Deloitte Access Economics

The economic impact of vision impairment and blindness in the Republic of Ireland

NCBI (National Council for the Blind of Ireland)

May 2011

Deloitte.

Contents

Glossary i

Executive Summary i

1 BACKGROUND 5

1.1 Definitions: vision impairment and blindness 6

1.2 Conditions leading to vision impairment and blindness 8

2 PREVALENCE OF VISION IMPAIRMENT AND BLINDNESS 12

2.1 Population data 13

2.2 Prevalence sources 14

2.3 Blindness 22

2.4 Mild and moderate vision impairment 27

2.5 Total population with vision impairment and blindness 35

3 HEALTH CARE COSTS 36

3.1 Hospital expenditure 37

3.2 Prescription drugs 42

3.3 General ophthalmic services 43

3.4 Other direct healthcare costs 45

3.5 Summary of direct health care costs 46

4 INDIRECT COSTS 48

4.1 Productivity losses 49

4.2 Informal care costs 56

4.3 Deadweight welfare loss 60

4.4 Summary of indirect costs 64

5 BURDEN OF DISEASE 66

5.1 Methodology 66

5.2 Estimated YLDs 69

5.3 Estimated YLLs 72

5.4 Estimated DALYs 72

5.5 Monetary equivalent of DALY burden 73

6 THE TOTAL COST OF VISION IMPAIRMENT AND BLINDNESS IN THE ROI 74

6.1 Summary 74

7 COST EFFECTIVENESS ANALYSIS OF THREE EYE CARE INTERVENTIONS 78

7.1 Screening the older population 79

7.2 Screening people with diabetes 86

7.3 Reduction of public waiting lists for cataract surgery 92

References 97

Limitation of our work 106

Charts

Chart 2.1 : Age distribution: % of total registered blind people in age group 19
Chart 2.2 : Registered blind people - % breakdown by cause 20
Chart 2.3 : Registered blind people - % breakdown by cause for age 20-44 years 21
Chart 2.4 : Registered blind people - % breakdown by cause for age 45-59 years 21
Chart 2.5 : Registered blind people - % breakdown by cause for age 60+ years 22
Chart 2.6 : Projections - people with VI and blindness in the ROI 35
Chart 3.1 : Distribution of public and private hospital expenditure by eye condition related to vision impairment 41
Chart 6.1 : Components of the total economic cost of VI and blindness in 2010 76
Chart 6.2 : Components of the total financial cost of VI and blindness in 2010 77

Tables

Table 2.1 : ROI population projections 13
Table 2.2 : Past studies on blindness and VI - ROI and Northern Ireland 15
Table 2.3 : Prevalence rates for blindness(a) in the ROI, by age and gender(b) 23
Table 2.4 : Prevalence rates for blindness (a) in the ROI, by cause, age and gender (b) 24
Table 2.5 : Projections of blind people in the ROI, by age and gender 25
Table 2.6 : Projections of blind people in the ROI by cause 27
Table 2.7 : UK ratios - mild and moderate VI to blindness, by age and gender 28
Table 2.8 : Prevalence rates for mild VI in the ROI, by age and gender 30
Table 2.9 : Prevalence rates for moderate VI in the ROI, by age and gender 30
Table 2.10 : Projections of people with mild VI, by age and gender 31
Table 2.11 : Projections of people with moderate VI, by age and gender 32
Table 2.12 : Projections of people with mild VI, by cause 34
Table 2.13 : Projections of people with moderate VI, by cause 34
Table 3.1 : AR-DRG mapping to eye condition within acute public hospital activity data 37
Table 3.2 : Average public hospital cost per bed day ($A and €) in 2010, selected AR-DRGs 38
Table 3.3 : ALOS and estimated discharges by year for selected AR-DRGs 39
Table 3.4 : Estimated public hospital costs (€) by selected AR-DRGs 40
Table 3.5 : Estimated expenditure on glaucoma drugs by all health care payers (€) 42
Table 3.6 : Eye examination scale of fees (HSE Community Ophthalmic Services Scheme) 43

