RANZCO Position Statement: Progressive Myopia in Childhood

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1. Purpose and scope

This position statement was developed by The Royal Australian and New Zealand College of Ophthalmologists (RANZCO). The purpose of this position statement is to provide guidance to RANZCO Fellows and other health professionals regarding best practices for the diagnosis and treatment of progressive myopia in children. We acknowledge that there is still much to be determined regarding factors that bring about progressive myopia and the optimal interventions to minimise progression.

2. Background

Myopia is one of the most common eye disorders, and its prevalence is increasing worldwide. Increased incidence and prevalence of myopia in Australia have also been reported[2 3]. Refractive error occurs when there is a mismatch between the axial length and the optical power of the eye. The axial length increases throughout childhood, and curvature changes[4 5]. Myopia is defined as a spherical equivalent refractive error of -0.5 dioptres (D)or greater[6]. There is a direct relationship between the amount of myopia and axial length (the distance between the front surface of the cornea and the back of the eye's retina) in axial myopia. By 2050, 10% of the global population has been predicted to have high myopia, defined as myopia of -6.0 D or greater and axial length of 26.0 mm or more in either eye[6].

Myopia with associated complications is termed pathological myopia and is a major cause of visual impairment worldwide[7]. Longer axial length increases the risk of myopic complications, including glaucoma, choroidal neovascular membrane secondary to myopic macular degeneration, retinal detachment, and presenile cataract[6 8 9]. The prevalence of pathological myopia is as high as 8% in the young adult Asian population[10] and has been reported at between 1-4% in adult Australian populations[3]. Recent review studies[7] noted that approximately half of the individuals with high myopia could develop pathological myopia.

3. The need for a collaborative approach to myopia control management

Collaborative care involves an integrated patient-centred approach with various health professionals, including general practitioners (GPs), optometrists, paediatricians, ophthalmologists, and others working together to prevent or address vision loss caused by eye disease. With the improved accessibility of monitoring tools and the advent of intervention strategies for myopia progression in children, practitioners can now take an active role. Co-management, collaborating with optometrists and orthoptists for ongoing care, is considered the best-practice approach. However, expert consensus highlights the importance of involving an ophthalmologist.

High myopia may be associated with at least 200 systemic/syndromic diseases, of which Stickler syndrome, Marfan syndrome and Inherited Retinal Dystrophies are the most common. Patients with these disorders often require specific ophthalmic and paediatric clinical reviews.

Syndromic myopia differs from juvenile progressive myopia; therefore, the interventions outlined below may not apply to syndromic myopia. If syndromic myopia is suspected, a review with an ophthalmologist is recommended. Further investigations and a review with a general physician or paediatrician will ensure the patient's overall health[1]. Other conditions, such as keratoconus and spherophakia, can mimic myopia progression, which should be considered when refractive changes do not match axial growth.

4. Treatment of progressive myopia

Initial myopia management involves taking a general and family history, including parental refraction, familial genetic diseases, and other systemic medical concerns. The patient should undergo a comprehensive ophthalmic examination, including visual acuity testing, ocular motility examination, cycloplegic retinoscopy, and a dilated fundus examination. Ocular biometry should be measured at baseline. Full correction of the refractive error is recommended.

Once myopic, intervention to slow myopia progression is recommended if the progression is more than 0.5 D per year, with axial length increasing by more than 0.20 mm/ year[11 12]. Assessment of known risk factors such as younger myopic patients, high myopia at a young age and/or a strong family history of high myopia is also helpful when considering myopia control intervention[13]. Progression is best assessed by monitoring axial length, with interferometry the most accurate method[14-16].

a) Environmental risk factors

Environmental influences such as reduced sunlight exposure (lux) and excess near work are implicated in the development of myopia and its rate of progression in many animal models and epidemiological studies[17-23]. Genetic studies have confirmed the role for light-induced signalling as a driver of refractive error[24]. Increased time in education and reduced time spent outdoors have been identified as key risk factors[13]. There is evidence that, in some communities, educational pressure is driving the development of myopia[25].

Rose K et al.[26] analysed outdoor activity and concluded that the light intensity measured in lux was the most critical factor. Indoors, the lux of light is typically between 50 lux at home[24] and 320–500 lux at an indoor workplace[27]. Outdoors, the magnitude of light during the day ranges from over 100,000 lux for direct sunlight to 20,000 lux on a cloudy day. The lux of light required to reduce myopia progression has been difficult to quantify. Studies have suggested that the minimum intensity required ranges between 1000-2000 lux with a dose-response effect[28]. A recent Asian study identified that intermittent time spent outside as short as 15 minutes may have a beneficial effect rather than the exposure having to be continuous[29].

Ho CL et al.[30], in their meta-analysis of the dose-response relationship between outdoor exposure and myopia indicators, found that more than 120 minutes of daily outdoor light exposure decreased myopia incidence by 50%, spherical equivalent refraction by 32.9% and axial elongation by 24.9% for Asian children aged 4–14 years. Furthermore, spending less than 40 minutes outdoors/per day is associated with more rapid axial length progression[31]. Hence, it is recommended that children spend at least 2–3 hours per day outdoors. Public health measures such as the Taiwanese Tia-Tian project of introducing 120 minutes of outdoor exposure daily into the school curriculum reversed the long-term prevalence trend of reduced vision (due to myopia) within five years[32].

