ECONOMIST IMPACT

Vision for change: Meeting the growing demand for eye care

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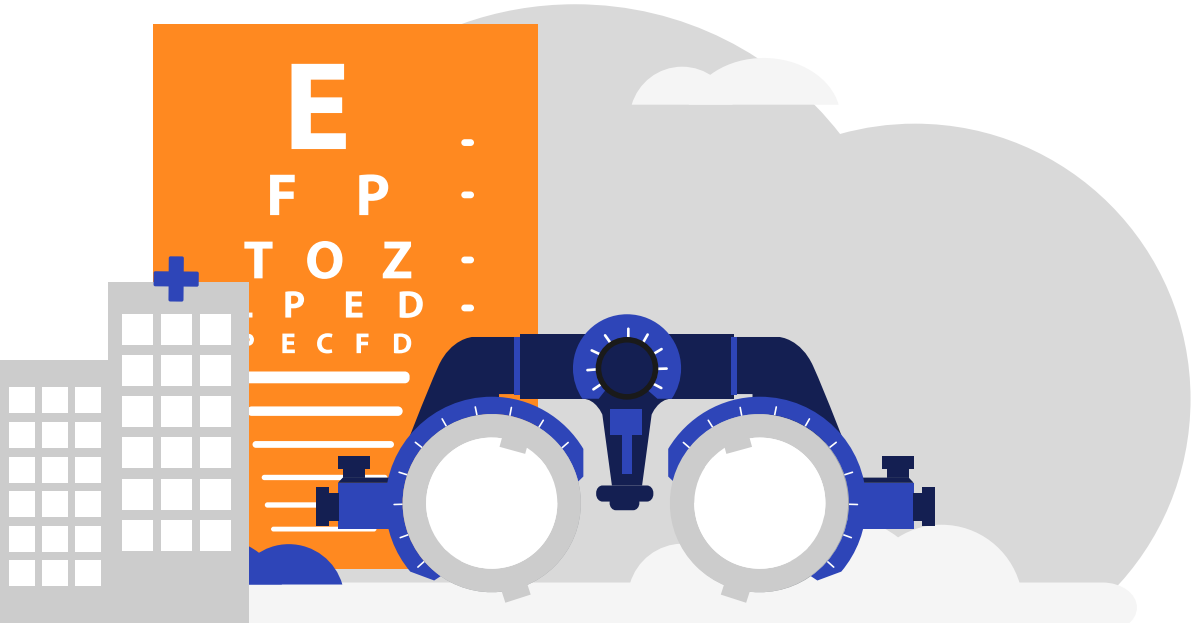


Executive Summary

Vision loss is the third-largest global impairment after anaemia and hearing loss in terms of the number of people affected worldwide.[2] Almost 300m people experience moderate to severe vision impairment and an additional 43m are classified as blind. By 2050 these numbers are expected to increase to 474m and 61m respectively.[3] In western Europe, cataracts, age-related macular degeneration (AMD), glaucoma and diabetic retinopathy (DR) are the main eye diseases (they account for more than half of all cases of blindness), particularly among those aged 50 or older.[4] More specifically, AMD and diabetic macular edema (DME), a complication of DR, are the leading causes of vision loss in developed countries. This calls for a targeted approach.[5, 6]

In 2013 the World Health Organisation (WHO) launched the Global Action Plan towards Universal Eye Health, which outlined a global target for a 25% reduction of avoidable vision loss in adults over 50 by 2019.[7] Unfortunately, this target was not achieved, as many health systems struggled to keep pace with rising demand and inadequate resources. In July 2021 the 193 UN member countries unanimously adopted an agreement to target eye care for all by 2030, firmly placing eye health in the UN's Sustainable Development Goals.[8] This Economist Impact white paper examines the global burden of vision loss across key conditions, the causes and consequences of inadequate care now and in the future, and the most promising solutions. Key findings include:

- **AMD and DR are two of the leading causes of visual impairment and prevalence is set to grow in the future, taking an unequal toll** (on people living with the diseases, and their families and loved ones) based on socio-economic factors**.** Women are more affected than men, and the poorest in society are more likely to suffer adverse outcomes due to lack of access to timely, high-quality care. By 2040, population ageing could lead to 288m people being affected by AMD (compared with 170m in 2014); likewise, incidence of DR will increase, taking a heavy toll on individuals, their families and loved ones, and wider society.[9]

- **Health systems are presently not able to meet the demand for eye care, and demand is expected to increase exponentially, particularly as new therapeutic modalities arise.** The majority of vision loss can be prevented or treated, yet access to appropriate support is constrained. Factors include a shortage of eye care specialists; regional inequality in service provision, with rural areas in particular lagging; poorly integrated health systems for diagnosis and referral; high financial cost of care for people affected; treatment intensity of available therapies; lack of public awareness about eye health; and long waiting lists. If these factors are not addressed the chasm between need for and access to care will grow.

- **Treatment burden for many people with AMD and DR is significant and can lead to suboptimal outcomes if patients are unwilling or unable to adhere to multiple clinic visits and treatments such as intraocular injections**. This presents an opportunity to partner with industry to devise innovations that reduce treatment burden. For people who have to endure ongoing treatment through multiple courses of injections into the eye of anti-VEGF or other medications over several years, frequent visits can prove costly and burdensome, particularly for those from rural areas or a lower socioeconomic background, raising barriers to completion of treatment. This burden extends to family members who need to accompany patients to their appointments and care for them. Patients who drop out of such long term treatment can experience disease progression and vision loss for which care can be more costly, further placing strain on providers. Reasons for dropping out include costs, treatment fatigue, which reduces compliance, but the end result is advanced disease and increased risk of comorbidities.
- **Reducing the number of clinic visits due to less frequent introcular injections for retinal conditions may relieve capacity constraints across ophthalmology services and free up time for the growing demand of eye care.** This may also be achieved through bolstering primary care and the number of non-medical healthcare practitioners (HCPs) who can provide treatments, freeing up time for ophthalmologists to handle more complex conditions. International guidelines recommend the use of intravitreal anti-VEGF intraocular injections as a first-line therapy for neovascular non-age-related macular degeneration and diabetic macular edema (DME). Vision gains seen early on in treatment of such conditions are frequently not maintained, as treatments require multiple, frequent injections and monitoring visits that may become a burden for many. Alternative treatments, which reduce the number of visits through longer-lasting medications, are being explored.
- **Action is needed to tackle preventable sight loss in keeping with the UN General Assembly resolution on vision**. There are disparities in access to care that are dependent on socioeconomic backgrounds: those who can afford to pay out of pocket can jump the queue to access care in a timely fashion while those who cannot are forced to wait for increasingly longer periods of time owing to demand for services. Access also varies based on geographic location, with ophthalmology services often clustered in urban regions, forcing those living in rural areas to travel greater distances or forego treatments. In the resolution unanimously adopted by UN member countries in 2021, a target to achieve eye care for all was set for 2030.

Interview list

Doug Earle, president and CEO, Fighting Blindness Canada

Peter Holland, chief executive, International Agency for the Prevention of Blindness, United Kingdom

Jacinto Zulueta, co-founder and president, Macula Retina Association, Spain

Dr Jaimie Steinmetz, managing research scientist, Institute for Health Metrics and Evaluation, University of Washington, US

Dr João Furtado, associate professor of ophthalmology, Ribeirão Preto Medical School, University of São Paulo, Brazil

Professor Ningli Wang, director, Beijing Tongren Eye Centre, China

Robert Layman, president, the American Optometric Association, US

Introduction

Vision loss is the third-largest global impairment after anaemia and hearing loss when measured by disability-adjusted life years (DALYs), a disease burden indicator that reflects years of healthy life lost due to disease.[2] Almost everyone, at some point in their lifetime, will experience impaired vision or an eye condition that will require some sort of eye care.[1] In 2013 the World Health Organisation (WHO) launched the Global Action Plan towards Universal Eye Health, which outlined a global target for a 25% reduction of avoidable vision loss in adults over 50 by 2019.[1] Unfortunately, this target was not achieved as health systems struggled to keep pace with the growing disease burden. Demand for eye care will rise in the next decade due to ageing populations and the resulting spike in chronic diseases. In a move determined to tackle preventable vision loss, in July 2021 all 193 UN member states unanimously adopted an agreement to target eye care for all by 2030, firmly placing eye health in the scope of the UN's Sustainable Development Goals.[8]

This Economist Impact white paper, drawing from extensive desk research and an expert interview programme, analyses the global challenge of vision loss, the pressures facing health systems—now and in the future, with examples from 11 countries (Australia, Brazil, Canada, China, France, Germany, Italy, Spain, Switzerland, the UK and the US)—and the innovations and ideas that can transform patient care. It seeks to engage healthcare stakeholders on the current landscape relating to ophthalmic services, and explore policy gaps, opportunities for action and global recommendations for the future of ophthalmic practice.

Vision loss: A global view

In 2020, 43m people worldwide were deemed blind—defined as vision acuity less than 3/60 Snellen or corresponding visual field loss in the better eye with despite best possible correction refractive/spectacle.[10] Another estimated 596m were diagnosed with a distance vision impairment and over a half a billion had a near vision impairment. Figure 1 outlines at what life stage various eye ailments can become a risk and what factors can put someone at risk.

Demographically, women are slightly more affected than men (55% of people with vision loss are female), and children and older people are particularly affected. Rural populations and ethnic minority groups are also more likely to develop a visual impairment.[11] In western Europe, more than 1m citizens are blind and 3m-10m people over the age of 40 live with a visual impairment.[4]

The prevalence of blindness and vision loss has increased globally since 1990. Figure 2 shows data for the epidemiological burden of vision loss in the US, UK, Germany, Spain, Italy, France, Brazil, China, Canada, Australia and Switzerland from 1990 to 2019. By 2050 the effects of an ageing population could lead to an estimated 895m people being affected by distance vision impairment, of whom 61m would be blind.[2]

Figure 1: Life course perspective on eye health.[1]

Arrows indicate the period in the life course in which different conditions typically present. The yellow line indicates a hypothetical functional vision trajectory of someone with a condition leading to increased vision impairment. The black line represents the functional vision trajectory of someone who does not have a condition leading to vision impairment. The disability threshold represents the level of functional vision below which there is functional vision impairment.

Life course stage	Before birth	Childbirth	Childhood	Adolescence	Adulthood	Older life
Biological determinants	• Genetic determinants • Maternal nutrition • Maternal vaccination • Intrauterine infections • Intrauterine growth restriction	• Premature birth • Low birth weight • Infection • Birth injury	• Genetic determinants • Infection • Nutritional deficiencies	• Genetic determinants • Infections • Trauma	• Genetic determinants • Diabetes • Trauma • Infection	• Ageing • Genetic • determinants • Diabetes • Trauma • Infection
Social and environmental determinants	• Poverty • Access to health care • Maternal education • Maternal health care • Maternal smoking	• Poverty • Access to health care • Maternal education • Maternal health care • Obstetric health care	• Poverty • Access to health care • Education • Nutrition • Environment and activity	• Poverty • Access to health care • Education • Nutrition • Environment and activity	• Poverty • Access to health care • Education • Nutrition Occupational hazards	• Poverty • Access to health care • Education • Nutrition
Conditions (onset)						
Cataract			→		→	→
Refractive error			→	→	→	
Glaucoma			→		→	→
Diabetic retinopathy					→	→
Age-related macular degeneration					→	→
Trachoma or cornea opacification			→	→	→	→
Congenital conditions	→	→	→			
Functional vision			Disability threshold			
	Crucial period	Crucial period	Crucial period	Sensitive period		

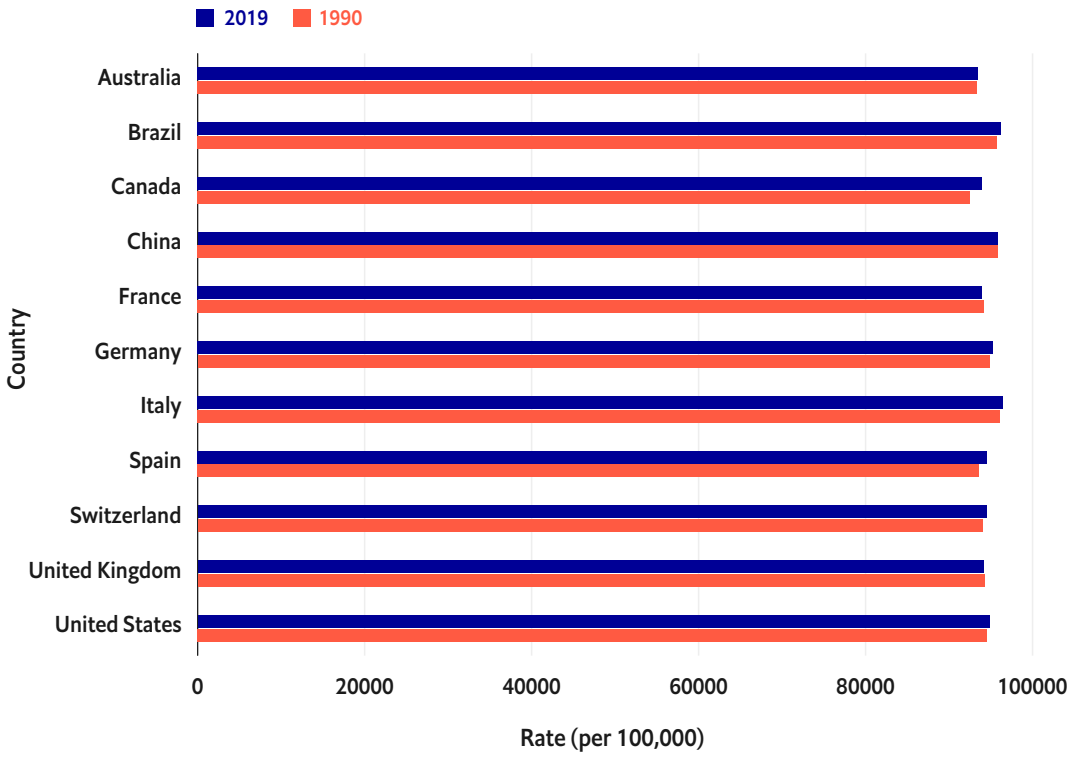
Source: Burton et al, 2021.

