

Impact of Myopia on the Academic Performance of Children: A Narrative Review

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Abstract

Myopia, or nearsightedness, has become one of the most common ocular disorders of childhood, with global prevalence in children and adolescents rising from roughly 24% in 1990 to nearly 36% by 2023 and projected to affect almost 40% of this age group by 2050. Beyond its well-documented ophthalmic consequences, myopia has increasingly been examined for its bidirectional relationship with academic performance. Uncorrected refractive error can directly impair a child's ability to see the blackboard, read text, and sustain near work, while paradoxically, intensive schooling, near-work demands, and reduced outdoor time associated with high-achieving academic environments are themselves powerful risk factors for myopia onset and progression. This narrative review synthesizes evidence from epidemiological surveys, cohort studies, randomized controlled trials, and systematic reviews to examine the prevalence and risk factors of childhood myopia; the evidence linking myopia, uncorrected refractive error, and cognitive performance to academic outcomes; the psychosocial and quality-of-life burden of myopia in children; long-term ocular complications; the economic burden of the condition; and current approaches to screening, correction, and myopia control. The evidence indicates that uncorrected refractive error consistently impairs reading speed, literacy, and standardized test performance, and that timely spectacle correction and school-based vision programmes improve academic outcomes, particularly in under-resourced settings. Conversely, the relationship between myopia itself (as opposed to uncorrected refractive error) and academic achievement appears to run in the reverse direction, with higher academic performance, more time spent on near work, and less time outdoors predicting faster myopic progression rather than the other way around. These findings carry important implications for school health policy, pediatric eye care, and public health strategy, underscoring the need for routine vision screening, timely correction, and behavioral interventions that protect both visual health and educational potential.

Keywords

Myopia; Children; Academic Performance; Vision Screening; Myopia Control; Quality of Life

1. Introduction

Myopia (nearsightedness) occurs when the eye grows too long relative to its optical power, so that images of distant objects focus in front of, rather than on, the retina [[1],2]. Once regarded chiefly as a benign refractive inconvenience

correctable with spectacles, myopia is now recognized as a major global public health issue because of its rapidly rising prevalence, its tendency to progress during childhood and adolescence, and its association with sight-threatening complications later in life [1,3,4]. A comprehensive systematic review and meta-analysis covering 276 studies and more than 5.4 million children and adolescents across 50 countries estimated that global myopia prevalence rose from 24.3% in 1990 to 35.8% in 2023, and projected a further rise to nearly 40% by 2050, representing more than 740 million affected children and adolescents worldwide [5]. Earlier modelling by Holden and colleagues similarly projected that around half of the world's population could be myopic by 2050, with almost one-tenth affected by high myopia [6].

Alongside this epidemiological trend, a substantial and sometimes counter-intuitive literature has developed around the relationship between myopia and academic performance in children. On one hand, uncorrected or under-corrected refractive error can directly impede a child's ability to see the blackboard, read printed text, and sustain the visual demands of the classroom, plausibly translating into poorer test scores, reduced reading fluency, and diminished classroom engagement [7,8,9]. On the other hand, a large and consistent body of evidence from Asian school cohorts indicates that children with higher academic achievement, more years of schooling, and greater exposure to near work are themselves more likely to become myopic and to show faster axial elongation, suggesting that the direction of causality runs at least partly from academic pressure to myopia rather than the reverse [10,11,12,13,14]. Both directions of this relationship carry important implications for school health policy, pediatric eye care, and the design of myopia-control programmes.

This narrative review aims to (i) summaries the global and regional epidemiology of myopia in children, with particular attention to trends in India and other Asian settings; (ii) examine the genetic and environmental risk factors that drive myopia onset and progression, including near work, outdoor time, and screen exposure; (iii) critically evaluate the evidence linking myopia and uncorrected refractive error to academic performance and cognitive function; (iv) describe the psychosocial, quality-of-life, and long-term ocular complications associated with childhood myopia; (v) outline the economic burden of the condition; and (vi) review current strategies for screening, correction, and myopia control, concluding with a discussion of evidence gaps and directions for future research.