Sunlight contains wavelengths of visible light and invisible ultraviolet (UV). UV consists of shorter wavelengths that are known to cause diseases in the eye and skin. Many animal studies, including in rhesus monkeys[33], chicks[34 35] and tree shrews[36 37], have shown that the UV component of light is not critical for regulating ocular growth. Bright light, produced from UV-free lighting systems, was used experimentally to inhibit scleral growth rates. Furthermore, alterations in light intensity using UV-free lighting systems have been shown to modify the normal emmetropisation process.

Near work is considered an independent risk factor for the increased rate of myopia progression in children. However, the evidence regarding the amount or distance preferred for near work remains unclear, with conflicting reports [38-40]. A recent systematic review found a dose-response effect between digital screens and myopia risk, with the risk increasing significantly between 1-4 hours of daily screen time [41] although lack of outdoor time may still be a confounder. As with earlier reports of outdoor sunlight exposure effect using only surveys, more elegant studies using more objective measurements, such as light meters and distance monitoring devices to validate parent and patient recall, will add further clarity to the parameters to advise families on lifestyle intervention for myopia progression in children.

b) Optical devices

Refractive intervention, established by animal experiments, identified the modifying effect of lenses on various animal species' eye growth[42-44]. Trials have included multifocal contact lenses of multiple designs, hard contact lenses and novel dual focus contact lenses, as well as bifocal/progressive spectacle and novel spectacle lens designs creating peripheral myopic defocus to prevent axial elongation[45-48]. Novel dual-focus contact lenses use an annular peripheral plus zone with a central zone for clear vision. Defocus Incorporated Multiple Segments(DIMS) and Highly Aspherical Lenslet (HAL) design spectacles utilise plus power lenslets incorporated in the peripheral area while maintaining a central zone for clear vision. Both novel spectacle (HAL and DIMS) and dual-focus contact lens design statistics significantly reduce myopia progression in axial elongation and dioptres, with studies over 5-6 years[45-50].

c) Pharmacological interventions

Research using pharmacological intervention to retard eye growth, and hence myopia progression, has a history spanning over 100 years. Atropine is the most extensively studied drug, and atropine eye drops are now commonly used to manage childhood myopia progression. Various concentrations (0.01%–0.05%) have been trialled, e.g., the ATOM[51-54] and LAMP studies [55-58] and preparations are available via compounding pharmacies. Atropine 0.01% (Eikance™) eye drops are TGA-approved in Australia for 4- to 14-year-olds, demonstrating a greater than 0.5D progression in 1 year. In New Zealand, dilute atropine eye drops are supplied through compounding pharmacies.

In the last five years, additional randomised atropine studies of an Australian and European cohort have added some controversy regarding the optimal low-dose atropine dose required for myopia treatment. The WA-ATOM study, which enrolled participants aged 6-16 years, included almost 50% of European descent, compared to Atropine 0.01% and placebo. The inclusion criteria required at least 0.5 D progression in the previous year[59]. Analysis at each 6-month endpoint had a statistically significant effect on diopter and axial length progression, except for the last six months. Other European studies have found significant and insignificant effects using atropine 0.01% [60-62]. The confounding problem with these studies was the effect of COVID-19 and indoor confinement and increased near work due to home learning[63].

Additionally, not all these studies had enrollment criteria that included increased progression the year prior, which may affect the effectiveness of atropine 0.01% in children of European descent. Generally, all concentrations of atropine are well tolerated, although an increased dose-related side effect of near blur and glare due to pupil dilation is noted with concentration[57]. The Irish MOSAIC study recently found that children reported more glare and blur with atropine 0.05%, however, this did not translate to stopping treatment[64]. Atropine 0.05% has not been studied in Australia, and the effect of photophobia is unknown in our population.

d) Physical device, Orthokeratology (Ortho-K)

Ortho-K incorporates a rigid contact lens design with a distinctive back shape to be used overnight to reshape the corneal epithelium. Ortho-K was initially used to flatten the central corneal zone, thus negating the need for individuals with low or moderate myopia to wear glasses during the day. The refractive effect is achieved by reshaping the central corneal epithelium, and its use has been extended to include the treatment of childhood myopia progression, again by modifying peripheral defocus[65 66]. The risk of infectious keratitis is a concern with Ortho-K[67]. The long-term efficacy of Ortho-K has been demonstrated with greater effect in combination with low-dose atropine[68]; however, little data exists regarding the rebound effect once treatment is discontinued.

Repeated Low-Level Red Light therapy (RLRL) was TGA-approved in Australia in 2023 and is a home-use device that emits visible red light at 650nm. The therapy requires two sessions daily, each lasting three minutes, five days a week, with a mandatory four-hour interval between sessions. The landmark publication demonstrated high effectiveness in reducing myopia progression over 2 years[69]. Although various studies have reported a low side effect rate, one study has an adverse event with loss of vision, which recovered over time[70].