The leading global causes of blindness in those aged 50 years and older in 2020, shown in Figure 3, were cataracts (15.2m cases), followed by glaucoma (3.6m cases), under-corrected refractive error (2.3m cases), age-related macular degeneration (AMD; 1.8m cases) and diabetic retinopathy (DR; 0.86m cases). Leading causes of moderate to severe visual impairment (MSVI) were under-corrected refractive error (86.1m cases) and cataract (78.8m cases).[11] In developed countries, AMD and diabetic macular edema (DME) are leading causes of vision loss; in the case of DME, this is particularly true among working-age adults.[5, 13]

Demographic shifts, including population ageing and changes in lifestyle factors, are driving an increased prevalence of some blindness-related comorbidities, further increasing the burden of vision loss. One of the most common of these is diabetes mellitus, complications of which include DR and DME. As diabetes becomes increasingly endemic in parts of the global population, the resulting increases in DR and DME prevalence will weigh increasingly heavily on health systems.

In western Europe, cataracts, age-related macular degeneration, glaucoma genetic conditions and diabetes are leading causes eye diseases. Such matters account for more than half of all cases of blindness, and the impact is particularly pronounced among those aged 50 or older.[4]

Figure 2: Global burden of vision loss, 1990 and 2019[12]



Source: IHME, 2019.

Socioeconomic and personal burden

Vision loss and blindness cause significant disability and economic burden. Approximately 90% of those with visual impairment live in low-income settings, regardless of whether in high-income countries or low- and middle-income countries (LMICs).[11] The prevalence of avoidable vision loss varies according to socioeconomic status within countries, particularly those with growing gaps in wealth and education such as China.[14]

At an individual level, vision loss can have consequential effects. In adults, it can affect a person's ability to work, including impacts on productivity and output. In 2020 the excess societal costs related to blindness due to AMD, DME and proliferative diabetic retinopathy in the US were US$20bn, a number that is expected to triple by 2050. Societal costs were calculated based on direct costs such as medical services and indirect costs such as reduced work productivity and informal care costs, as well as quality adjusted life year loss per blind patient.[15] A similar burden has been reported in Europe, although data are less recent: in 2016 the total direct and indirect costs due to AMD (there was a lack of comparable DME data) were an estimated €89.5bn annually, ranging from €282m in Slovenia to €3.3bn in Poland.[16]

Managing visual impairment is a major public health challenge; beyond costs associated with visual impairment and blindness and its personal impact, individuals are at risk of physical injuries, social withdrawal and chronic health comorbidities such as depression. For instance, the prevalence of depressive symptoms such as low mood and anhedonia (loss of pleasure) in visually impaired individuals ranges from 14% to 44%.[17-19] All of these comorbidities carry an increased need for the healthcare resources of an already strained system.

Treatment burden

Historically, effective treatment for DME and neovascular macular degeneration (nAMD), a less common form of AMD, include inhibitors to vascular endothelial growth factor (anti-VEGF) A and bi-specific (or combined) inhibition of VEGF-A and Ang-2. VEGF-A is a compound that plays a major role in the growth of abnormal blood vessels that characterise many retinal disorders, including nAMD and DME.[20] The treatment involves an injection of anti-VEGF medication into the vitreous cavity of the eye using a fine needle in a procedure that takes five to seven minutes, although the injection itself is over in less than 20 seconds. The patient normally lies or is seated comfortably while anaesthetic and antiseptic agents are applied before the intravitreal injection is administered. Most patients will need a loading course of three such injections spaced at regular, usually, four-week intervals and treatment intervals are then extended gradually based on disease activity.[21]

Despite the advent of anti-VEGF treatment, which is transformative for patients, visual gains in the real world are often hard to maintain owing to the ongoing burden of treatment. For many affected people, barriers to treatment include lack of access, cost, fear and the requirement of recurrent treatment. Some may also not want to burden relatives or caregivers by requiring them to transport them to every appointment, thus they do not continue with treatment. For many people, access to ophthalmic care is a big impediment, particularly among those who live in rural settings.[23] When people are able to get to the ophthalmologist, some fear the examination and/or necessary treatment, which presents a barrier: studies show that intravitreal injections have lower compliance rates, resulting from the frequency of clinic visits, fear of injections, an overall lack of understanding of the eye disease process and the resulting knock-on effect of suboptimal clinical outcomes.[24]

In the US, people needing intravitreal injections were more likely to miss visits, which could result in decreased injection frequency, potentially leading to gradual decline in visual acuity over time.[25] Similar patterns have been reported in the UK.[26] If the durability of current treatments can be increased, it may improve adherence to therapy, thereby improving clinical outcomes. Furthermore, more durable intravitreal anti-VEGF injection medications would be likely to decrease the burden on people, their families and loved ones, and health systems. As each intravitreal injection is associated with potential intraocular inflammation/infection as well as discomfort, any reduction in injection frequency requirements is welcomed from an economic and patient safety basis. Less frequent travel for intravitreal injections is also likely to reduce the carbon footprint of such care.

Treating cataracts often includes surgery. This takes an hour or less and patients see improvements within days of cataract surgery, a procedure that has been revolutionary in restoring vision loss for patients.[27] Although that significantly improves quality of life, it requires a specialist, many of whom tend to work in larger hospitals located in cities. Research showing the relationship between healthcare coverage and access to cataract surgery highlights a need for broad coverage of surgical treatment within social and private insurance provision, particularly as some reports suggest that around 40% of patients require surgery for both eyes.[28, 29] Treatment of uncorrected refractive error involves corrective spectacles or contact lenses. Refractive surgery is a potential option for some people. Corrective contact lenses and glasses may need to be replaced often, which can be costly and burdensome for people. Corrective refractive eye surgery, known as corneal laser refractive surgery, is rarely covered by universal or private health insurance and can be costly; often it is only an option for those who can afford it.

For people living with open angle glaucoma, treatment can require , in a stepwise manner, medication, specialist laser in a stepwise manner, specialist laser treatment, incisional surgeries and/or stents. Some of these treatments can be expensive and usually require lifelong ophthalmology care and expense. People living with or at risk of narrow angle glaucoma are often treated with laser iridotomy, a form of laser treatment.

Attitudinal and literacy barriers

Health attitudes and behaviours relating to eye health are often suboptimal in the general population. A recent large-scale worldwide survey found that while 80% of respondents view eye exams as important, less than half undertake them regularly.[30] Even more concerning is that almost 30% of survey respondents were more concerned about the appearance of their eyes than eye health. Other problematic attitudes persist, such as adults who find ways to compensate for poor health or accept poor vision as an inevitability of the ageing process, or those who allow cultural stigmas around wearing glasses to prevent them seeking help. In children there is the added problem of them not noticing that their vision might not be as good as their peers.[31] In all of these instances, the patient-doctor relationship and patient awareness are important drivers of accessing care, as they help to inform patient expectations about eye health and treatment.

Burden

Global prevalence of cause-related conditions for blindness and vision loss

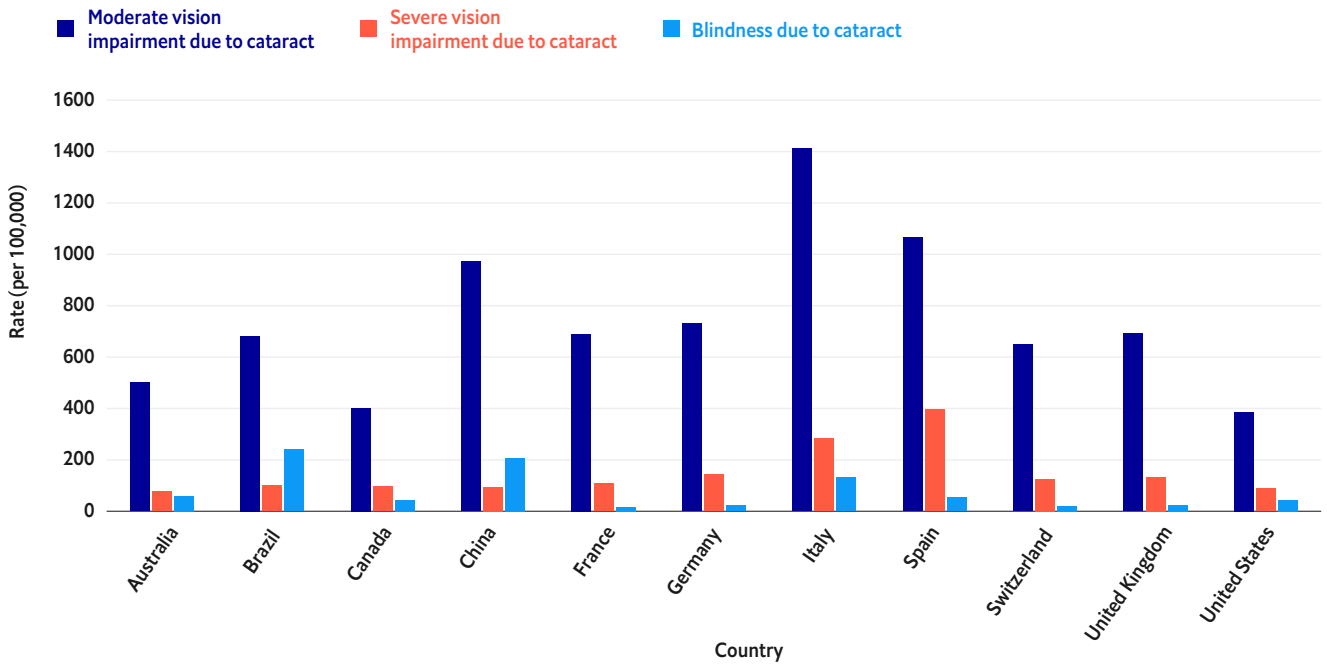
This section analyses the main causes of blindness and visual impairment —defined as Snellen visual acuity of between 6/18 to 6/60 for moderate impairment and of 6/60 to 3/60 for severe impairment—focusing on cataracts, glaucoma, AMD, uncorrected refractive errors and DR.[32]

Cataracts

Globally, cataracts remain the leading cause of blindness and the second leading cause of moderate and severe vision impairment. Cataract affects more than 100m people, including 17m who are blind.[33] Italy, Spain and China have the highest prevalence of moderate vision impairment attributed to cataracts, while Spain and Italy have the highest prevalence of severe vision impairment. Blindness due to cataract was less prevalent than MSVI across all 11 countries. The highest levels of prevalence of blindness were recorded in Brazil, China and Italy. Indeed, Italy has the highest prevalence of blindness from cataract among OECD countries, with one older paper suggesting that the rates of cataracts are highest in the older population who neglect vision loss and fail to seek surgical treatments owing to perceived risks of surgery and perceived inconvenience of temporary hospitalisation.[33-35]

One study notes an 89.4% increase in disability globally owing to cataracts, which varied with socioeconomic status, gender and age.[2] Older age is a casual factor for cataracts. Therefore, as population ageing accelerates substantially in the coming years, the number of people with cataracts—and demand for cataract services—is expected to increase.[33] Ways to prevent cataract blindness include timely identification of at-risk populations, identifying populations for cataract surgery and increasing cataract surgery rates.[36]

Figure 3: Global prevalence of cataract-related vision loss in 2019[12]