Table 3.7 : Eye tests in Scotland 2010 – distribution by eye condition 44
Table 3.8 : Estimated total expenditure on general ophthalmic services 44
Table 3.9 : Estimated expenditure on 'assessment and care of the visually impaired' 46
Table 3.10 : Summary of direct health care costs of VI and blindness 46
Table 4.1 : Estimated adults in private households unable to work due to seeing disability 51
Table 4.2 : Estimated productivity losses due to seeing disabilities in the ROI 51
Table 4.3 : Estimated deaths attributable to VI and blindness in the ROI 53
Table 4.4 : Estimated cost of premature mortality from VI and blindness in the ROI, 2010 55
Table 4.5 : Estimated productivity losses from premature mortality (€) 56
Table 4.6 : People with a seeing disability in private households indicating help with everyday activities, by source in 2006 58
Table 4.7 : Estimated people with a seeing disability receiving informal care 59
Table 4.8 : Carers aged 15 years and over in the ROI in 2006 59
Table 4.9 : Estimated value of informal care for people with a seeing disability in the ROI 60
Table 4.10 : Government-funded health care costs on VI and blindness 61
Table 4.11 : Calculated taxation losses – people with a seeing disability and their carers 61
Table 4.12 : Estimated people receiving the Blind Pension 63
Table 4.13 : Estimated people receiving the Blind Welfare Allowance 63
Table 4.14 : Total DWL by component (a) 64
Table 4.15 : Summary of indirect costs of VI and blindness 64
Table 5.1 : Estimated YLDs due to VI and blindness 70
Table 5.2 : Estimated YLLs due to VI and blindness 72
Table 5.3 : Estimated DALYs due to VI and blindness 73
Table 5.4 : DALY burden (€'000) from VI and blindness in the ROI 73
Table 6.1 : The total cost of VI and blindness, by component 75
Table 7.1 : People with partial sight and blindness not in touch with eye care services, UK 81
Table 7.2 : Number of eye tests and undetected mild VI cases diagnosed by screening 81
Table 7.3 : Treatment effectiveness and compliance parameters 83
Table 7.4 : Discounted five-year treatment costs of diagnosed cases 84
Table 7.5 : Total costs associated with intervention 85
Table 7.6 : Prevalence of diabetes in the ROI in people aged 10 years and older 87
Table 7.7 : Number of eye tests and undetected mild VI cases diagnosed by screening 89
Table 7.8 : Discounted five-year treatment costs of diagnosed cases 90
Table 7.9 : Total costs associated with intervention 91
Table 7.10 : Costs of cataract surgery in the ROI 94

Table 7.11 : Hypothetical intervention costs against WHO cost effectiveness thresholds.....95

Glossary

ABS	Australian Bureau of Statistics
ALOS	average length of stay
AMD	age-related macular degeneration
AR-DRG	Australian Refined Diagnosis Related Groups
BCVA	best-corrected visual acuity
BOD	burden of disease
CEA	cost effectiveness analysis
CPI	consumer price index
CSO	Central Statistics Office of Ireland
DALY	disability-adjusted life year
DCBA	disease cost-burden analysis
DM	diabetes mellitus
DR	diabetic retinopathy
DWL	deadweight welfare loss
ESRI	Economic and Social Research Institute
GA	geographic atrophic
GBD	Global Burden of Disease
GDP	gross domestic product
HIPE	Hospital In-Patient Enquiry scheme
HRG	Health Resource Group
HSE	Health Service Executive
ICD-10	International Classification of Diseases, tenth revision
ICER	incremental cost effectiveness ratio
MCPF	marginal cost of public funds
MVIP	Melbourne Visual Impairment Project
NCBI	National Council for the Blind of Ireland
NDS	National Disability Survey
NTPF	National Treatment Purchase Fund
PCRS	Primary Care Reimbursement Service
PPP	purchasing power parity
QALY	quality-adjusted life year
RE	refractive error

