

Childhood blindness prevention in Aotearoa New Zealand

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ABSTRACT

AIM: While less common than adult blindness, childhood blindness has a significant burden in terms of the total number of “blind years”. We aim to determine if there is scope for improved strategies in the prevention of childhood blindness in Aotearoa New Zealand.

METHOD: We conducted a review of New Zealand childhood blindness data.

RESULTS: In New Zealand, there is a paucity of data on childhood blindness. However, significant scope remains for prevention through optimising maternal health, neonatal care, increasing uptake of immunisations and attendance at vision screening programmes, as well as the earliest possible detection of myopia and keratoconus.

CONCLUSION: Ophthalmologists and the Royal Australian and New Zealand College of Ophthalmologists must continue to actively collaborate with obstetricians, paediatricians, general practitioners, optometrists, national screening units, vaccination programmes, epidemiologists and Health New Zealand – Te Whatu Ora to promote primary prevention strategies and improve visual outcomes for our tamariki.

Childhood blindness, while representing only 5% of worldwide blindness, ranks second as the leading cause of “blind years”. One-point-five million blind children account for 70 million blind years.¹ Childhood blindness definitions vary from visual acuity of less than 3/60 in the better eye (World Health Organization [WHO]) to 6/24 or less in Aotearoa New Zealand.^{1,2} Children under the age of 5 years have the highest incidence of blindness. Early onset blindness adversely affects the development of psychomotor, social and emotional skills. In addition to disability affecting their opportunities for education, employment and earning potential, blind children have a higher mortality rate.³

In New Zealand, more population data on childhood blindness have been published in recent years, but knowledge gaps remain. We, therefore, often extrapolate from Australian data; however, our populations differ. In New Zealand, the burden of blindness is inequitable, with nearly a quarter of blind children being Māori.³ The leading causes of childhood blindness in New Zealand are cortical vision impairment (CVI; 31.5%), retinopathy of prematurity (ROP; 18.2%) and optic nerve hypoplasia (ONH; 9%).⁴ In 2023, the Royal Australian and New Zealand College of Ophthalmologists (RANZCO) published *Vision 2030 and Beyond*, which aims to provide a road map to deliver better eye care nationwide despite challenging resource constraints in the public health sector.² This article aims to review New Zealand’s specific prevention strategies for childhood blindness.

Prevalence, incidence and cost of childhood blindness in New Zealand

The prevalence of childhood blindness in New Zealand has been reported as 5 per 10,000 children.³ We do not have data on incidence currently.

In Australia, the prevalence of childhood blindness is fairly similar at 3.4 per 10,000 children, and the incidence rate is close to one per 10,000 live births.⁵ Estimated direct healthcare costs in Australia have been evaluated at around AU\$30,000 per year per child, while indirect costs such as education, support services and caregivers’ loss of productivity have been estimated at around AU\$45,000 per year per child.^{5,6} The health burden in terms of Disability-Adjusted Life Years (DALYs) lost due to paediatric visual impairment in Australia has been estimated at 7,011 annually.⁶ Using an estimated Value of a Statistical Life Year of AU\$187,200, the total monetary value of the disease burden of 7,011 DALYs amounts to AU\$1.3 billion in 2015.⁶

Main causes of childhood blindness and preventive interventions

CVI

CVI is a decreased visual response to a stimulus due to brain injury rather than ocular disease. Brain injury can occur before, during or shortly

after birth.⁷ CVI is the leading cause of preventable childhood blindness in high-income countries, with as many as 50% of cases being preventable.⁸ CVI accounts for 31.5% of childhood blindness in New Zealand.⁴ Of these cases, CVI is idiopathic in 36% but is caused by perinatal hypoxia/asphyxia in 18–25% and non-accidental injury in 8%.⁷ Rarer causes include hydrocephalus, severe epilepsy, neonatal central nervous system infections, prematurity or genetic conditions. It has also been associated with antenatal maternal drug use. There is no treatment for CVI; therefore, prevention is a priority.⁷ To reduce the prevalence and impact of this condition, we summarise potential interventions in Table 1.