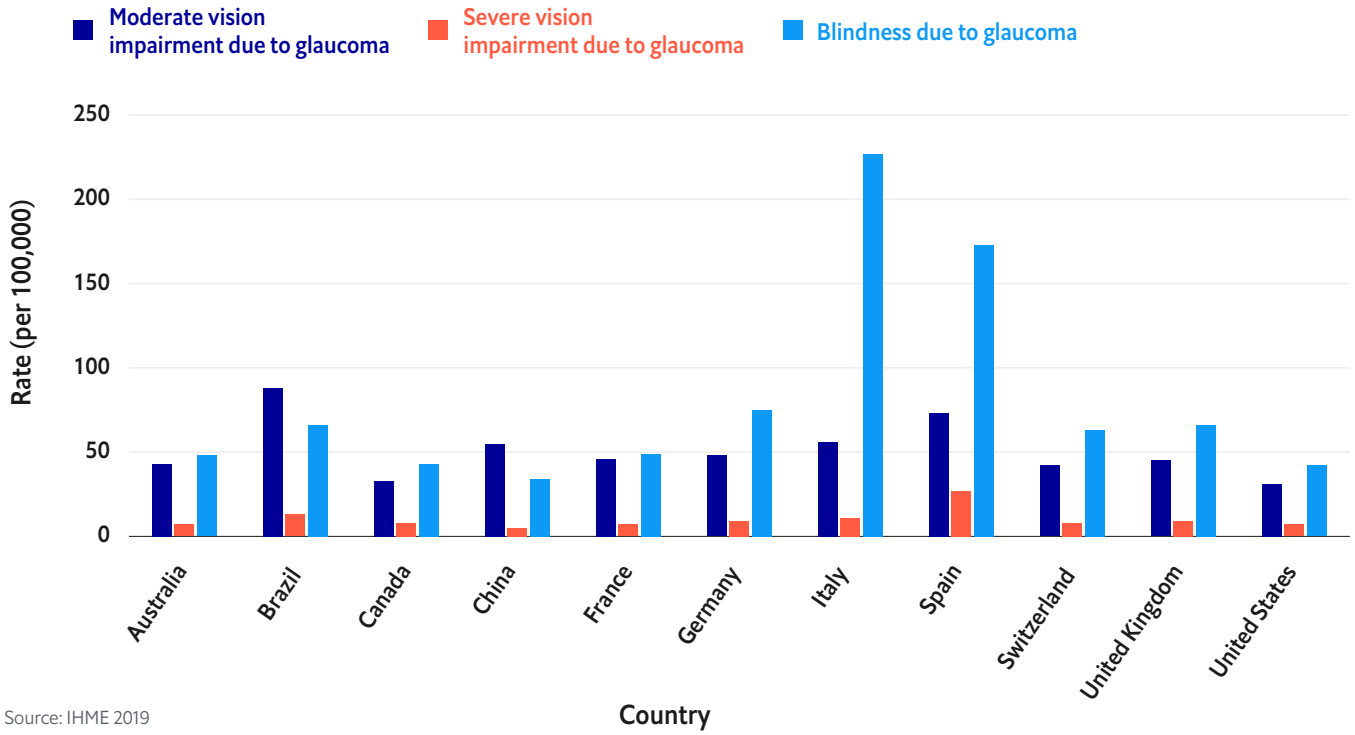
Source: IHME, 2019

Glaucoma

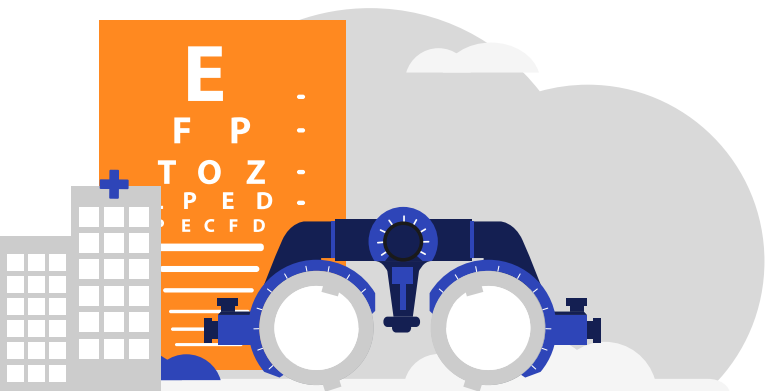
Second to cataracts among leading causes of blindness worldwide, glaucoma poses a significant ocular public health concern, as blindness from glaucoma is most often irreversible. Estimates suggest that 57.5m people are affected worldwide by the more common form of the disease, primary open-angle glaucoma.[37] This number is expected to grow to 111.8m by 2040, with Asia having the largest number of people affected.[38] According to 2019 data, blindness due to glaucoma is most prevalent in European countries, with Italy and Spain having the highest prevalence of blindness (see Figure 4). In comparison, moderate vision impairment is more prevalent in Brazil and China.

There is presently no cure for glaucoma and treatment is lifelong. This places a heavy burden on health systems. In the US, it is estimated that glaucoma costs US$1.9bn in direct costs and US$600m in indirect costs.[39] In China, costs for glaucoma drugs have increased from Rmb2.33m-3.95m (US$330,000-560,000) in 2017.[40] Differences in socioeconomic status, geographical location and gender influence access to treatment.[41]

Figure 4: Global prevalence of glaucoma-related vision loss in 2019[12]



Source: IHME 2019

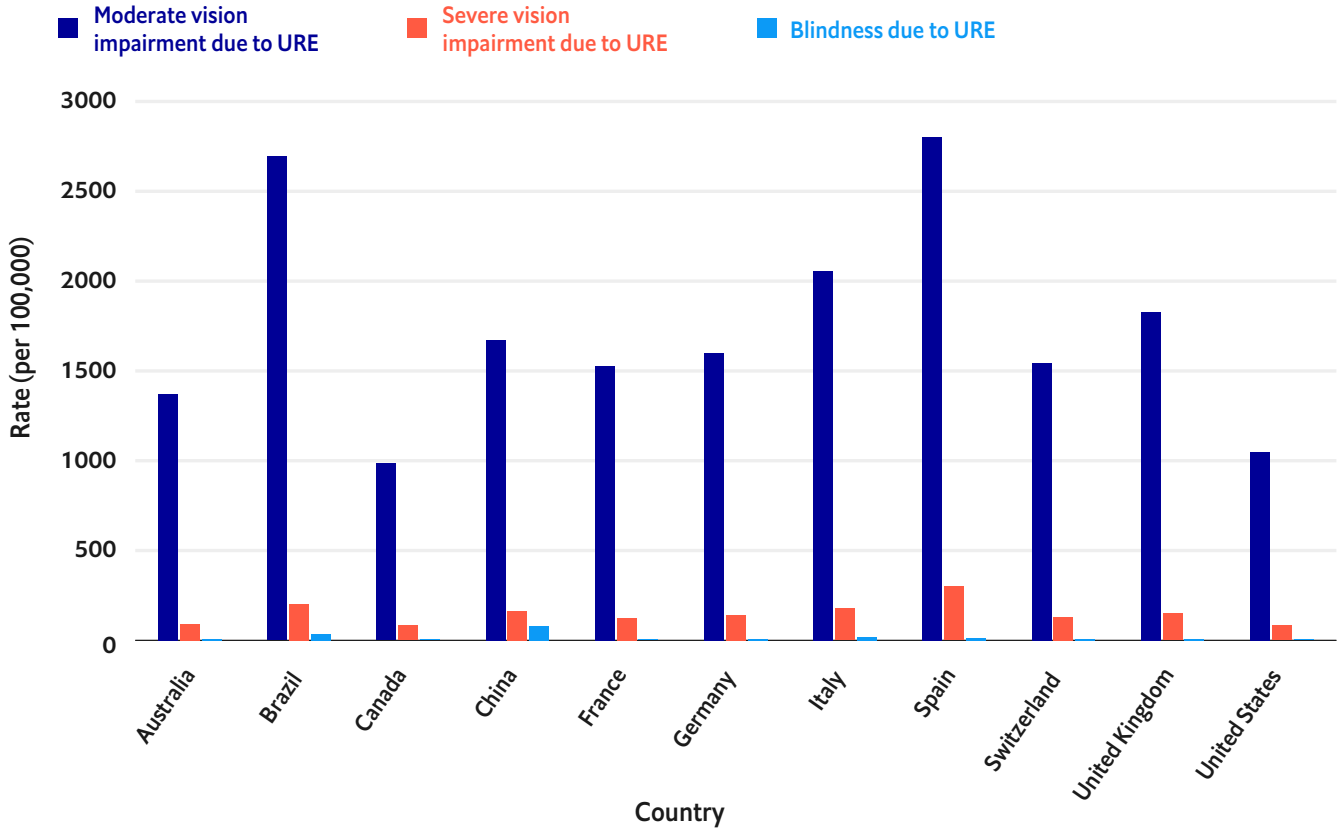


Uncorrected refractive error (URE)

The most common refractive disorders—and the leading causes of vision impairment worldwide—include myopia (short-sightedness), hyperopia (far-sightedness), presbyopia (age-related far-sightedness) and astigmatism. A study found that between 2000 and 2020 the prevalence of blindness or vision loss due to uncorrected refractive error (URE) increased by 22% and 72% respectively. Figure 5 shows that moderate vision impairment is the most common consequence of URE in the countries of interest for this study, with Spain, Brazil and Italy having the greatest prevalence of MSVI and China having the most cases of blindness. The US and Canada have the least prevalence of vision loss due to URE.

Visual impairment from uncorrected refractive errors is preventable. Regular visits to an optometrist are vital. Treatments include spectacles/eyeglasses, contact lenses and corneal refractive surgery. Investing in services to prevent URE could create a global savings of US$202bn to the global economy.[42]

Figure 5: Global prevalence of URE-related vision loss in 2019[12]



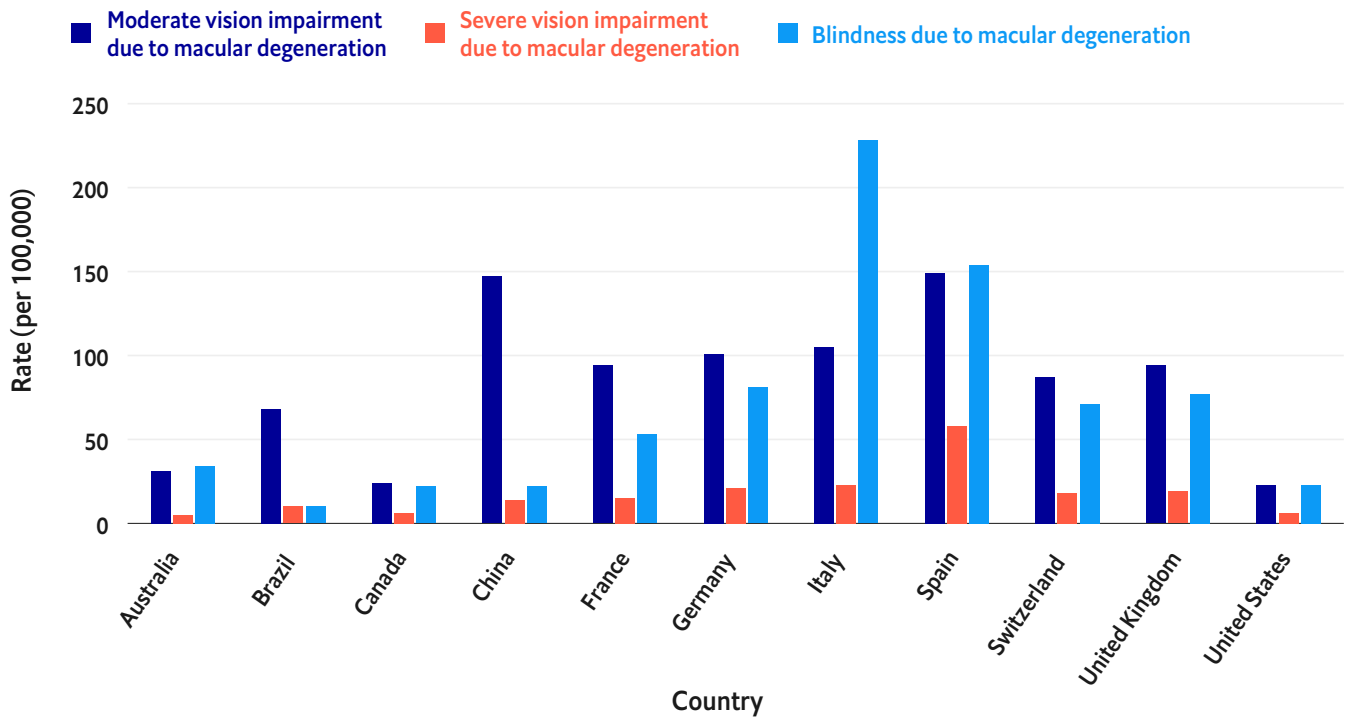
Source: IHME 2019

Age-related macular degeneration (AMD)

AMD is a chronic, progressive degenerative disease of the retina. It represents the leading cause of blindness in high-income countries. There are two types of AMD: dry, which is more prevalent, and wet or neovascular (nAMD), which is less common but more advanced and depletes vision quicker. Dry AMD happens in three stages (early, intermediate and late) and progresses slowly over many years; there is currently no licensed treatment for dry AMD. nAMD is defined by choroidal neovascularization (CNV), which causes bleeding, accumulation of fluid and fibrosis of the macula, the most photosensitive area of the retina.[43, 44] While CNV only affects 10-15% of people who are diagnosed with AMD, it accounts for 90% of severe vision loss caused by AMD.[44]

The global prevalence of AMD is expected to increase from 170 m in 2014 to 288 m in 2040.[9] Despite the existence of anti-VEGF substantial treatments for nAMD, success is limited by substantial burden, making the need to reduce the burden of vision loss and blindness caused by AMD a public health challenge.[45, 46]