ROI	Republic of Ireland
TFR	total fertility rate
VA	visual acuity
VAT	value-added taxation
VI	vision impairment
VSL(Y)	value of a statistical life (year)
VISPA	Vision Impaired Service Providers Alliance
WHO	World Health Organisation
WTP	willingness to pay
YLD	years of healthy life lost due to disability
YLL	years of healthy life lost due to premature death

Executive Summary

Deloitte Access Economics was commissioned by the NCBI (National Council for the Blind of Ireland) to estimate the economic impact of vision impairment (VI) and blindness in the Republic of Ireland (ROI), including costs to the health care system (direct costs), other financial costs to society such as the inability to work due to vision loss (indirect costs), and the burden of vision loss on individuals' wellbeing.

Deloitte Access Economics also conducted cost effectiveness analyses of three eye-care interventions:

- eye screening for people with diabetes in the ROI;
- eye screening for the elderly in the ROI; and
- reducing cataract surgery waiting lists in the ROI.

Burden of disease study

This report comprises the following estimates:

- the numbers of people with mild VI (6/18 ≤ visual acuity [VA] < 6/12), moderate VI (6/60 ≤ VA < 6/18), and blindness (VA < 6/60), by primary cause;
- the costs of VI and blindness to the health care system based on Irish data (or international data using price adjustments between countries);
- the value of lost production/employment due to VI and blindness;
- the cost of informal care provided to people with VI and blindness
- the tax inefficiency associated with public funding of health care for people with VI and blindness (known as deadweight welfare loss [DWL]);
- the burden of VI and blindness on individuals, measured using disability adjusted life years (DALYs), which includes healthy years of life lost due to disability (YLD) and life lost due to premature death (YLL) associated with VI;
- projections of the above outcomes to the year 2020.

These estimates are reported for the years 2010, 2015 and 2020 and all cost results are expressed in 2010 euros.

The numbers of blind people in the ROI were derived from the NCBI register, with an adjustment for the likely extent of under registration. The numbers of people with mild and moderate VI in the ROI were estimated by applying to these data international figures on the relative prevalence of mild/moderate VI to blindness. These prevalence figures were estimated to 2020 by applying ROI population projections (CSO, 2008).

Table i reports the numbers of people with VI or blindness (and associated prevalence rates) in the ROI in 2010. This study indicates that 224,832 people are vision impaired or blind in 2010. Of these, 157,156 have mild VI, 54,681 have moderate VI and 12,995 are blind. The numbers of people with VI and blindness are predicted to increase with population growth. There are projected to be 271,996 people with mild/moderate VI or blindness by 2020.

Table i: Prevalence of VI and blindness (% of all ages population) in the ROI

	2010	2015	2020
Mild VI	157,156 (3.42%)	171,514 (3.42%)	187,928 (3.49%)
Moderate VI	54,681 (1.19%)	59,989 (1.20%)	66,070 (1.23%)
Blind	12,995 (0.28%)	15,270 (0.30%)	17,997 (0.33%)
Total	**224,832 (4.90%)**	**246,773 (4.92%)**	**271,996 (5.06%)**

Source: Deloitte Access Economics calculations

Health care system costs of VI and blindness were estimated using Irish public hospital activity data (ESRI, 2010). In the absence of published Irish cost data, the costs per bed day were imputed using Australian costs and relative health care prices, following a published methodology (Access Economics 2010b, Wimo et al, 2006). DWL was calculated using the proportion of health care costs funded by the Irish government through taxation, and a 57% 'marginal cost of public funds' or tax inefficiency rate (Kleven and Kreiner, 2003).

