[57] 国家卫生健康委员会等 13 部门关于印发儿童青少年"五健"促进行动计划(2026—2030 年)的通知[EB/OL].(2025-12-25)[2026-08-13]. https://www.gov.cn/zhengce/zhengceku/202512/content_7053270.htm.

收稿日期:2026-08-11　**修回日期**:2026-08-14　**本文编辑**:孙曼莉