Figure 6: Global prevalence of age-related macular degeneration-related vision loss in 2019[12]

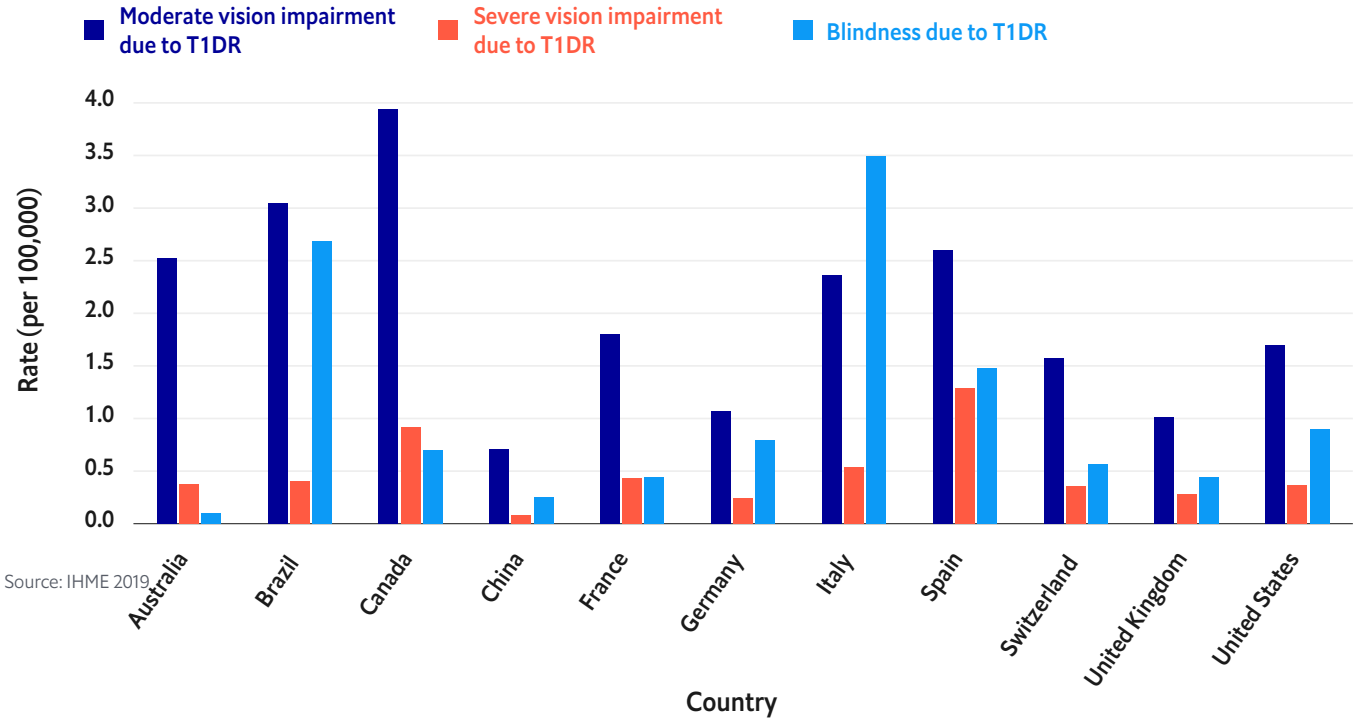


Source: IHME 2019

Figure 6 shows that the European countries of focus in this paper (France, Germany, Italy, Spain, Switzerland and UK) have the highest prevalence of blindness due to AMD, perhaps in line with their more aged populations and increasing prevalence of diabetes mellitus.[47] Moderate AMD-related vision loss is also higher in Europe than in other countries, with China being a notable exception. The prevalence of severe vision impairment from macular degeneration is greatest in Spain. Moderate AMD-related vision loss is more prevalent in Brazil than severe vision impairment and blindness. Italy has a high prevalence of blindness due to macular degeneration. In addition, the majority of people living with AMD (some sources estimating as many as 80-90%) exhibit an untreatable atrophic form of the disease for which innovative treatment development is needed. The incidence of AMD varies according to factors such as ethnicity and smoking, and the condition is also associated with certain specific genetic mutations. As cigarette smoking and poor diet are modifiable risks for AMD development and progression, preventative public health initiatives on such matters have merit. Health warnings have appeared on cigarette and tobacco products in many nations to draw attention to such risks as part of tobacco control policy.

Treatment for nAMD often consists of anti-vascular endothelial growth factor (anti-VEGF) injections, which have proven effective, reducing the prevalence of blindness by 30% between 1990 and 2020.[48] However, there is a discrepancy between the high treatment burden and lower visual acuity rates in the real world versus data in clinical trials.[44] As such, there is a need for more durable treatments that last longer with less burden. Furthermore, anti-VEGF injections do not fully address the multifactorial nature of nAMD, meaning that new trials and treatments are needed. New trials may be able to identify alternative factors in retinal and choroidal angiogenesis. Other trials, which are underway, are looking to find novel pathways or use different delivery systems or a combination of both.[44]

Figure 7: Global prevalence of vision loss due to T1DR in 2019[12]



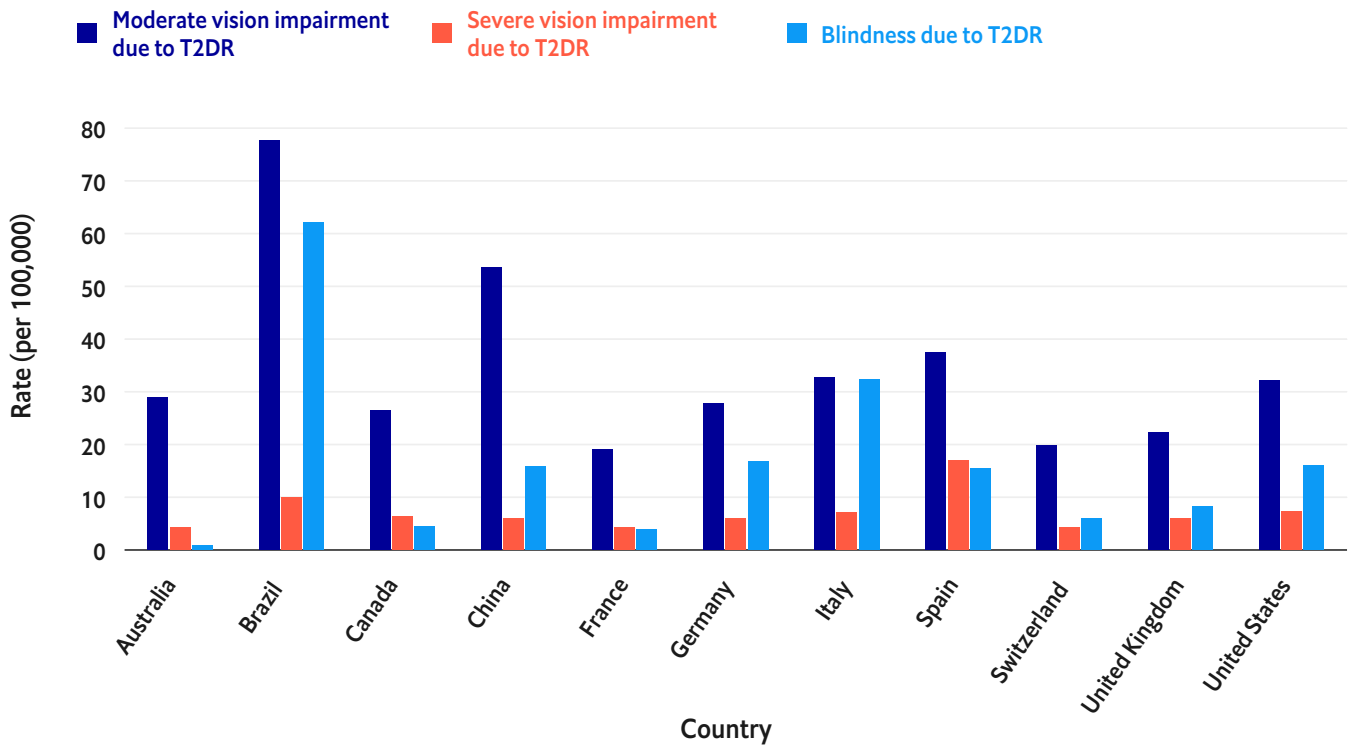
Source: IHME 2019

Diabetic retinopathy

An estimated 463m people worldwide live with diabetes mellitus, a number predicted to reach 700m in 2045.[49] When looking at DR associated with type 1 diabetes, Italy has the highest prevalence of blindness, while Canada has the highest prevalence of moderate vision impairment and China the lowest. With the exception of blindness, China has the lowest prevalence of all types of vision loss due to type 1 diabetes (the lowest prevalence of blindness is in Australia). While people living with type 1 diabetes are more likely to be affected by DR, there is a higher prevalence of type 2 diabetes, mirroring an equally high likelihood that people living with type 2 diabetes will face vision loss after 10 years of the disease.[20] Australia has the lowest prevalence of DR-related blindness arising from type 2 diabetes and Brazil the highest.

As diabetes trends increase worldwide—increases of 110% in men and 58% in women were seen between 1980 and 2014—morbidity, mortality and associated costs due to diabetes-related complications will rise as a global public health concern. Chronic high blood glucose levels damage the small blood vessels of the retina, resulting in microvascular complications such as DR and DME, a leading cause of blindness in working-age adults.[50] DME in particular is a complication of DR that frequently leads to vision impairment. In 2020 the respective numbers of people worldwide aged 50 years or older living with DR-related blindness or vision impairment were 861,000 and 3m.[51]

Figure 8: Global prevalence of vision loss due to T2DR in 2019[12]



Source: IHME 2019

When left untreated, DR can lead to DME, vitreous haemorrhage and tractional retinal detachment. Advanced diabetic eye disease can progress to neovascular glaucoma.[52] Highly effective treatments for DR have been developed to prevent vision loss, notably laser photocoagulation of the retina. Injections of anti-VEGF agents and corticosteroids are also effective and frequently used for DME. Effectiveness of DR treatment is dependent on early disease detection (before the condition becomes visually symptomatic). Screening programmes for early detection of DR have been established in many developed economies. By the time DR becomes visually symptomatic, the prognosis, despite treatment, is much more guarded.[5] Although early DR screening programmes have been established in many countries, uptake across the at-risk population living (and adherence to retinopathy screening protocols) can be variable. Good control of glycaemia, systemic blood pressure and general health is associated with lower risk of retinopathy progression. Poor control of such systemic risk factors, alongside socioeconomic deprivation and associated mental health challenges, is associated with more adverse DR clinical and visual outcomes..

Health system capacity

Delivering appropriate eye care requires an appropriately trained and enabled workforce that is accessible to patients, and matched to dynamic population eye health needs. It also requires a workforce that is scaled up to meet demand. This chapter examines the most important systemic factors currently affecting the capacity of health systems—mainly public—to respond effectively to people's needs now and in the future.

Barriers preventing care

Health system barriers

In the countries of focus, healthcare systems are mostly funded by governments, out-of-pocket (OOP) payments, external development assistance and alternative financing. The latter includes blended finance (public and philanthropic capital used strategically to attract commercial investment) and public-private partnerships.[53, 54] In many countries, including Canada and the US, rudimentary and preventative eye care services, such as basic optometry examinations and check-ups, require payment from the treated person and are not covered by the system. Other economies such as Switzerland are also seeing trends towards less cover for routine eye care within basic healthcare packages.[55] This is an impediment, and a reason for some people not seeking medical attention until it is too late (early diagnosis is critical for preserving vision).

As the global population ages, the number of people living with vision loss is expected to grow. Without additional investment in global eye health, an expected 1.8bn people will be living with untreated vision loss by 2050.[56] Eye care needs to be integrated into general health system financing to remove cost barriers and mitigate expenditure. The WHO has urged countries to consider eye care an essential service within universal health coverage and for it to be included in national health plans, with policies and financing structures to facilitate delivery of comprehensive services that include promotion, prevention, treatment and rehabilitation.[1]

Workforce capacity

There is a global need for more eye care specialists. "There is a capacity issue in the system," says Doug Earle, president and CEO of Fighting Blindness Canada. "We don't have enough optometrists, we don't have enough ophthalmologists." In keeping with the need for more eye care specialists is the urgent need for better treatments that would reduce the labour-intensive care that patients require, particularly for retinal issues, thereby reducing some workforce capacity issues.