The health burden of VI and blindness on individuals was calculated using published disability weights from the Netherlands (Stouthard et al, 1997) and the estimated numbers of people with mild VI (weight 0.02), moderate VI (weight 0.17) and blindness (weight 0.43) reported above. These weights have previously been applied in international studies of the burden of VI and blindness (Access Economics, 2004; 2006; 2008a; 2008b; 2009; 2010b; Begg et al, 2007; Mathers et al 1999).

Annual numbers of deaths due to VI were estimated using published mortality rates by age in the ROI, and the relative mortality risk (2.34) in people with a VA less than 6/12 (Access Economics, 2010a). The calculation of deaths accounted for the small proportion of excess deaths specifically attributable to VI (1.38%).

Productivity losses due to VI and blindness were calculated using the human capital method, which values time off work due to VI and blindness using average wages as a proxy for the value of production. These calculations used National Disability Survey (NDS) data on the number of people unable to work due to a seeing disability (CSO, 2010d).

Informal care costs were also estimated using NDS data on the number of people with a seeing disability that receive (unpaid) assistance from friends or relatives. Following standard methodologies, the value of carer time was proxied by GDP per capita.

The results of the burden of disease study are summarised in Table ii. Where data permit, detailed results are presented by VI cause and severity in the main report. The results indicate that 224,832 people are vision impaired in 2010. The health care system costs of VI and blindness total €116.8 million in 2010. Other costs in 2010 total nearly €269.3 million, including an expected DWL of €104.4 million, productivity loss of €56.7 million and an informal care cost of €108.3 million. In total the financial cost of VI and blindness is estimated to be €386.1 million.

The health burden of VI and blindness in the ROI is estimated to be 18,537 DALYs in 2010. The economic valuation of this disease burden (using the reported value of a statistical life year = €94,794) is nearly €1.76 billion.

The burden of disease is projected to increase with population growth.

Table ii: Summary of the burden of vision impairment and blindness in the ROI

	2010	2015	2020
Prevalence of VI (number)	224,832	246,773	271,996
Health care system costs (€ million)	€116.75	€127.42	€136.80
Lost production (€ million)	€56.72	€60.61	€63.74
Informal care (€ million)	€108.25	€118.14	€126.83
Deadweight welfare losses (€ million)	€104.37	€113.57	€121.62
Total financial cost (€ million)	€386.09	€419.73	€449.00
DALYs (number)	18,537	20,804	23,465
Economic value of DALYs (€ million)	€1,757.16	€1,972.11	€2,224.37

Source: Deloitte Access Economics calculations. All costs expressed in 2010 euros.

The results of this study demonstrate the substantial economic impacts of VI and blindness in the ROI. In 2010, the cost to the health care system alone is estimated to be €116.8 million, whilst the total financial cost to society is €386.1 million. These costs could potentially be reduced through coordinated care strategies to reduce the prevalence, incidence and progression of sight loss in the ROI. Without intervention, these costs will continue to increase with population growth.

The health impacts of VI and blindness to affected individuals are equivalent to a burden of 18,537 DALYs in 2010. Using published data on the valuation of life, this burden is valued at nearly €1.76 billion. The health burden of VI and blindness is also forecast to increase over time without increased intervention.

Cost effectiveness analyses

The second part of this report presents the cost effectiveness of three potential (hypothetical) eye care interventions. These analyses are conducted from two perspectives. The health care perspective only includes the costs (and cost savings) to the health care system in the ROI from implementing the interventions. The societal perspective also includes the DWL associated with the government funding each intervention through taxation.

The first intervention was an educational program targeted at people aged 70 years and over, consisting of messages and advertisements through national and regional television and radio stations, national and regional newspapers, and alternative publications such as magazines and online media outlets. The education program was assumed to increase the uptake of eye tests in the elderly population. Intervention costs were derived from a similar educational campaign in Australia (Müller et al, 2007) and the cost of screening tests

in the ROI. The analysis included treatment costs for people diagnosed with VI through screening. The cost effectiveness of the screening program was estimated to be **€17,738 per DALY averted** under a societal perspective, and **€11,974 per DALY averted** under a health care perspective.

