The Royal Australian and New Zealand College of Ophthalmologists

RANZCO Position Statement: Progressive Myopia in Childhood

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We acknowledge the Aboriginal and Torres Strait Islander Peoples, the Traditional Owners of Country throughout Australia and recognise their continuing connection to land, waters and community. We pay our respects to them and their cultures; and to their Elders past, present and emerging.
In recognition that we are a bi-national College, we also acknowledge the Rangatiratanga of Māori as Tangata Whenua and Treaty of Waitangi partners in Aotearoa New Zealand.

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[1]. Refractive error is due to a mismatch between axial length and the optical power of the eye. The axial length increases throughout childhood, and curvature changes [2,3]. Myopia is defined as a refractive error of ≥ -0.5 dioptres (D)[4]. There is a direct relationship between the amount of myopia and axial length in axial myopia. By 2050, 10% of the global population has been predicted to have high myopia, defined as myopia of ≥ -6.0 D and axial length of ≥ 26.0 mm or more in either eye[4].

Myopia with associated complications is termed pathological myopia and is expected to become the leading cause of permanent blindness worldwide. Longer axial length increases the risk of myopic complications, including glaucoma, choroidal neovascular membrane secondary to myopic macular degeneration, retinal detachment, and presenile cataract[4-6]. The prevalence of pathological myopia is as high as 8% in the young adult Asian population[7]. Recent review studies[8] 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 other health professionals working together to prevent or address vision loss caused by eye disease. With improved accessibility of monitoring tools and the advent of intervention strategies for myopia progression in children, the practitioner 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. These disorders often require specific ophthalmic and paediatric reviews. Syndromic myopia is not juvenile progressive myopia, and the interventions outlined below do not necessarily apply to these forms of myopia. Other conditions can also mimic myopia progression, such as keratoconus and spherophakia, 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 full ophthalmic examination, including visual acuity, ocular motility exam, retinoscopy, and dilated fundus examination. Measurement of ocular biometry should be included at baseline. Full correction of the refractive error is recommended.

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[9,10]. Progression is best assessed by monitoring axial length, with interferometry the most accurate method[11-13].

a) Environmental risk factors

Environmental influences such as sunlight exposure and near work are implicated in the development and rate of myopia progression in many animal models and epidemiological studies[14-19]. Genetic studies have confirmed the role for light-induced signalling as a driver of refractive error[20]. Increased time in education and reduced time spent outdoors have been identified as key risk factors [21]. There is evidence that educational pressure in some communities is driving the development of myopia [22].

Rose K et al.[23] 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] to 320–500 lux at an indoor workplace[24,25]. Outdoors, the magnitude of light during the day ranges from about 100,000 lux for direct sunlight to 20,000 lux on a cloudy day. The lux of light that arrested myopia progression in rhesus monkeys in a laboratory was 20,000 lux, given 12 hours a day, over 103–115 days. However, it is not possible to directly extrapolate what equivalent light intensity and exposure would be needed to arrest myopia progression in a child's life.
Ho CL et al.[26], in their meta-analysis of the dose-response relationship between outdoor exposure and myopia indicators found that more than 120 min 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 mins outdoors/per day is associated with more rapid axial length progression[27]. Hence, it is recommended that at least 2–3 hours of outdoor exposure per day should be encouraged during childhood.
Light contains the wavelengths of visible light and the shorter ultraviolet (UV) wavelengths, which are known to cause diseases to the eye and skin. Although many studies are still ongoing, it is known from well-designed animal studies, including in rhesus monkeys[28], chicks[29] and tree shrews[30], that UV light is not critical for the regulation of ocular growth. Bright light, produced from UV-free lighting systems, was used experimentally to inhibit scleral growth rates. Furthermore, alterations of light intensity using UV free lighting systems were shown to modify the normal emmetropisation process.