2. Methods

This is a narrative review rather than a formal systematic review. Relevant literature was identified through structured searches of PubMed/MEDLINE, Scopus, and Google Scholar, supplemented by hand-searching of reference lists of key systematic reviews and White Papers of the International Myopia Institute. Search terms included combinations of "myopia", "refractive error", "children", "academic performance", "school achievement", "cognitive function", "near work", "outdoor activity", "screen time", "quality of life", and "myopia control". Priority was given to systematic reviews, meta-analyses, large cohort studies, and randomized controlled trials published in peer-reviewed journals, with additional inclusion of key epidemiological surveys and public health reports. Reference formatting follows the Vancouver style, as required for biomedical journal submission.

3. Epidemiology of Myopia in Children

Myopia prevalence varies markedly by region, urbanization, age, and sex. East Asian populations bear the highest burden, with prevalence in Chinese school-based cohorts reported as high as 78% among adolescents in some cities and rising sharply between the ages of 6 and 16 years [5,6]. In the United States, national survey data documented an increase in myopia prevalence among people aged 12–54 years from 25% in 1971–1972 to 41.6% by 1999–2004, indicating that the myopia epidemic is not confined to Asia [15]. Global pooled estimates show higher prevalence among adolescents (47.0%), high-school students (45.7%), urban residents (28.6%), and girls (33.6%) compared with younger children, rural residents, and boys respectively [5]. By comparison, other pediatric visual disorders such as amblyopia occur far less frequently, with a global pooled prevalence of approximately 1.4% in children, underscoring that myopia now represents a disproportionately large share of overall pediatric visual morbidity [16].

In India, the burden is lower than in East Asia but is rising. A meta-analysis of four decades of Indian data (59 studies, approximately 286,000 children aged 5–15 years) estimated an overall crude myopia prevalence of 7.5%, with higher rates in urban (8.5%) than rural (6.1%) children; notably, the increment in prevalence over the preceding decade was four times greater in rural children than urban children, suggesting rapid environmental change in rural India [17]. The North India Myopia Study reported a prevalence of 13.1% among urban schoolchildren in Delhi, with only about a quarter of affected children wearing appropriate spectacles [18], while a follow-on incidence study documented an annual myopia incidence of roughly 3–4% in the same population [19]. A systematic review of refractive error prevalence across Indian states similarly confirmed a growing but heterogeneous burden, shaped by urbanization, school type, and socioeconomic status [20].

The International Myopia Institute has proposed standardized definitions and thresholds for myopia (spherical equivalent ≤ -0.50 diopter) and high myopia (≤ -6.00 diopters) to allow comparability across studies [2], and has characterized myopia as a pressing 21st-century public health issue given its scale, its tendency to begin in childhood, and its association with irreversible visual impairment in adulthood [4,21].

4. Etiology and Risk Factors

4.1 Genetic factors

Myopia is a complex, polygenic trait with substantial heritability. Twin and family studies estimate the heritability of refractive error at 50–80%, and children with two myopic parents carry a three- to six-fold greater risk of developing myopia than children of non-myopic parents [22,23]. Genome-wide association studies have identified more than 150 independent genetic loci associated with refractive error, implicating pathways involved in retinal signaling, light processing, and scleral remodeling [24,25,26]. However, genetic risk alone does not explain the rapid rise in myopia prevalence over the past few decades, pointing strongly toward gene–environment interaction as the principal driver of the current epidemic [27,24].

4.2 Environmental and Behavioral Factors

Two environmental exposures are most consistently implicated in myopia development, interacting with the underlying genetic susceptibility described above [28]: near work and time spent outdoors. Systematic reviews and meta-analyses have found that greater near-work activity (reading, writing, and screen-based tasks performed at close distance) is associated with increased odds of myopia, although the strength of this association is more modest and less consistent than that for outdoor time [11,29]. In contrast, the protective effect of outdoor time is one of the most robust findings in myopia epidemiology: a landmark meta-analysis by Sherwin et al. found approximately 2% reduced odds of myopia for each additional hour spent outdoors per week [30], and subsequent randomized trials have confirmed this causal relationship. In a cluster-randomized trial in Guangzhou, China, adding 40 minutes of outdoor activity to the school day reduced 3-year myopia incidence by about 23% compared with control schools [31]. Similarly, outdoor activity during recess reduced myopia onset and progression among Taiwanese schoolchildren [32], and a school-based cluster-randomized trial demonstrated that increasing outdoor light intensity exposure slowed myopic shift [33]. Cohort data from Sydney, Australia, and rural China corroborate that children who spend more time outdoors have consistently lower rates of incident myopia, independent of near-work exposure [34,35,27].