Currently, on average, there are 15.6 optometrists and 7.6 ophthalmologists per 100,000 people in high-income countries, but numbers are even more stretched in lower-income countries.[56, 57]

Estimates suggest that there are 232,866 ophthalmologists spread across 194 countries globally, with a ratio of 3.7 per million population in low-income countries, compared with 76.2 per million in high-income countries. China is at the lower end of the key countries covered in this report, with 20 per million, and Switzerland is at the upper end, with 91 per million.[58, 59]

Disparities also exist across the rural and urban divide. An Australian report showed that the rates of ophthalmologists per 100,000 people averaged around two or three in rural and remote areas, compared with six per 100,000 in urban areas. In North America, rural residents are less likely to have had an eye exam in the previous year and have lower rates of eye care utilisation, resulting in reduced detection of treatable eye diseases, including cataract and glaucoma.[60] Table 1 shows the average number of optometrists and ophthalmologists of the 11 countries covered in this report.[61-65]

Table 1: Average number of optometrists and ophthalmologists in the 11 countries of interest in this report

Country	Number of optometrists per 100,000 population	Number of ophthalmologists per 100,000 population
Australia	22.7	4.0
Brazil	n/a	6.7
Canada	17.0	3.3
China	3.1	3.0
France	4.7	8.8
Germany	27.7	4.9
Italy	36.4	12.6
Spain	35.4	8.9
Switzerland	14.7	13.8
United Kingdom	23.7	2.2
United States	8.6	5.4

Optometrists are often at the frontline of vision care. In Canada—there were around 6,000 optometrists in 2020, compared with 1,323 ophthalmologists.[66, 67] The number of ophthalmologists in the US is expected to remain fairly flat, but the need for care is increasing. The US has an estimated 18,500 practising ophthalmologists, and the American Association of Medical Colleges predicts a shortage in 2025 due to ageing populations.[63] From 1995 to 2017 the number of ophthalmologists per 100 000 people decreased, while that of optometrists increased, prompting debates about how optometrists could complement the shortage of ophthalmologists.[68] Integrated eye care practices in the US are taking advantage influx of optometrists, as well as increases in numbers of other professionals, to manage increased demand for care.

Personnel shortages equate to unequal access. In Australia, the approximately 1,000 registered ophthalmologists work mainly

in the private sector—only 16% work in the public system—limiting access for those from a lower socioeconomic background.[69] There are an estimated 6,000 optometrists, with a demographic distribution that matches the general population, resulting in shortages in rural and remote areas. Reports from Health Workforce 2025 and the Australian Department of Health's Future Health Workforce Report for Ophthalmologists both support a model where care is shared between ophthalmology and optometry to reduce wait times, reduce the adverse consequences of chronic disease and efficiently deliver care.[70]

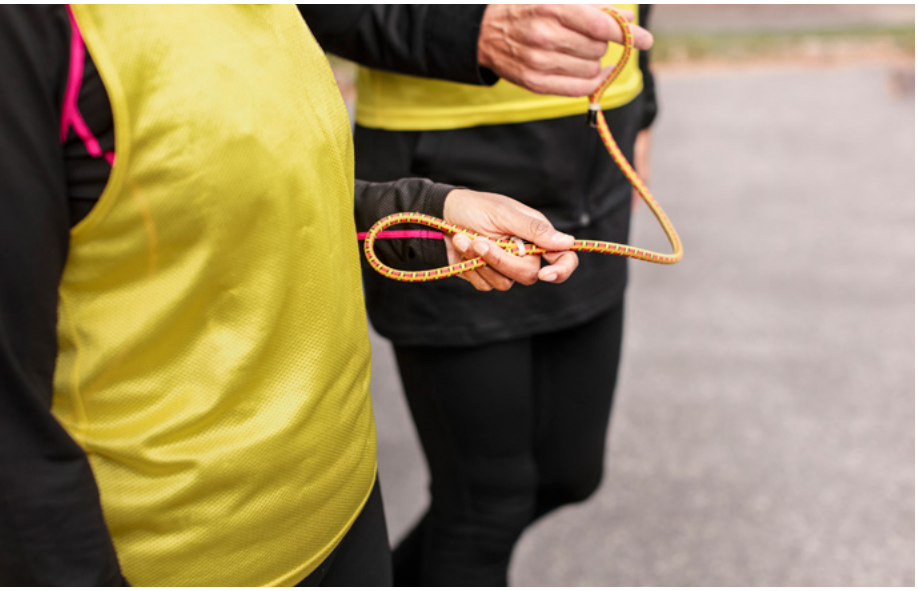
There is also the issue of lack of future supply of providers. Data from the International Council of Ophthalmology showed just over 18,000 ophthalmologists in the US in 2012. However, with less than 500 medical students matching into the specialty annually from 2012 to 2021 and more than two out of every five clinicians approaching retirement, the number of ophthalmologists is not increasing in line with demand.[71] The reasons for a similar deficit in ophthalmology numbers in Europe are slightly more complex: shortages of specialists are reportedly a result of the numerous clauses implemented to prevent overcrowding in medical schools and meet government workforce requirements.[72] While eye care continues to evolve with new treatments, the shortage of trained professionals raises demand on the existing workforce to bring new treatments to people.

Distribution of resources

In some countries, Brazil being one example, uneven distribution of ophthalmologists is an important challenge, according to João Furtado, associate professor at the University of São Paulo. In 2015 there were 14,000 ophthalmologists (or 67.4 per 1m people) and 3,500 optometrists, and approximately 650,000 cataract surgeries were performed in Brazil.[73] Between 2000 and 2019, a total of 8.4m cataract treatment procedures were performed through the Brazilian public health system, the Sistema Único de Saúde (SUS), with a significant increase over time, from 228,145 in 2000 to 663,186 in 2019.[74] However, ophthalmologists are clustered in cities and more affluent areas. Furtado thinks that a better union of primary care and ophthalmology would improve access in rural areas, where primary care physicians could be trained to perform eye examinations and prescribe glasses and using telemedicine and remote supervision.

China shows a similar trend. Although the country has significantly improved its eye care systems and has over 1.5 ophthalmologists per 50 000 people, they are concentrated in urban areas and their ability to perform cataract surgeries is uneven.[64, 75] There were 36,342 ophthalmologists in 2015 representing 26.4 per 1m people and 2100 optometrists, with only 2,070 cataract surgeries performed per million.[76] Ningli Wang, director of the Asia-Pacific Ophthalmic Society, identifies three important factors for improvement. "The first is human resources; in China the number of ophthalmic health workers is not too low, it reaches the average number for the world, but compared with western countries, we still need more [ophthalmologists]. The second is to increase the quality of doctors. The third is to support community primary eye care."

Simply increasing the size of the ophthalmic workforce is not enough, as ophthalmic clinic space is also in demand. In England, 49 of 52 providers surveyed said that they felt lack of space in their department was a limiting factor in the delivery of care. Some have adopted innovative approaches to remedy this, such as using mobile units and opening clinics in community centres and shopping centres. Many also offer virtual



clinics and run out-of-hours clinics to make use of the available space as efficiently as possible.[77]

Better distribution of services would include coordination of appointments and clustering of services. In Germany, for example, where patients can use any physician of their choosing, the importance of good coordination between healthcare professionals treating a patient is clear.[78] More specifically, the integration of services such as diabetes clinics and DR care will address service gaps and prevent complications of diabetes and DR through promotion of healthy lifestyles, early detection, adhering to treatments and monitoring treatment outcomes.[79]

Inequalities and disparities in the accessibility of healthcare systems

There are multiple barriers that delay or prevent service utilisation. These include affordability of health services, lack of good quality health insurance and inflexible schedules for addressing healthcare needs. The availability of ophthalmic resources also plays a role as the demand for ophthalmologists increases, leading to long waiting lists in some countries.[80]

Reports from the IAPB Vision Atlas and the Lancet Global Health Commission on Global Eye Health suggest that 90% of vision loss can be treated or prevented.[76] Despite this, many people cannot access affordable eye care. In Brazil, for example, provision of access to secondary and tertiary care in the SUS is challenging, resulting in long wait times for specialty care, underdiagnosis of eye conditions and treatment delays. In 2020, 29m people were living with vision loss and 1.8m were living with blindness. Furtado argues that in many cases blindness could be avoided if healthcare was more accessible. "We have more knowledge, and the gap is reduced, but we still have around 70% of cases that could be preventable or treated if people could reach quality services."

While geography may be a barrier for some, the main obstacle is economic—dividing those who can pay for their eye care and those who rely on the public health system. "We have different levels of quality and access to healthcare in general and eye care", says Furtado. "If you are rich, you are in wealthier states in wealthier cities, sometimes the state or the municipality provide what is missing from the federal government. As an example, in São Paulo, there is a programme to provide free anti-glaucoma drugs, but if we travelled for a couple of hours to a neighbouring state, people don't have this access. In terms of cataract surgery, it may take a week to receive surgery in one place and a year to receive the same surgery in a different city." Those able to afford health insurance will be in a better position to access care, and only around a quarter of the population is able to do so, he adds. Robert Layman, president of the American Optometric Association, makes a similar observation about services in the US, citing differences in prescription practices for interventions like laser therapies as a cause of uneven care.

Wait times are a further access issue, and they are getting longer across a number of countries in this study. For example, wait time for cataract surgery in Ontario was 93 days in 2019, a substantial increase from 69 days in 2014.[83, 84] In the UK, cataract surgery is of low clinical priority in the NHS, with a resulting 84% increase in wait times from 2019 and 2021, further compounded by the covid-19 pandemic.[85] Wait times from referral to surgery are more than nine months with a median wait time of 11 weeks for ophthalmic-specific procedures, and delays could rise to 1 to 2 years.[86, 87] In the case of nAMD, for which outcomes can be improved through early diagnosis and treatment, a short wait time will prevent the rapid vision loss that occurs during a wait for treatment for a patient. In the UK, the recommended wait for the first injection is two weeks but there have been reports of patients waiting for up to six months.[88]

Socioeconomic status and geographical location further impact access to care. For example, data suggest that China has had one of the lowest cataract surgery rates in Asia, with 1,067 operations performed per 1m people in 2014, and a more recent study found a low overall ten-year incidence of cataract surgery of 9.4%; those with higher income were more likely to have received surgery.[89] Cost was cited as the main reason why those from lower socioeconomic backgrounds found surgery less accessible. In Canada, since the delisting of routine eye care from provincial vision care insurance programmes the use of eye care providers by vulnerable populations in Ontario has decreased significantly—one study shows that the highest rate of uncorrected visual impairment was found among those with only primary school education.[90]

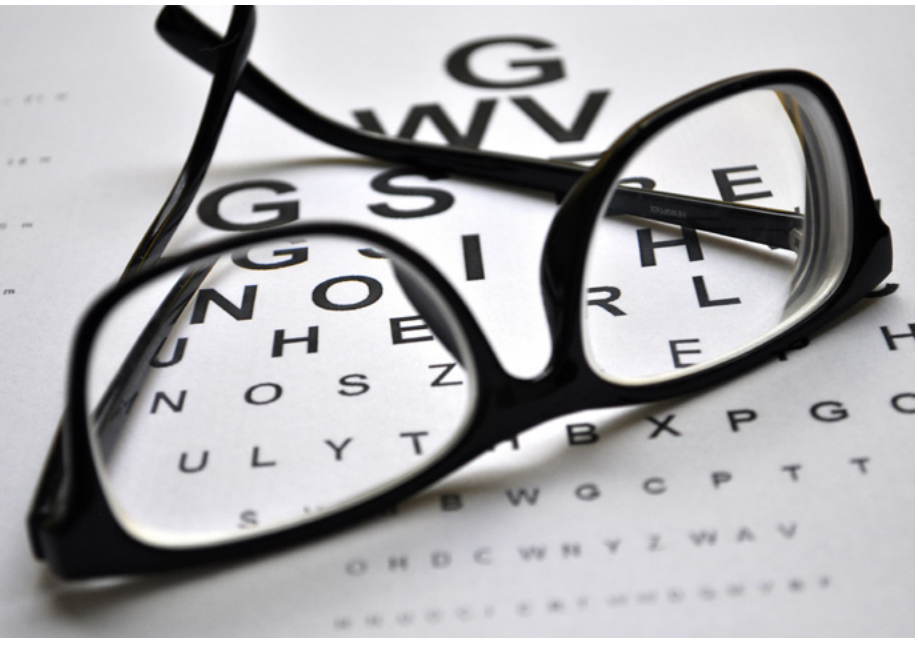
Current estimates suggest that 90% of blindness and vision loss among both indigenous and non-indigenous Australians is preventable or treatable if detected early and 80% of vision impairment can be treated either by the provision of glasses or through cataract surgery.[69] Yet frequently Australians living with eye disease are not diagnosed or treated in a timely manner. In Western Sydney median cataract surgery wait times are more than 300 days, with indigenous Australians waiting more than 50% longer for the same surgery. Only half of all Australians living with diabetes get the required eye checks and a 2018 poll revealed that only 36% of those living with diabetes understood that their eyes could be affected. There has also been a decrease in the rate of injection treatments, despite the good outcomes associated with them.[69]

Reasons for later diagnosis and treatment, as well as reduced rates of injection treatments, in Australia include a lack of health promotion campaigns, inconsistent referral guidelines and processes, long wait times, workforce shortages and clustering of the workforce within urban spaces, and a lack of connectedness within the eye health system. Many patients have to seek private treatment; of the more than 250,000 cataract surgeries performed annually, 70% are performed privately, with those on limited incomes forced into lengthy wait times owing to increasing demand for under-resourced public ophthalmology clinics.[91] Remote and rural patients are forced to travel or rely on outreach clinics that have limited access to ophthalmologists.[69]