5. Efficacy of treatment

Only relatively short-term treatment outcomes are available. The ATOM2 study has reported five year results[53], and the LAMP study has recently published results out to five years as well[58]. In both these well-conducted, prospective, randomised controlled trials, most children still showed some myopia progression **regardless of treatment received,** and the optimal duration of therapy has not been determined. An associated rebound effect has been noted when atropine eye drops are ceased. This results in accelerated growth after ceasing atropine, which is more pronounced the higher the concentration of atropine. This was demonstrated in the five year LAMP study where after a one year wash out, most children were required to restart atropine 0.05% to achieve myopia control[58]. Importantly, a significant rebound effect in the WA-ATOM study with atropine 0.01% was noted with drug cessation in an Australian population[71]. Further concerns have been raised regarding the length of treatment and the overall impact of rebound, which can negate better treatment outcomes, in the context of the Atlas study, which examines the long-term refractive outcomes of the original ATOM study groups[72]. The Atlas study followed a quarter of the original ATOM participants using atropine 0.01%-1%

for a duration of 2 to 4 years during childhood and was not associated with differences in final refractive errors 10 to 20 years after treatment[72]. Rebound is thought to occur when the eye is still in a growth phase. Longer treatment is recommended with axial length monitoring to ensure the best treatment effect while minimising side effects, which include rebound. This should involve titrating the concentration and a longer treatment period of atropine drops to maximise patient treatment efficacy[73 74].

Rebound has not been reported with the discontinued use of novel dual-focus contact lenses[50] and novel peripheral defocus spectacles DIMS or HAL design when the spectacles were ceased[75-78]. Other modalities, including Ortho-K and recent TGA-approved red-light therapy, show evidence of rebound as well[79].

Data concerning the value of additive treatments is slowly accumulating, such as combining environmental, optical, and pharmacological interventions, are available[80-82]. Further research is required to establish the efficacy of combination treatments in different patient groups.

Any treatment initiated in childhood aims to reduce the burden of higher myopia and, ultimately, the incidence of high myopia and the associated risks of visual impairment related to the development of pathological myopia. Patients and their families must understand that any attempt to prevent or slow myopia is akin to playing a long game, and the potential benefits are largely realised over several decades in the future.

6. Role of public health advocacy

Public awareness of the increasing incidence and lifelong visual complications of myopia is currently limited. Parental understanding of the causes and health risks of myopia is poor, and parents/caregivers may be nonchalant regarding myopia in their child[83]. Increasing public awareness could be valuable in improving myopia control[84]. This review also strongly advocates increased sunlight exposure as a public health strategy to limit myopia progression.

The SunSmart® public health campaign has effectively modified public awareness and behaviour concerning sunlight exposure and reduced skin malignancy.[85 86]. This campaign primarily aims to reduce UV light exposure to lessen the risk of skin malignancy[87], and there is evidence that adolescents in Australia understand this causal link. There is also evidence that reduced sunlight exposure can have significant ill effects on health, more generally[88 89].

In recommending children increase outdoor time, a child's subsequent risk of skin cancer and UV-related eye diseases, including periorbital skin cancers[88], ocular surface tumours, including limbal squamous cell carcinomas[90], pterygium[91], cortical cataract[92-94] and increased risk of age-related macular degeneration[95] must be balanced with their risk of myopia[96].

By increasing the exposure of the paediatric eye to an increased lux of visible light and limiting a child's exposure to UV radiation, it should be possible to reduce both UV-related eye diseases and myopia. A Singaporean study used child mannequin heads with sunglasses and a hat for UV protection to assess the effect of different outdoor environments on the lux of light reaching the eye. Even with UV protection, including sunglasses or hats and keeping the mannequin in shaded areas, the light levels were still 11–43 times higher than indoors[97]. This light level was sufficient for myopia control if outdoor exposure was undertaken for at least 2 hours per day[98]. Hence, we must simultaneously encourage outdoor activity for myopia control while encouraging UV radiation protection for the eye and skin[28]. Sunglasses complying with AS/ NZS 1067.1 Categories 2 or 3 provide adequate protection and are recommended for children outdoors with high UV exposure with additional skin protection. High myopes and children should consider wearing impact-resistance lenses.

RANZCO recommends adopting a more nuanced public policy regarding sunlight exposure. This policy should aim to minimise exposure to UV light to reduce skin malignancy, but not to the extent that it results in vitamin D deficiency[99]. It should also maintain exposure to sufficient high-intensity sunlight to minimise myopia progression.

Key points for the media:

i. The incidence and prevalence of myopia are increasing worldwide, including in Australia. This is a significant public health concern.
ii. With a lower age of onset of myopia in children, there is a greater incidence of high myopia, leading to sight-threatening vision loss, including complications like retinal detachments, myopic macular degeneration, and glaucoma.
iii. Research in the understanding and intervention of myopia progression in children is now available to modify outcomes. Early intervention can reduce myopia complications and severity.

7. Record of amendments to this document

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	Minor amendments and references added	May 2023
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8. References

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