The second intervention was an eye screening program for people with diabetes. This would target people in the ROI aged 10 years and older with registered diabetes and deliver free eye tests via an annual, mobile screening service. The service could pick up other eye conditions in addition to diabetic retinopathy. The intervention costs included retinal photography and three-stage grading with internal and external quality assurance, derived from a similar program in Dublin (HSE and Irish College of Ophthalmologists, 2008). Again, the analysis included treatment costs for people diagnosed with VI through screening. The cost effectiveness of the screening program was estimated to be **€9,090 per DALY averted** under a societal perspective, and **€6,031 per DALY averted** under a health care perspective.

Both screening programs are highly cost effective according to World Health Organisation (WHO) thresholds for the cost per DALY averted (WHO, 2011).

The third intervention was government initiatives to improve the efficiency and capacity of cataract surgery services in public hospitals. These initiatives were assumed to reduce the waiting time for cataract surgery by 50% (i.e. double the annual volume of cataract surgeries) in line with a Canadian cataract surgery efficiency program (Boisjoly et al, 2010). The costs of the intervention included:

- bringing forward surgeries;
- increasing capacity (beds, theatres etc) in public hospitals to perform more surgeries;
- increasing the number of ophthalmic surgeons trained in cataract surgery (training and recruitment costs);
- investing in better technology to undertake cataract surgery more efficiently; and
- DWL associated with government funding of these costs.

Since no data were identified to estimate these key intervention costs, rather than estimating the cost effectiveness of this intervention, the CEA estimated the highest intervention cost for which the initiative would be considered cost effective under WHO thresholds.

Under a **health care perspective**, an initiative to reduce cataract surgery waiting lists would be considered highly cost effective if it costed less than €1,869,916, and cost effective if it costed between €1,869,916 and €5,445,733.

The societal perspective for this intervention also included reductions in informal care and productivity losses due to less time living with cataracts and VI. Under a **societal perspective,** the initiative would be considered highly cost effective if it costed less than €1,280,538, and cost effective if it costed between €1,280,538 and €3,558,320.

Deloitte Access Economics

1 BACKGROUND

SUMMARY BOX

Vision impairment is broadly defined as a limitation in one or more functions of the eye or vision system. This study uses the following definitions:

* **blindness -** best-corrected visual acuity of less than 6/60 in the better-seeing eye;

* **moderate vision impairment -** best-corrected visual acuity of less than 6/18 but better than or equal to 6/60 in the better-seeing eye;

* **mild vision impairment -** best-corrected visual acuity of less than 6/12 but better than or equal to 6/18 in the better-seeing eye.

A range of eye conditions can lead to vision impairment and blindness. This study presents the total prevalence rates of mild/moderate vision impairment and blindness, and the proportions of vision impairment and blindness primarily due to cataracts, glaucoma, age-related macular degeneration, diabetic retinopathy and other causes.

Low vision and blindness are prevalent within populations worldwide. In the Republic of Ireland (ROI), the prevalence of blindness alone in 2003 was estimated to be 227 cases per 100,000 adults based on NCBI register data (Kelliher et al, 2006). Accounting for unregistered cases of blindness and less severe vision impairment (VI), the prevalence of vision loss is expected to be far greater. Vision loss imposes a major personal impact on people's daily lives, but there are also major economic impacts on individuals, families, support agencies, society and the state (Jackson et al, 2008).

Deloitte Access Economics was commissioned by the NCBI (National Council for the Blind of Ireland) to estimate the economic impact of VI and blindness in the ROI in 2010, including health system costs, other financial costs, and the loss of wellbeing. This study also includes future projections of VI in the ROI to the year 2020, and cost effectiveness analyses for three eye care interventions that could be used to manage the prevalence and cost of vision loss in the ROI.