In contrast, Italy has the lowest average median wait time for cataract surgery, at 24 days.[92] Coincidentally, the country also has a higher rate of optometrists (3.64 per 100,000 people affected) and ophthalmologists (1.26 per 100,000 people affected).[61] Italy has kept waiting times short by using a classification system known as the Homogenous Waiting Times Group, which facilitates coordination between primary and secondary care, and

ensures that both GPs and specialists assess need and urgency in the same way and agree on assigning different maximum wait times based on urgency with common criteria .[93]

Wait time guarantees involve setting waiting time targets and holding providers accountable for achieving them; or allowing people to choose alternative health providers (including those in the private sector) if they have to wait beyond a maximum amount of time.[92] Borrowing an example from another country of how the system could work, between 2005 and 2018, Denmark implemented a waiting-time guarantee for people, set at one month since 2007. If a particular region cannot ensure that treatment will be initiated in time, people have the right to an extended free choice of hospital, which allows them to choose to go to a private hospital in the country or to a public or private hospital abroad. If the treatment is provided outside of the region's own hospitals, the expenses are covered by the originating region through a tariff, thereby providing an incentive to perform surgeries quickly within the region.[94]



Another example, taken from outside of the 11 countries of interest, is Hungary, which has seen reduced waiting times for elective surgery as the result of the implementation of a 2014-20 health sector strategy, which included a goal of 60 days for minor surgeries and the adoption of new laws and regulations on the management of waiting lists. This included the development of an online waiting-list system to monitor care in real time across the country. Additional finding was provided to reduce waiting times in selected clinical areas and hospitals, and reallocation of patients from providers with longer waiting times to those with shorter waiting times was encouraged.[94] Elsewhere, Finland introduced a National Health Care Guarantee in 2005, which led to a reduction in waiting times for elective surgery.[95]

Jaimie Steinmetz, research scientist for the Global Burden of Disease Study at the Institute for Health Metrics and Evaluation, identifies another inequality dynamic: gender. "One thing that we see is that across all severities of vision loss, and almost every cause of vision loss, there are higher rates in women than men," she said. "In particular, avoidable and treatable causes of vision loss like cataract and refractive error are more common in women, and there are studies showing, for example, that the ability to access care, it's just harder for women."

A further cause of inequality is an unreasonably high bar to accessing care and rehabilitation, as is the case in Spain, where the threshold for legal blindness is higher than among European neighbours, as explained by Jacinto Zulueta, president of the Macular Retina Association, a patient organisation in Spain. "As a result [of this high threshold]," he says, "we have 214,864 people legally recognised as visually impaired [who would be recognised as blind in other countries] who do not have the right to instruments for visual rehabilitation, to regain autonomy, to have psychological support, etcetera. This is discrimination."

Patient Education

Eye health education and promotion within communities can lead to improved knowledge and service uptake.[96] The delivery of education and promotion within integrated eye care requires the use of more people-centred or community-centred design approaches. Digital communication offers new routes to share and amplify such messages. Mr Zulueta has some ideas for successful eye care. "Let›s say that prevention would be the number one fundamental element [through] promotion of visual health and social awareness for the prevention of eye pathologies. We would need early detection of visual deficits and coordination with social and specialised services, between primary care and the hospital setting and with different specialties such as psychology, psychiatry and social work."

Previously, a leading cause of blindness in China was trachoma, an infectious bacterial disease of the ocular surface, and interventions were implemented there for decades, leading to a successful decline in prevalence.[97] With changes in lifestyle, DR is now a major cause of vision impairment. With 87% of people living with DR treated at county- or lower-level facilities, protocols and guidelines for diagnosis, treatment and referral at this level have been issued. In addition to these government-led efforts, non-governmental organisations have also played an important role in eye health promotion in China. Their combined efforts led the prevalence of blindness and vision impairment among those aged 50 years or older to fall by 27% and 16% respectively between 2006 and 2014.[98]

Research and development

In recent years, most notable progress in ophthalmic care in developed nations has included multifocal contact lenses introduced in the fight against myopia, with studies revealing a 60% slowing of disease progression in 167 children using a special lens in their glasses.[99] An innovative research breakthrough, recently approved by the US Federal Drug Administration (FDA), is a glaucoma implant proven to reduce intraocular pressure (IOP). The device releases a glaucoma drug into the cavities of the eye and helps those who struggle with eye drops. In one study, IOP reduced by 30% over a 12-week period, and one year after three rounds of treatment most participants had their IOP under control without the need for further treatment.[100]

In the field of cataract removal, considered one of the most successful developments in the field of medicine was the development of small incision cataract surgery by phacoemulsification, first introduced in 1967 with frequent refinements over the years.[101] Optical coherence tomography, introduced in the 1990s provides quickly accessible, high-resolution images of the retina, revolutionising diagnosis and management of retinal disorders.[102]

The publication of an article in 1994 suggesting a role of VEGF in retinal disease led to the first trials, in 1997, and subsequent 2004 approval of anti-VEGF treatments, which have revolutionised the treatment of AMD.[103] Since first approval, these treatments have been repeatedly refined from first only showing some ability to maintain vision to restoring lost vision and the portal delivery systems that allow continuous delivery of drugs to the eye without the need for repeat injections.[104, 105]

There are also other promising therapeutic innovations. These include self-plugging microneedles that use a biodegradable microneedle and are coated with a drug released when inserted into the eyeball; punctal plugs, which are inserted into tear

ducts for prevention of dry eyes; drug-eluting contact lenses which can deliver drugs to the hard-to-reach back of the eye; and ocular iontophoresis, which uses low-amplitude electrical current to facilitate drug delivery to the eye.[106-109] These all represent state-of-the-art interventions for sustained and controlled drug release and—in the case of punctal plugs—treating ocular disorders. Such less invasive and/or sustained methods of drug delivery will allow for greater access beyond barriers such as fear of injections and eye drops.

Recent years have also seen existing methods further refined. Ophthalmic laser treatments for glaucoma, retinal diseases and corneal refractive procedures have all been refined, as have vitreoretinal surgical instruments and techniques.[110, 111] Improvements have been made to intraocular lens implant materials and design, while screening programmes for detection of retinopathy in individuals living with diabetes have also been improved.[112, 113]

Yet there are a number of research gaps to be addressed. One of particular note is the absence of a gold-standard treatment for dry AMD, despite a number of therapeutic options being explored and some clinical trials providing promising results.[114] Another example is methods of diagnosing glaucoma via endpoints that are evident at the earliest stages of disease without the need to wait for damage to have already occurred to vision. Similarly, treatment for DR is available only for advanced, sight-threatening stages of the disease, and there is an urgent need to understand the progression in order to be able to treat earlier.[115] Overall, a high treatment burden and capacity challenges call for development of longer-lasting therapies that address key unmet needs so that patients can better adhere to treatment and health systems can treat increasing patient numbers.

Mr Earle says that more clinical research is the only way to drive the implementation of effective policies. "We need real-world data, and we need to understand what's going on in the clinic, because there is episodic information coming out and we need to announce the impact of innovation," he says. Real-world outcomes data are especially important, particularly in the light of capacity challenges and increasing patient numbers. Policymakers need to be aware of the challenges facing the world of ophthalmology: the shortage of specialists, the prolonged waiting times, the inequalities in access, and the need for further research and development to yield effective diagnosis and treatments.

Conclusion: A bolder vision for healthy sight

Across the desk research and expert interview programme of this report, a number of key action areas have emerged to improve the ability of health systems to tackle vision loss and prepare for the increased health burden expected in the coming years.

A collective effort from researchers, providers, governments, policymakers, patient and advocacy communities, and industry partners is needed to stem the rising tide of vision loss. Recommendations from Economist Impact include the following:

- Invest in technology and supporting innovation and research and development in drug therapies and delivery technologies to ensure that treatments address medical unmet needs and contribute to lowering the patient and health system burdens and barriers highlighted in this paper. Investment increases access, cost-effectiveness of treatments and productivity.
- Expand the scope of practice for optometrists, primary care physicians and other allied health professionals to address capacity challenges, such as has been implemented in the UK.
- Use a multi-faceted approach to increase awareness of vision loss and put a focus on prevention so people are aware of their risks. This could include ambassadors promoting the need for good eye care, as well as other strategies for health promotion, education and prevention that complement existing clinical interventions, policies and awareness.
- Advocate for more equitable access to care to resolve sociodemographic, gender and income barriers.
- Improve surveillance and data collection to better understand if policies and investments are leading to better outcomes. Reduce the number of unnecessary non-treatment visits by using remote monitoring through mobile devices.

This conclusion presents recommendations and draws from useful examples and case studies that could be emulated or adapted to local circumstances.

Supporting innovations in drug development

Despite the remaining unmet needs, recent innovations in eye care have made a difference to the field. Gene therapy presents yet another promising area of innovation. Peter Holland, chief executive of the International Agency for the Prevention of Blindness, is optimistic that techniques like gene therapy will provide pharmaceutical intervention to improve eye care. “Researchers are suggesting that within a few years, they might be at the point where

they can really give people vision back using gene therapy," he said. "There is a real role for these interventions for diseases like AMD." He is not alone in his optimism; since the approval and success of the first gene therapy for genetic retinal diseases approved by the FDA, research into gene therapy has thrived.[116] Scientists who developed gene editing, a type of gene therapy, were recently awarded a Nobel Prize for their pioneering work, which has the power to transform the lives of those who have genetic vision disorders. Their technique, Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) is already being used in trials to restore function to eye cells.[117]

Leveraging primary care

The Lancet Global Health Commission on Global Eye Health has advocated access to high-quality eye care as a part of universal health coverage. The Commission argues that primary eye care, including promotive and preventive services, is a crucial component of delivering eye health within universal health coverage and encompasses activities within community settings.[1]

One measure that could improve access to high-quality eye care is teaching primary care providers to identify conditions and streamline the referrals process for more serious conditions.[118] This could bring a more preventative focus, create and increase capacity among the workforce and reduce inequity of care among rural and urban geographies.

Primary care is the first point of contact for healthcare for most people, and some countries are adopting a model of shifting routine services to local optometrists, leaving hospital ophthalmology departments to manage specialist and complex care. Proposals announced at the European Council of Optometry and Optics meeting in Dublin in May 2022 focused on optimising primary eye care. In practice, this would allow optometrists to refer people directly for specialist care without the added need for a GP referral. Optometrists would then be able to provide treatment of additional conditions such as stable glaucoma, dry eye and dry macular degeneration. Restrictions on their ability to prescribe should be removed and a hospital rotation in optometry included in their training, which would allow for better integration of primary and specialist eye care.[119] In some places, optometrists, orthoptists and nurses are already undertaking expanded outpatient roles, with nurses in the UK, for instance, carrying out many procedures, most notably intravitreal anti-VEGF injections. Some laser treatments are also carried out by nonmedical healthcare professionals in the UK.[120]

Integrating eye care services into mainstream health services is needed to pick up the full range of eye conditions and sight loss, including DR and other vision loss related conditions, according to Holland. "People may present for a reason other than poor vision, but this could provide an opportunity for a vision test to be done, to screen for and detect serious illness. Being able to identify and deal with conditions at a primary care level is crucial," he says. "You're not just dealing with vision issues, but some of the biggest reasons that people visit are things like red eyes and conditions which are not about vision at all. Being equipped at the primary care level to deal with those [simple] things is important, but it also gives you an entry point to do vision tests."

In more rural settings, a lack of proper screening is a major contributor to poor eye care, and primary care health professionals could be trained to improve the situation. An innovative study in remote Australia highlights the benefit; DR screening was performed

using a non-mydriatic fundus camera—an instrument effective in ocular examinations in non-ophthalmology settings—as part of a multidisciplinary diabetes service already visiting remote communities. Images were forwarded to a GP who identified and graded retinopathy, with screen-positive people referred to ophthalmology. The service ran over two years and screened a significantly greater number of people living with diabetes for each year of operation.[121]

Integrating eye care into primary care will require considerable investment in training existing staff and enabling existing workspaces. For service integration to be effective, strong communication needs to be established between all the stakeholder participants, particularly when catering to people with complex needs. "We need good communication between systems", says Furtado. "For example, the rehabilitation service does not provide outreach campaigns, they receive people but they don't look for them and not everyone is aware of them. Therefore, a person living with blindness might think there is nothing that can be done, but even without trying to restore vision there are psychological aspects that we can work on. We can adapt his or her house to avoid falls and optimise their quality of life. The service providing examination of the eye needs to communicate with educators, therapists, psychologists to optimise quality of life."

Improving individual and public awareness

Enhancing knowledge about potential threats to vision is an important first step in promoting change. With 80% of blindness being preventable, and with some conditions asymptomatic in the early stages, vision loss, in some cases, cannot be recovered. However, it can be slowed down or prevented if caught early. Better awareness can have a large impact on individuals and could also provide a platform for improved wellbeing and support systems. An example is Fighting Blindness in Canada's patient education programmes, which feature peer support.