The COVID-19 pandemic provided an unplanned natural experiment. Home confinement, school closures, and a sharp increase in remote and device-based learning were associated with a marked acceleration of myopic shift among school-aged children; a large cohort study in China found substantially higher rates of myopia in children examined during 2020 compared with the same age groups examined in the preceding five years, coinciding with reduced outdoor time and increased screen exposure during confinement [36]. These findings reinforced concerns that increasing digital device use, even outside pandemic conditions, may be reshaping the environmental risk profile for childhood myopia.

Family history of myopia, higher parental education, urban residence, and higher socioeconomic status have also been repeatedly identified as risk factors, likely reflecting both shared genetic risk and shared environmental exposures such as more intensive early education, greater near-work demands, and less unstructured outdoor play [10,27]. Mendelian randomization analyses using genetic variants associated with educational attainment have provided evidence that more years of education causally increases the risk of myopia, supporting a causal (rather than purely correlational) role for intensive schooling in myopia development [12].

5. Myopia, Uncorrected Refractive Error, and Academic Performance

5.1 The reverse-causation paradox: academic pressure as a driver of myopia

A central and somewhat counter-intuitive theme in this literature is that myopia itself is more often a consequence of high academic engagement than a cause of poor academic performance. Longitudinal data from the Singapore Cohort Study of the Risk Factors for Myopia (SCORM) found that both school academic performance and IQ scores were independently associated with myopia, with higher-achieving children showing greater subsequent myopic shift [13,37,38]. Studies of Singaporean military conscripts similarly found that higher academic achievement and greater near-work exposure during school years predicted higher rates of myopia in early adulthood [13]. Large cross-sectional and longitudinal analyses from Chinese school cohorts have shown that children with higher academic grades have a higher prevalence and faster progression of myopia even after adjusting for body mass index, outdoor activity, screen time, reading time, and parental myopia, and that this association strengthens around the high-stakes examination years (entry to junior and senior secondary school) [5]. This pattern is consistent with the broader risk-factor literature implicating near work and reduced outdoor time as consequences of an academically intensive lifestyle [11,30].

Population-based cognitive studies add further nuance. In the Gutenberg Health Study, myopic adults performed better on the Tower of London executive-function test than non-myopic adults, but this association was substantially attenuated after adjusting for years of education, leading the authors to conclude that the apparent link between myopia and cognitive performance is mediated primarily through its association with prolonged education rather than through any direct effect of myopia on cognition [39]. Twin-based analyses have found shared genetic variance between myopia and general cognitive ability, suggesting that some of the epidemiological correlation between myopia and academic achievement may reflect common underlying genetic factors rather than a direct causal pathway in either direction [40]. Early work by Saw and colleagues similarly found higher non-verbal IQ scores among myopic Singaporean children compared with non-myopic peers, again consistent with a shared-determinant rather than a simple cause-and-effect model [37].

5.2 Uncorrected refractive error and educational outcomes

A distinct and more directly actionable body of evidence concerns the impact of uncorrected (as opposed to corrected) refractive error on classroom function. Because uncorrected myopia blurs distance vision, affected children may struggle to read the blackboard, copy notes accurately, or engage fully in visually demanding classroom activities, particularly when spectacle coverage is poor. Population data suggest that only about a quarter of Indian schoolchildren with myopia wear appropriate corrective spectacles [18], and unmet need for correction is similarly high in many low- and middle-income settings [8,9,41]. A cluster-randomized controlled trial in rural China found that providing free glasses to myopic schoolchildren produced statistically significant improvements in mathematics test scores compared with children who were not provided glasses, despite imperfect spectacle-wear compliance [42]. In the United States, a large cluster-randomized trial of a school-based vision programme providing eye examinations and free eyeglasses to students in grades 3–7 in Baltimore City Public Schools found that students receiving glasses achieved significantly better reading scores over the following year, with the greatest benefit among girls, students receiving special education services, and those with the lowest baseline scores, although the benefit was not fully sustained at two years [43].