ROP

ROP affects premature infants weighing $\leq 1,250$ grams and born before 30 weeks gestation. It is

caused by incomplete retinal vascularisation secondary to oxygen-induced damage, although rates have been lower in recent years. There are multiple risk factors, including gestational weight/age and oxygen supplementation. ROP can lead to a spectrum of visual changes ranging from myopia, strabismus, amblyopia and anisometropia to blindness from retinal detachment.⁹ Worldwide, ROP is the primary cause of blindness in premature infants. In New Zealand, ROP accounts for an estimated 18% of childhood blindness and low vision.⁴ There is a higher rate of prematurity among Māori children.⁹ To reduce the prevalence of this condition, we summarise potential interventions in Table 2.

ONH

ONH is a congenital condition in which the optic nerve under-develops during pregnancy.

Table 1: Specific interventions to prevent cortical vision impairment.

Type of prevention	Specific interventions
Primary prevention	Optimal access to, and provision of, antenatal care to prevent premature birth.
	Optimal access to, and provision of, obstetric and perinatal care to prevent perinatal hypoxic brain injury.
	Optimal access to, and provision of, postnatal care.
	Interventions to reduce maternal alcohol and other drug use (e.g., opioids, methamphetamine).
	Interventions to reduce sexually transmitted infections (e.g., to prevent congenital syphilis and congenital herpes simplex virus infection).
	Interventions to reduce intentional and non-intentional injuries in pregnancy (e.g., family violence preventive interventions; seat belt use and other road safety interventions).
Secondary prevention*	Screening for maternal alcohol/drug use and then appropriate provision of treatment services.
	Screening for family violence or other exposure to intentional injuries during pregnancy.
Tertiary prevention**	Access to assessment for early diagnosis and intervention to optimise visual function (e.g., management of associated refractive errors, strabismus and amblyopia).
	Referral to the Blind and Low Vision Education Network New Zealand to reduce the impact of disability.

*Secondary prevention involves detecting disease at an early stage and intervening to halt or slow its progression.

**Tertiary prevention involves reducing the impact of an already established disease by preventing complications and improving quality of life.

Table 2: Specific interventions to prevent retinopathy of prematurity.

Type of prevention	Specific interventions
Primary prevention	Optimal access to, and provision of, antenatal care to prevent premature births.
	Administration of steroids to women with impending premature delivery. ⁹
	Minimisation of mechanical ventilation when not absolutely indicated. ⁹
	Minimisation of oxygen saturation fluctuations. ⁹
	Minimisation of blood transfusions when not absolutely indicated. ⁹
	Optimal access to, and provision of, neonatal and postnatal care: specifically, adequate nutrition and use of human milk where possible to encourage good postnatal growth. ⁹
Secondary prevention	Ensure ophthalmic screening of all infants $\leq 1,250\text{g}$ at birth and/or born at <30 weeks gestation to detect treatable disease.
	Early treatment with anti-vascular endothelial growth factor (VEGF) injections and laser if required.
Tertiary prevention	Referral to Blind and Low Vision Education Network New Zealand to reduce the impact of disability.
	Access to ophthalmic care to manage associated refractive errors, strabismus and amblyopia, which can worsen visual function.

Table 3: Specific interventions to prevent optic nerve hypoplasia.

Type of prevention	Specific interventions
Primary prevention	Interventions to reduce maternal smoking, alcohol and other drug use (e.g., opioids, methamphetamine).
	Appropriate sexuality education in schools to reduce the incidence of teenage pregnancies.
	Optimal access to, and provision of, family planning/sexual health services to reduce the incidence of teenage pregnancies.
	Optimal access to, and provision of, antenatal care.
Secondary prevention	Screening for maternal smoking/alcohol/drug use and then appropriate provision of treatment services.
Tertiary prevention	Referral to Blind and Low Vision Education Network New Zealand to reduce the impact of disability.
	Access to ophthalmic care to manage associated refractive errors, strabismus and amblyopia, which can worsen visual function.