Awareness campaigns can help, and take many forms, starting at the primary care level. Healthcare professionals should emphasise the importance of eye checks, since the eyes are an important early warning system for overall health issues. "Eye examinations can help pick up over 200 systemic diseases," says Layman.

Health literacy could be improved through communications campaigns such as celebrity ambassadors.[122] Borrowing an example from outside of the 11 countries of interest, the Fred Hollows Foundation recently ran a campaign using a popular Bollywood star, Shri Amitabh Bachchan, to prompt uptake of eye checks in India.[123] Mr Bachchan wears glasses proudly, and it was hoped that using him would help to remove the stigma attached to wearing glasses, a barrier for some to accessing eye care. Within the UK, Specsavers, a high-street optician, runs memorable television advertisements and uses augmented reality to promote eye health.[124] In France, an optician has offered free glasses for all in a campaign to ensure that lower-income citizens would not forego eye care due to costs.[125]

Immersive technologies like augmented and or virtual reality have proven to be effective at communicating important health information. After using immersive solutions, 20 participants to a study in Singapore had statistically significant improvement in their understanding of the pathophysiology of glaucoma, the condition's effects, the purpose and recommended frequency of eye screening, and the impact of peripheral vision loss. The results are encouraging for the future use of

gamification in eye healthcare promotion, which could be applied in a remote context.[126]

Carers should also be more explicitly supported. An innovative study in Australia will be the first to implement and evaluate a comprehensive support service tailored to families and loved ones of people living with AMD. The interventions include mail-delivered cognitive behavioural therapy; telephone-delivered therapeutic group sessions; and an information pack on available community services and resources (such as financial entitlements), respite services, and support groups. The hope is that families and loved ones will face a reduced burden and distress, and improved overall wellbeing. Researchers will also perform economic analysis to assess the feasibility of rolling out the service on a larger scale.[127]

Investing in technology and encouraging innovation

Technological advances such as teleophthalmology, mobile health and artificial intelligence (AI) can support enhanced care delivery.[1] Teleophthalmology has been successfully used and was of particular use during the covid-19 pandemic, which was a catalyst for embracing digital innovation. Teleophthalmology was successfully applied in virtual triage for people living with ocular discomfort or appearance abnormalities in the UK, France and China, making it easier for remote and house-bound people to access care.[128-130]

To take advantage of telemedicine, the UK College of Optometrists published an A4 home sight test chart to allow people with printer access to approximately measure their visual acuity before remote consultations.[131] Wang and Furtado suggest that telemedicine would be acceptable for large countries such as China and Brazil where there are large numbers of affected people living in remote regions. Other solutions include mobile health (mHealth) tools like Peek Acuity, a visual acuity smartphone app developed for use in resource-poor settings.[132] When compared to visual acuity charts such as the Snellen, the app was capable of acute and repeatable visual acuity measurements and offers a validated clinical solution during telemedicine consultations. Such smartphone apps provide solutions to expand existing capacities to reduce waiting time for care.

AI could revolutionise ophthalmic care by speeding up diagnosis and reducing the human resources required.[133] Use cases include supporting point-of-care diagnostics, surgical decision-making (such as risk stratification), patient management and treatment, and public health screening programmes. In Iowa, a new FDA-approved diagnostic system for DR can accurately image and assess the state of the eyes of a person living with diabetes in the absence of a specialist.[134] This brings ophthamologist care to rural areas without the need for an increased specialist workforce.

Improving surveillance and data collection

Across countries, there is a need for investment in surveillance and data-gathering to better understand if actions and investments are improving patient outcomes and how to optimise eye care systems. Although eye care facilities collect routine data, the full potential of this data for health monitoring and policy development is not being realised.[135] Applications like Alleye could help with this by allowing monitoring through detection of decreases in vision before a patient spots them.[136]

In Canada, Foundation Fighting Blindness is working to improve data utilisation. Project OPEN is using administrative health data

to identify people living with diabetes who have not had an eye examination in more than a year; they are subsequently offered a free screening appointment at a community health centre. The programme focuses on underserved communities living with diabetes, such as new immigrants, young people and those from marginalised communities who may not realise that they are eligible to receive a preventative eye exam.

"There is a lot of frontline data that we would like to access," says Mr Doug Earle. "So we›re in dialogue around that to try to do the analysis and provide insight in the prevention space and the early diagnosis space." There is a wealth of information collected, and although it is often collected for the financial incentive offered rather than for useful information, the records collated provide important insights about the health of a country. In the US, a recent study found that uncorrectable visual acuity loss and blindness were larger drivers of national health burden than previously known. The study estimated prevalence of visual acuity loss of 7.1m, substantially higher than what was previously obtained, supporting the case for improved surveillance and investment.[137]

Data from ophthalmology clinical trials such as those focusing on diabetic eye diseases have historically been lacking in representation for some ethnic and racial groups, but this is changing.[138] With groups such as Black, Hispanic and indigenous people disproportionately affected by diabetes and therefore at a higher risk of developing these diseases, surveillance and data collection must include at-risk groups.

Advocating for more equitable access to eye care services

Current trends suggest that the majority of eye care professionals have a greater distribution in urban areas, leaving more remote areas with the challenge of retaining specialists.[58] To compensate for a lack of professionals in the French and Italian Alps, a partnership was set up to pool working methods and tools to provide services, while also working with a mobile teleophthalmology unit and home-based teams.[139] Similarly, researchers in Canada are devising ways to allow rural primary care providers to identify eye conditions.[118] To address the lack of access in rural areas, the German province of Baden-Wurttemberg initiated the "Eye Van" project, which offered visually impaired people on-the-spot ophthalmological exams and counselling on low-vision aids and social support with the aid of mobile transport.[140] Similarly, in Switzerland a mobile eye clinic service known as the Augenmobil helps to reduce logistical costs for immobile patients who would otherwise need to be transported to eye clinics.[141]

Innovative policies are required to lure professionals to rural areas. Looking at working options outside of the 11 countries of interest here, a study from Ghana showed that financial incentives, scholarships to further studies, good living conditions and the possibility to accelerate progress up the career ladder were the main incentives that influenced the intention of graduate optometrists to practise in rural areas. In addition, students of rural origin were more willing to practise in rural settings, suggesting a way forward through training and upskilling rural residents.[142] Such an approach has had success in medicine in Australia through a programme known as the rural pipeline concept: students from a rural background are recruited, exposed to rural practice through placements and offered graduate incentives and support to practise rurally.[143]

Ophthalmic education in some areas has been found to be based on outdated curricula that does not fit with the patient-centred approach outlined by the WHO, although this has been

addressed through extensive international efforts to redefine methods of teaching.[144, 145] Concerns now remain about insufficient training for surgical ophthalmologists, prompted the roll-out of improved training programmes that have already transformed quality of practice. One example rolled out in eastern African countries showed that simulation-based surgical techniques significantly improve surgical competence of trainees.[146] International competency-based assessments are showing promise for the assessment of ophthalmic training to perform complex procedures such as intravitreal injections, as well as the impact of different teaching methods on performance, thereby helping to standardise the global quality of care.[147]

Overall, a bolder vision for healthy sight must support innovation, leverage primary care to fill the gap in ophthalmic services provided, improve surveillance and data collection, highlight the need for greater awareness of good eye health, and advocate for access for all to good eye care.

Appendix: Country-specific burden of selected vision conditions

Appendix 1 presents country-specific disease burden, highlighting regional differences within countries, along with healthcare capacity, treatment costs and policies across different regions.

North America

Overview of eye disease burden

There are an estimated 1.2m Canadians living with vision loss (3.2% of the total population), more than 4.1% of whom live with blindness. Data also show that at least 8m Canadians are living one of four eye conditions: cataract, glaucoma, age-related macular degeneration (AMD) and diabetic retinopathy; approximately 867,000 people live with vision loss from these conditions. Research estimates place the total cost of vision loss in Canada in 2019 at US$32.9bn; the total financial cost of vision loss was US$15.6bn and the cost of lost wellbeing was US$17.4bn.[148] An estimated US$166.4m was spent on assistive technology, and a further US$84.9m was spent on low vision rehabilitation services, and Canadians living with vision loss may need further support to help them to fully participate in society. These represent significant out-of-pocket expenses.

To counteract the effects of vision loss, the Canadian government is investing in ways to adapt assistive technologies such as electronic

mobility devices and screen readers to be more accessible and efficient. Increasing expenditure on programmes to support such initiatives may lead to reductions in other costs such as productivity losses and informal care.

In the US, over 3m adults live with visual impairment or blindness and up to 80m live with eye diseases that may ultimately lead to blindness. The annual economic impact of blindness is estimated to be over US$35bn, with this number expected to increase as the population ages, causing the projected number of Americans living with blindness to double by the year 2030.[149]

A recent review estimated the total economic burden of vision loss in the US at US$134.2bn in 2017, US$98.7bn in direct costs and US$35.5bn in indirect costs.[150] The largest burden components were the costs of nursing home care (US$41.8bn), other medical care (US$30.9bn) and reduced labour force participation (US$16.2bn), all of which accounted for 66% of the total. Other medical care, including the costs of glasses, contact lenses and home healthcare services, accounted for 23% of the total burden. Vision rehabilitation accounted for most supportive service costs (72%), followed by special education (22%), federal support programmes (3%), and school vision screening (3%). Reduced labour force participation accounted for the largest share of indirect costs (46%), followed by informal care (26%), reduced earnings (22%), lost household productivity (5%) and absenteeism (2%).

The economic burden varied by state—the highest total burden was in California (US$13.5bn) and the lowest was in Wyoming (US$191m). Women accounted for 58% of the total burden, compared with 42% for men. People aged 0-18 years accounted for 8% of all people living with vision loss and generated 7% of the burden; people aged 19-64 accounted for 51% of people living with vision loss and generated 39% of the burden; and people aged 65 and older accounted for 41% of people living with vision loss and generated 54% of the burden.[23]

Cataract

Cataract is estimated to be the major cause of vision loss in Canada, accounting for 36.7% of total prevalence. It is the second leading cause of blindness in Canada. Currently, more than 2.5m Canadians are living with cataracts, with this number expected to rise to 5m by 2031. More than 350,000 cataract surgeries are performed each year.[151] In the US, the prevalence of cataract decreased by 0.2% in 1990-2019, and cataract-related disability-adjusted life years (DALYs; the sum of years lost due to disability and the years lived with disability) reduced by 3.5%, a reduction that may be explained by the high rates of cataract surgery in North America.[152]

Glaucoma

Of the 1.2m Canadians living with vision impairment in 2019, 129,101 had glaucoma.[148] There has been an increase in the availability of glaucoma medications in Canada since 1992, although the number of surgeries have declined.[153] With more optometrists than ophthalmologists per 100 000 people (16.5 and 3.5 respectively), the role and accessibility of optometrists has expanded.[154] Based on a model initiated by the Canadian Glaucoma Society, people suspected of having glaucoma may now receive initial assessment from an optometrist without ophthalmology referral. Optometrists are responsible for monitoring stable people, with ophthalmologist check-ins every two to four years, depending on glaucoma risk and severity level.[153] This is a cost-effective way to manage the growing need for eye care services.

Glaucoma is mostly asymptomatic until later in the disease, when visual problems arise, and some practitioners opine argue that the majority of glaucoma cases in the US appear to be undiagnosed. The US Centers for Disease Control and Prevention (CDC) estimates that only 50% of people affected are aware of their diagnosis.[155] According to Medicare data for 2017, 4m people were diagnosed with glaucoma, the majority of whom were aged 65-84 years. The condition was more prevalent in females than males (2.4m versus 1.6m). In terms race and ethnicity, it is most prevalent among African Americans (29.8%), followed closely by Asians (22.7%), and is the leading cause of blindness in Black and Hispanic communities.[37] The economic burden of glaucoma in the US is high, ranging from US$623 to US$2,511 annually per affected person, depending on severity.[156] This is partly due to the high costs of patented medication, which is more expensive in the US than in Canada. For example, the average branded glaucoma topical medication costs around US$1,166 per bottle in the US compared with US$307 in Canada.[37] In the US, some public health programmes are tailored towards early intervention and treatment, particularly for high-risk groups. For example, the US Vision Health Initiative is conducting sight studies to improve glaucoma detection, follow-up care and referral systems.[157]

Age-related macular degeneration

AMD is the leading cause of blindness in adults aged over 55 in Canada, with nearly 180,000 of the approximately 2.5m people affected experiencing loss of vision.[158] Smoking, diet, age, sunlight exposure and alcohol consumption are considered risk factors in macular degeneration development. Medications that reduce ocular swelling and prevent new blood vessel growth (that is, anti-VEGF treatment) are promising treatments for macular degeneration, many of which are covered by Health Canada, Canada's national health system.[148] In the US, the prevalence of AMD is 11m, similar to that of all invasive cancers combined, leading to an annual US$4.6bn direct healthcare cost.[159] Costs have increased since 1998, as have caregiver costs.[160]

Diabetic retinopathy

In Canada, diabetic retinopathy accounts for 25% of vision loss in those of visible minorities compared to 4% across all ethnicities. Complications from diabetes account for 80% of the costs associated with the disease, which in 2015 were estimated to be C$14bn (approximately US$10bn). The economic burden rests on the indirect costs of progressive sight loss, largely owing to decreased individual productivity, the use of counselling or rehabilitation services and the government›s income assistance policies in the event of total or partial incapacitation.[161] The use of anti-VEGF injections has been effective in improving visual acuity in about 25% of Canadian people living with diabetic retinopathy.[148]

The CDC found that diabetic retinopathy affected 4.2m Americans living with diabetes over the age of 40 (about one-third), with Black and Hispanic people more commonly affected than White people.[160] This number is projected to increase to 16m by 2040.[162] Factors associated with the presence of diabetic retinopathy in the US are male sex, duration of diabetes, use of insulin, higher HbA1c level and high systolic blood pressure. However, the functional burden of diabetic retinopathy is more significant for women and poor populations. Diabetes-related blindness and vision loss currently cost the US an estimated US$500m annually.[163] As estimates project that the number of Americans living with diabetic retinopathy will reach 16m by 2050, it is of increasing concern both nationally and globally.[162]

Europe

Overview of eye disease burden

According to data from 2017, 1.3m people aged 50 years and over in the EU (including the UK) were living with blindness and just under 10m were living with moderate to severe vision impairment. Productivity loss-related costs of blindness ranged from €6.3bn to €17.3bn (US$6.3bn-US$17.3bn) and those linked to moderate to severe vision impairment ranged from €18bn to €39.2bn euro.[164] The leading causes of blindness and moderate to severe vision impairment in Europe are AMD, cataract, glaucoma and diabetic retinopathy. Access to health services varies widely depending on the health system and disease-specific cost burden. There is a need for cost-effective innovative health technologies as a means to reduce the social and economic burden of vision impairment, and the overall burden to health systems.