Most of the direct causal evidence in this space actually concerns hyperopia rather than myopia. A systematic review and meta-analysis of 25 studies found that children with uncorrected hyperopia showed significantly poorer educational performance and reading skills compared with emmetropic or myopic peers, and that hyperopic spectacle correction significantly improved reading speed in interventional studies [7,44]. This asymmetry is biologically plausible: hyperopic children must exert continuous accommodative effort even for near tasks such as reading, producing visual fatigue, whereas myopic children typically retain clear near vision and are chiefly disadvantaged for distance viewing tasks such as reading the blackboard. Nonetheless, both hyperopic and myopic uncorrected refractive error, together with more general "reduced visual acuity" regardless of underlying refractive type, have been linked with poorer academic performance in Vietnamese and other Asian adolescent cohorts, particularly among students whose visual acuity remained below normal despite spectacle wear. A systematic review of spectacle correction and child well-being concluded that correcting refractive error improves children's educational performance, reading fluency, quality of life, and mental health outcomes across the studies reviewed [7]. Uncorrected refractive error remains among the leading global causes of avoidable visual impairment in children and carries a well-documented downstream cost in lost educational opportunity [8,9,41,45].

6. Psychosocial and Quality-of-Life Impact

Beyond direct effects on visual function and classroom performance, myopia carries a psychosocial burden that can indirectly affect a child's engagement with school and peers. Children who wear spectacles may experience teasing, social stigma, or reluctance from parents to pursue correction, particularly in settings where spectacle wear carries negative social connotations [45]. In the COMET cohort, myopic children generally reported moderate to high self-esteem across domains including scholastic competence, athletic competence, and social acceptance, though ocular and demographic characteristics modulated these scores [46]. Studies comparing myopic and emmetropic adolescents have found higher levels of trait anxiety among myopic children, particularly boys, which the authors linked to possible experiences of teasing or bullying related to spectacle wear [47]. Reduced health-related quality of life, particularly in domains of self-care, pain and discomfort, and anxiety/depression, has also been documented among myopic children compared with emmetropic peers in large Chinese school-based samples. Collectively, these findings suggest that the burden of childhood myopia extends beyond visual acuity to encompass emotional wellbeing and social functioning, both of which can plausibly influence classroom engagement and academic motivation.

7. Long-Term Ocular Complications and Public Health Burden

Childhood-onset myopia is of particular concern because earlier onset is associated with greater lifetime progression and a higher likelihood of developing high myopia in adulthood. High myopia (spherical equivalent ≤ -6.00 diopters) is strongly associated with sight-threatening complications including myopic macular degeneration, retinal detachment, cataract, and open-angle glaucoma [48,49]. A systematic review and meta-analysis quantified the dose-dependent relationship between myopic severity and these complications, confirming that risk rises steeply once spherical equivalent exceeds -6.00 diopters [49]. Myopic macular degeneration has already become a leading cause of irreversible blindness in several East Asian cities, reflecting the downstream consequence of a childhood-onset epidemic that is now reaching adulthood in cohorts with decades of high myopia exposure [5,48]. These findings underscore that interventions to prevent or slow myopia onset and progression in childhood are not simply about correcting a refractive inconvenience, but about mitigating a substantial future burden of irreversible vision loss, a conclusion echoed in International Myopia Institute consensus statements on the broader lifetime impact of myopia on individuals and society [50].

8. Economic Burden

The economic implications of childhood-onset myopia are substantial when aggregated at a population level. A systematic review, meta-analysis, and modelling study estimated that vision impairment and blindness resulting from uncorrected myopia caused a global potential productivity loss of approximately US\$244 billion in 2015, concentrated

disproportionately in East, South, and Southeast Asia, where the loss represented more than 1% of regional gross domestic product [51]. This estimate substantially exceeded the projected cost of correcting the underlying refractive error, indicating a strong economic case for investment in vision screening and spectacle provision [51]. Country-level analyses corroborate this picture: in Singapore, the annual direct and indirect economic cost of myopia among adults aged 40–74 years was estimated in the hundreds of millions of dollars once healthcare costs, low-vision aids, and productivity loss were included [52]. These economic analyses, taken together with the academic and psychosocial evidence reviewed above, support a life-course framing of myopia as a condition whose costs accrue silently through childhood and become fully realized only in adulthood.

9. Prevention, Screening, and Management Strategies

9.1 School-based vision screening and spectacle correction

Given the demonstrated impact of uncorrected refractive error on academic performance, school-based vision screening followed by timely spectacle provision represents one of the most cost-effective public health interventions available. Randomized and cluster-randomized trials from China and the United States have shown that providing free glasses to children with uncorrected refractive error produces measurable, if sometimes modest, gains in mathematics and reading scores [42,43]. However, spectacle-wear compliance remains a persistent challenge, with several studies documenting that only a minority of children with myopia in India wear correction consistently [18], often due to cost, access barriers, parental attitudes, or social stigma [45]. Strengthening school health infrastructure, integrating vision screening into routine pediatric and school health checks, and addressing barriers to spectacle uptake are therefore essential complements to any myopia-control strategy.