It can present unilaterally or bilaterally and is not progressive.^{10,11} It can occur in isolation; however, it is commonly associated with cerebral midline structure abnormalities and pituitary axis hormone deficiencies.¹¹ In New Zealand, ONH accounts for an estimated 9% of childhood blindness and low vision.⁴ It is the third most common cause of visual impairment in Māori children. Visual acuity can range from near normal to no light perception. A current hypothesis is that ONH is caused by vascular disruption during pregnancy. The risk factors are increased first-trimester bleeding, maternal smoking, maternal alcohol consumption, young maternal age, maternal diabetes, preterm labour, primiparity and use of abortifacients, anticonvulsants or antidepressants.¹⁰ There is no treatment for ONH; therefore, prevention is a priority.⁸ To reduce the prevalence of this condition, we summarise potential interventions in Table 3.

Refractive error (RE)

In 2006, the WHO recognised uncorrected RE as an important cause of vision loss. By broadening this definition, the estimated total number of visually impaired people worldwide effectively doubled.¹²

Twelve-point-eight million children aged 5–15 years are visually impaired from uncorrected RE worldwide, representing 8.3% of all visual impairment. There are three main types of RE: myopia, hyperopia (or hypermetropia) and astigmatism.¹³ In New Zealand, an estimated 24% of 7–10-year-olds had RE on a recent school-based screening project. Only half of those children were regularly wearing glasses.¹⁴

Myopia is predominantly caused by an increased axial length. While genetics play an important role, increasing evidence suggests that environmental factors—particularly limited exposure to natural light and extended periods of near work (such as reading, screen use or other close-up visual tasks) in low-light conditions—also contribute significantly.¹⁵ There are predictions that half the world will be myopic by 2050.¹⁶ Hyperopia is thought to be genetic and can delay visual development. It is a significant risk factor for strabismus and amblyopia. Astigmatism is mainly caused by an excessive corneal curvature. RE commonly coexists with other paediatric eye disorders. Therefore, the management and treatment of RE should be the initial strategy for all eye conditions.^{2,13} The main focus of RE prevention lies in preventing myopia and reducing

Table 4: Specific interventions to prevent refractive error.

Type of prevention	Specific interventions
Primary prevention	Public awareness campaigns targeted at parents of young children. Ministry of Education policy changes about outdoor time at schools and minimising near activities (or following the 20/20/20 rule) for children. Such outdoor time of course requires appropriate sun protection (shade cover, hats and sunblock etc) for some of the year.
Secondary prevention	Screening: Add an autorefractor to the Year 7 (age 11–12) vision and hearing technician school vision check to detect and refer early myopia to appropriate clinics.
	Screening and early optometry care: Provide broader public funding to improve access to glasses and optometry care (especially for more deprived communities).
	Family history of refractive error is to be actively sought by general practitioners, paediatricians, midwives and Plunket nurses.
	Provision of funding by Pharmac for appropriate provision of atropine eyedrops, which are proven to slow myopia progression. ¹⁶
	Support the New Zealand Association of Optometrist's recommendation for enabling funding of MiYOSMART and Stelless myopia-prevention spectacles. ²
Establish publicly funded optometry care (for example, at public hospitals or via funding contracts for community optometrists) to actively manage children with progressive myopia.	
Tertiary prevention	Referral to Blind and Low Vision Education Network New Zealand to reduce the impact of disability.

the prevalence of this condition. We summarise potential interventions in Table 4.