Deloitte Access Economics has previously conducted several country-specific burden of disease studies for VI in Australia, Canada, Japan, UK and US (Access Economics, 2004; 2006; 2008a; 2008b; 2009; 2010a), as well as a study on the global economic impact of VI (Access Economics, 2010b). This is the first study to comprehensively estimate the economic impact of VI in the ROI. The methodology employed is Deloitte Access Economics' robust disease cost-burden analysis (DCBA) framework, which has been considered a best practice approach for measuring the full cost of VI (Frick et al, 2010).

This report is structured as follows.

- Chapter 2 estimates the prevalence of VI and blindness in 2010 by age, gender and cause and includes projections for the years 2015 and 2020.
- Chapter 3 presents the direct health care system costs of VI in the ROI.
- Chapter 4 calculates the indirect financial costs of VI including productivity losses, costs of informal care, and deadweight welfare loss.

- Chapter 5 estimates the burden of disease from VI which is the intangible loss of wellbeing, measured in disability-adjusted life years (DALYs), and disaggregated by healthy years of life lost due to disability (YLD) and years of life lost due to premature death (YLL).
- Chapter 6 summarises the total economic cost of VI in the ROI in 2010 disaggregated by cost component.
- Chapter 7 presents the cost effectiveness analyses for three eye care interventions: screening for people with diabetes; screening for the elderly; and reducing cataract surgery waiting lists.

1.1 Definitions: vision impairment and blindness

VI can broadly be defined as a limitation in one or more sensory functions of the eye or vision system. The quantification of VI commonly involves an assessment of visual acuity (VA/high contrast spatial resolution), contrast sensitivity (CS/low contrast spatial resolution), visual field (VF/peripheral vision), and colour vision (CV/colour discrimination). Colour blindness, which is usually a genetically determined inability to distinguish differences in hue, is not a subject of this report.

VA is, in fact, a measure of the finest spatial detail that the visual system can resolve. It is usually measured using letter or symbol charts (optotypes) presented at test distances of 4-6 metres. The term 'distance visual acuity' implies that the measurement has been obtained after any refractive abnormality has been corrected. The term 'vision', when used to express resolution, should be restricted to situations when measurements are made without any optical correction in place. Additional terms in the literature include 'best corrected visual acuity' (BCVA), which indicates the system's optimal acuity with best correction; and 'habitual visual acuity' or 'presenting visual acuity' which refer to the VA measured using current spectacles or contact lenses. When expressing the ability of the eye or visual system to resolve high contrast detail at near or intermediate distances, the measurement is usually expressed as the actual size of the smallest symbol (letter) resolvable at a specified working distance. Letter size is, however, often expressed in printer's font size rather than millimetres or inches.

Contrast sensitivity differs from acuity in that it is not a single measure but a series of measurements designed to show how the eye detects fading detail at different spatial frequencies (acuity levels). Interestingly, the visual system's optimal contrast detection threshold is for large letters similar in size to the largest letter on a conventional Snellen chart. Contrast sensitivity is usually measured using letter or grating charts and is most accurately depicted in graphical form.

Vision, or VA, is usually expressed as a fraction – 6/6 (UK), 20/20 (US) – decimal 1.0 (European), or in a logarithmic series (0.0). In the fraction form the numerator (upper number) represents the test distance whereas the denominator (lower number) represents the distance at which the smallest letter detectable subtends an angle of 5 minutes of arc at the eye. When expressed in decimal or logarithmic form it is important to note the test distance. A figure of 6/12, for example, would indicate that an individual can clearly see the

high contrast detail within a target at a distance of six metres, that a person with unimpaired vision could see at a distance of twelve metres.

Visual fields are expressed in terms of the distance from point of fixation, measured in degrees along an arc, to the last point in the peripheral field that is just detectable. Diagnostic visual field tests usually assess retinal sensitivity using tiny flashing (static) targets presented randomly in the peripheral field as the patient fixates a central target.