9.2 Clinical myopia-control interventions

For children with progressive myopia, several clinical interventions have demonstrated efficacy in slowing axial elongation and dioptric progression. A Cochrane systematic review of interventions to slow myopia progression in children concluded that pharmacological agents (particularly topical atropine), and specially designed contact lenses and spectacle lenses, are more effective than single-vision correction alone in reducing progression [53]. Low-concentration atropine (0.01–0.05%) has shown a favorable balance of efficacy and tolerability in large randomized trials such as the Atropine for the Treatment of Myopia (ATOM) studies [54,55], while orthokeratology and multifocal soft contact lenses have demonstrated meaningful reductions in axial elongation in meta-analyses of randomized controlled trials [56,57]. Network meta-analyses comparing atropine, orthokeratology, and combination therapy suggest that combining optical and pharmacological approaches may offer additive benefit over monotherapy, particularly during the early months of treatment [58]. The International Myopia Institute has consolidated this evidence into consensus guidance on the prevention of myopia onset and progression, emphasizing a combination of outdoor time promotion, near-work moderation, and, where indicated, active clinical myopia control [21].

9.3 Behavioral and lifestyle interventions

Because outdoor time exerts a consistent protective effect independent of near-work reduction, public health strategies increasingly emphasize structured outdoor activity as a low-cost, scalable intervention for myopia prevention. School-based programmes that add outdoor class time or recess have demonstrated reductions in both myopia incidence and progression in randomized trials [31,32,33]. Complementary strategies include limiting continuous near-work sessions, encouraging the '20-20-20' rule (a 20-second break to view something 20 feet away every 20 minutes of near work), moderating recreational screen time, and ensuring adequate ambient lighting during study [11,29,30]. Given the acceleration of myopic shift observed during COVID-19-related school closures, restoring and protecting structured outdoor time following disruptions to normal schooling appears to be a particularly important public health priority [36].

10. Gaps in the Evidence and Future Directions

Several limitations temper the strength of causal inference in this literature. First, most studies linking myopia to academic performance are cross-sectional or observational, and while several large longitudinal cohorts (e.g., SCORM) and one Mendelian randomization analysis support a causal pathway running from education and near work to myopia, few studies have used designs capable of fully disentangling shared genetic confounding from environmental causation [12,38,40]. Second, the literature on uncorrected refractive error and academic performance is dominated by studies of hyperopia rather than myopia, leaving a comparative gap in high-quality interventional evidence specific to myopic children, particularly in low- and middle-income countries [7,43]. Third, most myopia-control trials have been conducted in East Asian populations with very high background myopia prevalence; the generalizability of both risk-factor and intervention findings to South Asian, African, and Latin American populations, where prevalence and environmental exposures differ, requires further study [17,20]. Finally, few studies have examined psychosocial and academic outcomes together within the same longitudinal cohort, limiting the ability to model how visual, cognitive, and psychosocial pathways jointly shape a child's educational trajectory. Future research would benefit from multinational longitudinal cohorts that track refractive status, spectacle compliance, objectively measured near-work and outdoor time, and standardized academic and psychosocial outcomes from early childhood into early adulthood.

11. Conclusion

Myopia in children is a rapidly growing global public health concern with a complex, bidirectional relationship to academic performance. Uncorrected refractive error, whether myopic or hyperopic, measurably impairs classroom function and can be improved through timely, accessible spectacle correction, with demonstrable benefits for reading and mathematics performance. At the same time, myopia itself appears to arise substantially as a consequence of the near-work-intensive, outdoor-time-limited lifestyle associated with high academic achievement, rather than as its cause, a relationship reinforced by genetic, cohort, and Mendelian randomization evidence. Addressing the myopia epidemic in children therefore requires a dual strategy: expanding school-based vision screening and spectacle provision to protect the educational potential of children with uncorrected refractive error, while simultaneously promoting outdoor time, moderating excessive near work and screen exposure, and deploying evidence-based clinical myopia-control interventions to protect long-term ocular health. Given the scale of the projected 2050 myopia burden and its substantial downstream economic and public health costs, integrating myopia prevention and management into routine school health policy should be regarded as a priority for pediatric, ophthalmic, and educational stakeholders alike.

Declarations

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