Amblyopia

Amblyopia can be caused by uncorrected RE, strabismus or deprivation. A 2022 review of 97 studies, including 4,645,274 children and 7,706 with amblyopia, reported an overall worldwide pooled prevalence of amblyopia of 1.36%.¹⁷ The only New Zealand data detected a prevalence of 1.8%.¹⁸ The *National Vision and Hearing Screening Protocols*, updated in 2021, specify the training and procedural requirements for vision-hearing technicians responsible for conducting childhood vision screening during the B4 School Check for 4–5-year-old children.¹⁹ The uptake of such screening in New Zealand is 92%.¹⁹ The long-term functional impacts of living with amblyopia are limited, and the main consequence of childhood amblyopia is bilateral vision impairment if loss of vision in the better eye occurs. Two New Zealand studies have shown a low positive predictive value (31%) but also a high negative predictive value (98%) for screening, so there is scope for optimising the prevention of childhood amblyopia. Firstly, the uptake of New Zealand screening should be increased to match the rates of 99% in Europe. Secondly, the screening protocol could be refined to target the detection of amblyopia with visual acuity of 6/15 or worse, as individuals with 6/12 vision in an amblyopic eye generally retain sufficient visual function for driving, employment and everyday tasks. Thirdly, it is important to ensure that bilateral amblyopia,

representing roughly 6% of all cases, is reliably detected across all screenings. The revised 2021 national protocol supports the adoption of an automated refraction device, which will contribute to improved outcomes.²⁰ To reduce the prevalence of this condition, we summarise potential interventions in Table 5.

Keratoconus

Keratoconus is characterised by progressive corneal thinning and protrusion, leading to irregular astigmatism and visual impairment. It is a bilateral, asymmetrical disease that develops during or before puberty.²¹ As keratoconus ectasia progresses, vision correction requires glasses, specially fitted (and expensive) contact lenses and, potentially, corneal transplant surgery. The prevalence is estimated at 1.38 per 1,000 people globally.²² In Wellington high school students, keratoconus affected one in 45 Māori students, compared with one in 191 New Zealand European adolescents. This study also found that eight out of 10 individuals with keratoconus identified by screening were unaware they had this condition and thus were not actively seeking appropriate care.²³ Therefore, in New Zealand, we have substantially higher rates, with an overall prevalence of 5.2 per 1,000 and up to 22.2 per 1,000 among our Māori population. Multiple New Zealand studies have demonstrated that Māori and Pacific people have a higher prevalence of keratoconus, present with more severe disease and have a more rapidly progressing disease form.^{23,24} As a result, New Zealand has the highest proportion of corneal transplants for

Table 5: Specific interventions to prevent amblyopia.

Type of prevention	Specific interventions
Secondary prevention	Screening: Increase the uptake of vision screening at the B4 School Check. ¹⁹
	Further optimise the screening protocol to only detect amblyopia of 6/15 or worse.
	Use an autorefractor in the screening process to better detect amblyogenic factors and bilateral amblyopia.
	Early treatment of amblyopia with patching, optical penalisation and/or atropine eye drops.
	Prompt management of amblyogenic risk factors including strabismus surgery and refractive error within the amblyogenic time frame.
	Improve public funding of patches and spectacles to improve access, especially in deprived populations.
Tertiary prevention	Referral to Blind and Low Vision Education Network New Zealand to reduce the impact of disability.

Table 6: Specific interventions to prevent keratoconus.

Type of prevention	Specific interventions
Primary prevention	Consideration of educational campaigns targeted at parents and teachers around children minimising eye rubbing and having any allergic eye disease appropriately managed (including lifestyle measures and the use of olopatadine eye drops).
Secondary prevention	Screening: Add an autorefractor and corneal topography to the Year 7 (age 11–12) vision and hearing technician school vision check to detect and refer early keratoconus.
	Public funding to improve access to optometry assessment for those identified as at risk for keratoconus by parents, school teachers or general practitioners, especially those in deprived communities.
Tertiary prevention	Improve access to prompt tomography diagnosis and corneal cross-linking.
	Referral to Blind and Low Vision Education Network New Zealand to reduce the impact of disability.
	Use of the Aotearoa Research Into Keratoconus registry to ensure high-quality management of cases.
	Increase awareness among health workers of corneal donor (tissue donors) impact and need.