Karouta and Ashby noted that UV exposure does not underlie the ability of bright light to retard the development of deprivation-myopia or the ability of bright light to maintain normal untreated eyes in a hyperopic state[29,31]. Instead, their data suggest that the ability of light to retard the development of deprivation myopia is driven by intensity-dependent increases in

retinal dopamine release[32]. Furthermore, the authors noted that broadening the spectral output of the lighting system to include UV output was unlikely to induce an even greater protective effect against the development of myopia, as the development of deprivation myopia can be abolished in rhesus monkeys at 20,000 lux[28] and chicks at 40,000 lux of bright light alone[33]. Hammond et al.[34] compared UV-free light to illuminance-matched UV-containing light and found no difference in compensation to -10 dioptre or -20 dioptre lenses. This result is consistent with the assertion that the absence of UV light does not modify the emmetropisation process.

b) Optical devices

Refractive intervention, established by animal experiments, identified the modifying effect of lenses on various animal species' eye growth. Trials have included bifocal, multifocal, contact lenses of multiple designs and novel dual-focus spectacle lenses with a centre-periphery design. Dual-focus lenses attempt to change the peripheral defocus, identified as the potential modifier of axial elongation[35,36]. Of the optical devices, the dual-focus lens design has demonstrated the most significant effect on limiting the elongation of the eye in myopia progression[37,38].

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 is now commonly used to manage childhood myopia progression. Various concentrations (0.01%–0.05%) have been trialled, e.g., the ATOM[39-42] and LAMP[43,44] studies, and preparations are available via compounding pharmacies. Recently atropine 0.01% (Eikance ™) has been 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 is supplied through compounding pharmacies.

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 and thus negate 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[45,46]. The risk of infectious keratitis is a concern with Ortho-K. The long-term efficacy of Ortho-K alone for myopia control is uncertain.

5. Efficacy of treatment

Only relatively short-term outcomes of treatment are available. The ATOM2 study has reported results out to 5 years[42], and the LAMP study has recently published results out to 3 years[47]. In both of these well-conducted, prospective, randomised controlled trials, most children still showed some myopia progression **regardless of treatment received,** and the optimal duration of treatment has not been determined. The use of atropine has an associated rebound effect when the medication is ceased too early. This results in accelerated growth after ceasing atropine, which is more pronounced the higher the concentration of atropine used[42,47]. Long-term outcomes recently presented include 5 year

data on dual focus spectacles, which reported no rebound when the spectacles were ceased[48] and published 6 year data on novel design contact lenses[49].

Little data concerning the value of additive treatments are available, such as combining environmental, optical, and pharmacological interventions.

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 "playing a long game", and the potential benefits are largely some 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[50]. Increasing public awareness could be important in improving myopia control[51]. This review also strongly advocates increased sunlight exposure as a public health strategy to limit myopia progression.

The "Sun Smart " public health campaign has been extremely effective in modifying public awareness and behaviour concerning sunlight exposure and reducing skin malignancy[52,53]. This campaign primarily aims to reduce UV light exposure to lessen the risk of skin malignancy[54], and there is evidence that adolescents in Australia understand this causal link[55]. There is also evidence that reduced sunlight exposure can have significant ill effects on health more generally.[56,57]

RANZCO suggests that a more nuanced public policy for sunlight exposure be adopted. This policy should aim to optimise exposure to UV light to reduce skin malignancy, but not to the level that results in vitamin D deficiency and, importantly, maintains exposure to sufficient high-intensity sunlight to minimise myopia progression. RANZCO recognises that periorbital skin cancers account for 5–10% of all skin cancers that occur in the body.[58,59]

In recommending children increase outdoor time, a child's subsequent risk of skin cancer and UV-related eye diseases, including periorbital skin cancers[58], ocular surface tumours including limbal squamous cell carcinomas[60], pterygium[61], cortical cataract[62-65] and increased risk of age-related macular degeneration[66] must be balanced with their risk of myopia[67].

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 limit 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 and hats and keeping the mannequin in shaded areas, the light levels were still 11 to 43 times higher than indoors[68]. This light level was considered sufficient for myopia control if outdoor exposure was undertaken for at least 2 hours per day[68]. Hence, we simultaneously need to encourage outdoor activity for myopia control while also encouraging maximum UV radiation protection

for the eye and skin[29].

Key points for media:

i. The incidence and prevalence of myopia are increasing worldwide, including in Australia. This is a significant public health concern.

ii. With the lower age 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 possibly modify this problem. Early intervention can reduce myopia complications and severity.

7. Record of amendments to this document

Page	Details of Amendment	Date amended
Entire document	Created	May 2022

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