Since VI and blindness can vary between one eye and the other, prevalence rates can be reported for either the better or the worse eye in terms of the extent of sight loss. Although sight loss may be asymmetrical, often it is only when sight loss becomes bilateral that it is identified and treated. When reporting prevalence rates, better eye measures provide conservative estimates of sight loss while worse eye measures may tend to overstate sight loss and costs. In this study, the conservative approach of reporting VI for the better eye has been adopted.

BCVA refers to a VA measurement with the best glasses or contact lens prescription for that person. On the other hand, presenting VA refers to VA that is unaided, or with spectacles, if worn. The major difference between the two measurements occurs with uncorrected (or under-corrected) refractive error as best-corrected measurements do not include the population with this condition. This study uses the best-corrected measure for VI definitions, as this was the best approach permitted by available prevalence data.

In this study, VI excluding blindness is disaggregated into mild and moderate VI. The definitions of VA for mild VI, moderate VI, and blindness are consistent with previous Deloitte Access Economics reports and are commonly used in North America, Australia, and most of Europe:

- **blindness** is defined as BCVA less than 6/60 in the better-seeing eye;
- **moderate VI** is defined as BCVA less than 6/18 but better than or equal to 6/60 in the better-seeing eye; and
- **mild VI** is defined as BCVA less than 6/12 but better than or equal to 6/18 in the better-seeing eye.

These definitions differ from those used by the World Health Organisation (WHO), which defines VI as BCVA <6/18 and blindness as BCVA <3/60. The WHO definitions align with International statistical classification of diseases, injuries and causes of death 10th revision (ICD-10) classifications.

The current definition of blindness in the ROI is VA corrected with glasses of less than 6/60 (0.1 decimal/1.0 logMAR) in the better eye, or a field of vision limited to a widest diameter of vision subtending an angle of not more than 20 degrees (NCBI).

In assessing the burden of VI in Ireland, it is important to include people with a VA between 6/12 and 6/18 since their quality of life will also be impacted by VI. Deloitte Access Economics has previously demonstrated increased health care costs and mortality for people with mild VI (for example see Access Economics, 2010). Furthermore, mild VI is associated with a disability burden, albeit relatively low (Mathers et al, 1999). Dandona and Dandona (2006) have recommended adding this mild VI category to ICD definitions. They argue that in more developed countries this level of vision is considered necessary for

daily tasks and is already used to define VI, while the increasing complexity of daily tasks in less developed countries will require better vision over time.

1.2 Conditions leading to vision impairment and blindness

There are a range of eye conditions that can lead to VI and blindness. This study presents VI prevalence for Ireland disaggregated by:

- cataracts;
- glaucoma;
- age-related macular degeneration (AMD);
- diabetic retinopathy (DR);
- other causes.

This report presents the cost effectiveness of three interventions to address the burden of VI in the ROI, specifically relating to these conditions including reduced waiting lists for cataract surgery, vision screening for the elderly, and vision screening for people with diabetes (the elderly and people with diabetes are two groups at higher risk of VI and blindness).

More detail is presented below for these four causes of VI.

1.2.1 Cataracts

A cataract is a cloudy area in the eye's lens. The lens is made mostly of water and protein, with the protein arranged to let light pass through and focus on the retina. Some of the protein may clump together and cloud a small area of the lens. Over time, the cataract may grow larger and cloud more of the lens, making it hard to see.

The most common symptoms of cataract are cloudy or blurry vision; problems with light – headlights that seem too bright, glare from lamps or the sun, or a halo or haze around lights; colours that seem faded; double or multiple vision (this symptom goes away as the cataract grows); and /or frequent changes required in eyeglasses or contact lenses.

There are four main types of cataract:

- **Age-related cataract**: Most cataracts are related to ageing.
- **Congenital cataract**: Some babies are born with cataracts or develop them in childhood, often in both eyes.
- **Secondary cataract**: Cataracts may be linked to certain other health issues, such as diabetes or steroid use.
- **Traumatic cataract**: Cataracts can develop soon after an eye injury, or years later.