keratoconus among the Organisation for Economic Cooperation and Development (OECD) countries.²⁵ To prevent vision loss and decrease disease burden, timely diagnosis and management of keratoconus are crucial. Early detection with diagnostic imaging modalities, such as corneal topography or tomography, leads to early intervention in the form of corneal cross-linking, which is effective at stopping the progression of ectasia. A Cochrane review found an 80–90% relative risk reduction in progression over 12 months following corneal cross-linking.²⁶ This intervention is also cost effective.²⁵ We propose a targeted screening programme for keratoconus in New Zealand for high-risk populations. Automated refraction and corneal topography could easily be incorporated into the National Vision and Hearing Screening Programme for children in Year 7 (ages 11 and 12). Further screening should be undertaken in the later teen years to rescreen for new cases of keratoconus. Several pilot studies are currently underway in New Zealand to identify the most cost-effective screening methods. To reduce the prevalence of this condition, we summarise potential interventions in Table 6.

Genetic eye diseases

Genetic eye diseases are now a leading cause of childhood blindness. Their impact on vision ranges from mild (particularly in carriers) to bilaterally blinding, and they may be associ-

ated with systemic syndromic manifestations. Hereditary eye conditions include congenital cataracts, congenital glaucoma, inherited retinal dystrophies, retinoblastoma (RB), optic atrophy and eye malformations (including corneal opacities), along with other rarer conditions. The main inherited retinal dystrophies are retinitis pigmentosa (54%), Stargardt disease (12%) and macular dystrophy (8%), as highlighted in a 20-year retrospective observational study in Western Australia.²⁷ RB is a malignant ocular tumour with an incidence of 1/18,000 live births. With early detection, survival rates for RB are more than 95%, but it can be associated with significant visual impairment post-treatment.⁸ Preventive measures for genetic eye disease in New Zealand include genetic counselling for affected people considering their pregnancy options and pre-implantation genetic testing to select embryos that do not carry the gene for the disease. Early diagnosis, counselling and support are essential for people who are carriers of genetic disease or parents of children born with genetic eye disease. Ophthalmology is leading human genetic therapies with approximately 10 approved genetic eye therapies worldwide, and the first New Zealand child was treated recently with Luxturna.²⁸ To reduce the prevalence of these conditions, we summarise potential interventions in Table 7.

Table 7: Specific interventions to prevent genetic eye diseases.

Type of prevention	Specific interventions
Primary prevention	Genetic counselling for affected individuals to inform their decisions about future pregnancies.
	Education on consanguinity.
	Access to in vitro fertilisation and pre-implantation screening.
	Germline therapy.
Secondary prevention	Prenatal diagnosis, allowing counselling and consideration of termination of pregnancy.
	Early diagnosis with routine red reflex assessments at birth and 6 weeks. ²⁹
	Early treatment of affected infants/children.
Tertiary prevention	Referral to Blind and Low Vision Education Network New Zealand to reduce the impact of disability.
	Inform parents of available national and international support groups.
	Patient enrolment to the New Zealand national Database of Inherited Retinal and Optic Nerve Disease, which can offer the option to participate in genetic studies and therapies. ³⁰