Cataract

A previous review reported a cataract prevalence rate of 64% in European people aged 70 years or older, although more recent data were unavailable.[165] Cataract surgery is a cost-effective healthcare intervention that brings both physical and psychological improvements. Of 20m global cataract surgeries, 7m are performed in Europe annually.[166] The prevalence of cataract decreased by 2% in 1990-2019, as did cataract-associated DALYs (8.9% reduction).[152] This may be attributable to success rates of cataract surgery and earlier detection.

Glaucoma

Most recent available estimates place the number of people in Europe living with glaucoma at 7.8m, with a total prevalence of 2.5%.[37] High-quality care is widely available in Europe, but health systems must expand their treatment capacities to deal with the projected rise in glaucoma prevalence.

AMD

AMD is the leading cause of blindness and vision impairment in Europe, and one study estimates that there will be a 15% increase in its prevalence by 2050.[13] Accordingly, demand for care will increase over the next few decades, requiring additional health resources and planning for effective disease management. According to one meta-analysis , the prevalence of AMD in populations of European descent is 12.3%; where older age and female gender were associated with higher prevalence.[167]

Diabetic retinopathy

Diabetic eye disease is the primary cause of vision impairment and blindness among Europeans of working age.[13] Many are asymptomatic in the early stages of the disease; as a result, European national and international guidelines strongly recommend diabetic eye disease screening for anyone living with diabetes. Moreover, population ageing is more pronounced in European countries than in other parts of the world—of the 20 countries worldwide with the highest median ages, 14 are in Europe, emphasising the importance of assessing health system capacity to ensure that it aligns with population needs.[168]

With a 1m people affected in each country, Germany and Italy carry the highest number of people living with diabetic eye disease, followed by Spain, the UK and France. Currently, 25.7% of Europeans living with diabetes live with diabetic retinopathy. One study estimates that there will be a 34% increase in type 1- and type 2- related visual disorders by 2050 in Europe, which will leave 1.4m people in need of close monitoring.[13]

People living with diabetes in Spain who also live with related visual disorders are typically referred to community eye clinics. In Germany, Italy and France, office-based ophthalmologists are commonplace, and there is no systematic screening or follow-up system. In the UK, a national, systematic diabetic eye disease screening process was implemented, which required a sizable cost investment initially but has resulted in decreasing vision loss.[13] To improve disease management in Europe, national strategies and policies are needed alongside increased healthcare capacity. This should include an increase in trained ophthalmology professionals and widespread use of telemedicine or other novel solutions to address gaps in health service delivery.

Australia

Overview of eye disease burden

In Australia, the prevalence of vision loss was reported at 6.6% in 2017. Indigenous Australians experience more cases of vision loss compared to non-indigenous Australians (11.2% versus 6.5%) and it is primarily caused by uncorrected refractive error, cataract and AMD, with diabetic retinopathy an additional leading cause in indigenous Australians.[13] Older Australians living in residential facilities seem to have particularly low access to corrective visual services, with one study finding that 70% of people living with vision impairments in these residential units could live with better vision and quality of life if given access to appropriate corrective services such as corrective lenses, surgery or medical interventions.[169] As a result, there is a mismatch between the prevalence of visual disorders and access to ophthalmic services that can perpetuate a higher prevalence of vision impairment. Incorporating eye care services within residential aged care facilities may be effective in expanding access to ophthalmic services and reducing blindness and vision impairment in Australia's older-age population.

Cataract

Indigenous Australians are three times more likely to develop cataracts than non-indigenous Australians. The prevalence of visually significant cataract in non-indigenous Australians is 2.7%, which is unsurprising, as cataract surgery is the most commonly performed elective surgery in Australia. In contrast, access to cataract surgery is urgently needed in indigenous Australian communities. The National Eye Health Survey found that males had a significantly higher prevalence than females, partially explained by lower health service utilisation and higher risk of vision loss due to cataract.[170]

Glaucoma

At 1.8%, Australia has the lowest prevalence of glaucoma when compared with the rest of the world, although some studies suggest that there are high rates of undiagnosed glaucoma.[171] One study reported 2,139 cases of glaucoma among indigenous Australians aged 40 or older and 198,923 cases in non-indigenous Australians aged 50 or older. These data suggest that cases of glaucoma are higher in non-indigenous communities, although this could also be due to limited care seeking and poor healthcare access in indigenous communities.[172] In the light of significant population ageing, accurate case detection is a vital element for Australia's health system to meet population needs of care and improve access to visual treatment facilities.

AMD

AMD is the leading cause of blindness and vision impairment in Australia, impacting over

1m people. Functional impairment, emotional distress and poor quality of life are consequences of macular degeneration for those affected, and its impacts extend to the families and loved ones of those living with the condition. This extended burden includes fatigue, poor quality of life and depression.[173] In addition to its severe effects quality of life, AMD poses a significant financial burden, with estimated annual direct costs in Australia of $750m.[174]

Diabetic retinopathy

Limited data are available regarding prevalence of diabetic retinopathy, as it primarily impacts indigenous Australian communities for whom access to care, health resources and research is scarce. A recent study indicated that diabetic retinopathy was attributed as the main cause of vision loss in 9% of non-indigenous Australians and 19% of indigenous Australian adults living with known diabetes.[175]

Brazil

Overview of eye disease burden

There are few nationally representative studies on glaucoma, cataract or AMD in Brazil. As a result, burden and prevalence data for some visual disorders are largely unknown. Studies focused on indigenous communities in Brazil report the prevalence of vision impairment and blindness to be greater than global estimates.[176] The annual medical expenses of severe vision impairment or blindness per affected person in Brazil are approximately US$879, and the lifetime productivity costs total US$13,442 per person.[177] For some people, especially in rural regions of the country, the availability of ophthalmic services is sparse, forcing people to pay out of pocket for care or not receive care at all. Future interventions to reduce the burden of blindness and visual disorders in Brazil must begin with increasing education and reducing geographical disparities through better distribution of eye care facilities and standard disease guidelines to ensure quality of care.[177]

Cataract

Although Brazil's public health insurance system covers cataract surgery, cataract remains a significant cause of blindness in the country, with long wait times for surgery and eye care services within the public health system a likely contributor.[178] There are other barriers preventing people from accessing required eye care services. A recent study found that a minority (42.3%) of those referred with cataracts attended for treatment, and of those only half followed through with surgery.[179] Distance to hospital, older age and residing in rural municipalities with fewer ophthalmic services were all barriers.

Glaucoma

Among all types of glaucoma, primary open-angle glaucoma accounts for 12% of blindness cases in Brazil, which is relatively low compared with rates in other global regions.[180] Given the rate of Brazilian population growth and ageing, along with the prevalence of glaucoma in people under 40, cases of glaucoma—and primary open-angle glaucoma specifically—are projected to increase significantly, along with the economic burden on health systems and those people affected.[181]

Diabetic retinopathy

Brazil lacks a national screening programme for diabetic retinopathy and appears to lack robust prevalence data. A cross-sectional study looking at data from 2010 to 2014 demonstrated a 35.7% prevalence of diabetic

retinopathy among people living with type 1 diabetes. A separate study estimated regional prevalence rates between 2011 and 2014 at 36.1% in the Southeast region, 42.9% in the South, 29.9% in the North and Northeast, and 41.7% in the Midwest.[182] Quality of healthcare and care uptake is known to be significantly lower in the poorer North and Northeast regions of Brazil than other regions. Moreover, the public health system is better organised in Brazil's Southeast region, allowing greater access to tertiary treatment centres for advanced diabetic retinopathy cases.[183]

China

Overview of eye disease burden

In China, DALYs due to moderate to severe vision impairment and blindness are ranked second in terms of burden among all health conditions. Cataract, refractive error, glaucoma and AMD are the leading causes of vision impairment and blindness. Although the prevalence of vision loss in China is lower than the global average, there have been significant increases in moderate and severe vision impairment in recent decades: the prevalence of the former rose by 133.7% in 1990-2019, while the prevalence of the latter rose by 147.1%. The number of people living with blindness increased by 64.3% within the same period.[184] The estimated OOP costs due to vision impairment were about US$6,989 per affected person per year, with 70.3% attributable to direct medical expenses; only 26.9% of these direct medical costs were reimbursable by insurance.[185]

Tailored intervention strategies to reduce the burden of eye disease are warranted. To this end, the Chinese government has been working to reduce the burden of blindness through continuously improved disease-management systems, national and local service systems, public health service projects, and technical guidance systems. These efforts have been effective, although the rapid rise in chronic disease and population ageing are causing the demand for eye services to increase—an increase that will be particularly stark in rural regions.[186] Intervention efforts must be focused on prevention and treatment of moderate to severe vision impairment, distribution of eye care services and increasing medical research.

Cataract

Nationally representative investigations on the magnitude of cataract in China are scarce. One has showed that 111.7m people aged 45-89 years had cataracts in 2015, an increase of almost 61m compared with 1990. Of this group, 71% were affected by age-related cataracts.[187] Government interventions and national public health programmes such as Sight First China Action helped to successfully increase China's cataract surgery rate and reduce the rate of cataract-related blindness between 2000 and 2017.[1] Despite this, cataract treatment rates still lag behind those of western countries.

Glaucoma

Glaucoma is the primary cause of irreversible blindness globally and the third leading cause of blindness in China.[1] In 2020 around 53% of primary open-angle glaucoma, the most common form of glaucoma, was reported in Asia. There are few studies in China that discuss prevalence in the context of demographics. One suggests that long-term exposure to fine particulate matter is associated with developing glaucoma, while another found that cases of secondary glaucoma, a form of glaucoma known to be caused by increased intraocular pressure, is a common comorbidity of trauma and vascular disease.[188] In the past 10 years, advanced treatments for

secondary glaucoma have emerged in China, reflecting positive efforts made towards ophthalmic service improvement.[189] The burden of glaucoma also varies by geographical region, with only 1.4% of incidences reported in rural China, although this may be due to underreporting. The disadvantage of the low figure means that the condition receives little attention on the part of governments and researchers.[190]

AMD

The burden of AMD is gradually increasing and has become a prominent cause of vision impairment among individuals aged 50-69 years. Intermediate and late macular degeneration, an untreatable form of the disease, occurs most frequently in people aged 70 or older.[191] Although the incidence of macular degeneration in females is higher than males in predominantly Caucasian populations, one longitudinal study conducted in rural China demonstrated that males had a higher incidence rate of macular degeneration. Within this same community, the six-year incidence rates of early and late stage macular degeneration were 4.2% and 0.2% respectively.[192]

Diabetic retinopathy

China has a large population of people living with diabetes, but there is poor awareness of the disease and its related complications.[193] Diabetic retinopathy is not a major cause of moderate to severe vision impairment or blindness in China, although some studies suggest that its prevalence is substantially increasing.[194, 195] In 2019 Chinese people at risk of diabetic retinopathy totalled 116m, with prevalence varying depending on the region.[196] In more affluent areas with higher levels of education, such as Shanghai, the prevalence is lower and possibly even decreasing.[1] In 2016, a 17% prevalence rate of diabetic retinopathy among patients with type 2 diabetes was recorded in Shanghai, an 8% decrease from 2007.[197] It is thought that this is partly due to Shanghai's chronic metabolic disease management system and the option for people to receive healthcare remotely. Thus, regular screening, tailored public health action plans and widespread availability of treatment is critical for the early detection of diabetic retinopathy and management in people living with diabetes, and may help to ease the burden on China's health system.

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