Infectious eye diseases

The most significant advance in paediatric ophthalmology in the twentieth century was childhood vaccination. The following infections can all result in visual impairment or blindness; however, vaccines are available to prevent their occurrence. These are mainly but not limited to rubella (congenital cataract, keratitis, Fuchs heterochromic iridocyclitis, glaucoma); measles (keratitis, uveitis, optic neuritis); mumps (keratitis, retinitis, optic neuritis); *Corynebacterium diphtheriae* (corneal scarring); *Streptococcus pneumoniae* (keratitis, endophthalmitis); *Neisseria meningitidis* (conjunctivitis, endophthalmitis); *Haemophilus influenzae type b* (orbital cellulitis, uveitis, vaso-occlusive retinal vasculitis, neuroretinitis, exudative retinal detachment, optic neuritis); varicella and herpes zoster (keratitis, uveitis, chorioretinal scars).³¹ The recent measles outbreak in Samoa and New Zealand highlights the need for ongoing and widespread emphasis on vaccination requirements. This has become an increasing challenge since the COVID-19 pandemic and the rise of anti-vaccine ideology. To reduce the prevalence of these conditions, we summarise potential interventions in Table 8.

Eye trauma

It is estimated that each year, 3.3–5.7 million eye injuries affect children worldwide.³² In 2019, the New Zealand childhood ocular trauma study determined an incidence of 719 cases per 100,000 children per year.³³ This study also highlighted that they occurred more commonly in males (63.2%), between the ages of 0 and 4 years (30.7%) and among those of New Zealand European ethnicity (60.8%). These injuries predominantly involved being “struck by an object” (53.7%), were typically in the home setting (50.9%) and reported protective eyewear use was very low at the time of injury (2.7%). Around one-fifth of cases (19.7%) admitted for tertiary assessment and treatment had final visual outcomes that were 6/12 or less, and Māori and Pacific people were over-represented in that category.³³ To further compound these statistics, up to 90% of ocular traumas are preventable. Prevention strategies, such as parental education, legislation (e.g., restriction on sales of hazardous toys and lasers) and the introduction of eyewear protection (e.g., for sporting activities, especially cycling, football and ball sports) effectively reduce the incidence of ocular trauma.³² RANZCO also recommends developing and

Table 8: Specific interventions to prevent infectious eye diseases.

Type of prevention	Specific interventions
Primary prevention	Promote and provide ready access to vaccination to increase coverage levels of all childhood vaccines. Elimination of some of these diseases is feasible (e.g., measles, mumps, rubella and <i>H. influenzae</i> type b).
	Prompt and effective control of outbreaks (e.g., measles, meningococcal disease outbreaks) if these arise.
Secondary prevention	Prompt identification and treatment of cases may reduce the risk of sequelae (e.g., early antibiotic treatment for meningococcal disease).
Tertiary prevention	Referral to Blind and Low Vision Education Network New Zealand to reduce the impact of disability.

Table 9: Specific interventions to prevent eye trauma.

Type of prevention	Specific interventions
Primary prevention	Mass media campaigns (e.g., funded by Accident Compensation Corporation [ACC]) to promote avoidance of hazardous situations for eye injury and to promote increased use of protective eyewear.
	Legislation to prevent the sale of high-risk toys, lasers and fireworks.
	Legislation to require eye protection use during specific sporting activities such as cycling, football and ball sports.
	Public funding of protective eyewear (e.g., from ACC).
Secondary prevention	Prompt and effective treatment to maximise recovery and minimise the risk of sequelae.
Tertiary prevention	Referral to Blind and Low Vision Education Network New Zealand to reduce the impact of any disability.

implementing a national strategy and awareness campaign to prevent ocular trauma.² To reduce the prevalence of ocular trauma, we summarise potential interventions in Table 9.

Conclusions

While less common than adult blindness, childhood blindness in New Zealand has a significant burden in terms of the total burden of blind years. Many prevention strategies must be initiated well

before vision loss occurs, and ophthalmology care can typically only prevent the worsening of vision rather than the restoration of vision. Ophthalmologists and RANZCO must continue to actively collaborate with obstetricians, paediatricians, general practitioners, optometrists, national screening units, vaccination programmes, epidemiologists and Health New Zealand – Te Whatu Ora to promote primary prevention strategies and improve visual outcomes for our tamariki.

COMPETING INTERESTS

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