It is still unclear what causes cataract, however age, smoking, diabetes, use of cortico-steroids and ultraviolet exposure increase the risk. Detection is through an eye examination including a VA test (eye chart test), pupil dilation (where the pupil is widened

with eye-drops to allow the eye care professional to see more of the lens and look for other eye problems).

For an early cataract, different spectacles, magnifying lenses, or stronger lighting may improve vision. At a certain point, based on VA and patient concern, surgery may be needed to improve vision.

1.2.2 Age-related macular degeneration

AMD usually develops after 50 years of age, progressively destroying the macula, the central portion of the retina and impairing central vision. Changes to the central area of the macula responsible for detailed vision can be rapid, impacting severely on day to day life.

In the early stages of AMD, pale yellow spots caused by distinct lesions consisting of lipids and protein (known as drusen) accumulate as deposits within Bruch's membrane and beneath the retinal pigment epithelium. The progression of 'early' AMD to 'late' AMD, is often from dry AMD to wet AMD, and is generally associated with decreasing VA.

Geographic atrophic (GA) AMD is characterised by light-sensitive cells in the macula slowly breaking down and being replaced with scar tissue. People with GA AMD have extensive medium-sized drusen or one or more large drusen in one or both eyes. At this stage, people with GA AMD will have substantially decreased capacity for near visual tasks as central vision deteriorates.

Wet AMD is caused by blood vessels reproducing in the choroid in a process called choroidal neovascularisation. The new choroidal vessels leak or bleed into the underlying retina, damaging the retina, including the central macula region. The blood and fluid can also cause macular scarring or the detachment of either the retinal pigment epithelium or sensory retina. Wet AMD is characterised by the appearance of central visual blurring and distortion, with straight lines appearing crooked or wavy. It can occur in one eye without any symptoms being recognised by the person, although symptoms become more noticeable once the second eye is affected.

Several risk factors can increase the risk of developing AMD and the speed at which the disease progresses. Cigarette smoking is the main lifestyle risk factor, although alcohol consumption and obesity have also been associated with an increased risk of developing AMD. Control of these modifiable risk factors could reduce the risk of developing AMD by 45% (Tomany et al 2004).

Progression of AMD will also occur more steadily if protective measures are taken. Nutrition, or more specifically dietary antioxidants, plays an important role in the occurrence, prevention and treatment of AMD. Recent research suggests that some foods may decrease a person's risk for the disease by up to 65% (Tan et al, 2008). Since there is currently no effective treatment for GA AMD, prevention is the first approach to reducing VI. Treatments available for wet AMD include laser treatment, photodynamic therapy, and recent injectable medications including ranibizumab.

1.2.3 Diabetic retinopathy

DR is an important cause of VI. It occurs when diabetes mellitus (DM) damages the tiny blood vessels inside the retina, and usually affects both eyes. At first, micro-aneurysms occur. As the disease progresses, some blood vessels that nourish the retina are blocked. There are two ways that VI occurs:

- **proliferative retinopathy**: if many blood vessels are blocked, and several areas of the retina are deprived of their blood supply, signals are sent to grow new blood vessels, which may be abnormal and fragile, growing along the retina and along the surface of the clear, vitreous gel that fills the inside of the eye. These blood vessels have thin, fragile walls that, if they leak blood into the centre of the eye, can result in blurred vision and blindness.
- **macular oedema***:* fluid can leak into the macula, causing swelling and blurred vision. This is more likely to occur as the disease progresses. About half of people with proliferative retinopathy also have macular oedema.

All people with type 1 or type 2 DM are at risk of developing DR and should have a comprehensive dilated eye examination at the time of diagnosis and at least once every two years thereafter if no DR is found (NHMRC, 2008). If DR is detected, further examinations should be conducted annually or at three-12 monthly intervals depending on the level of DR. Any visual symptoms should prompt a further referral (NHMRC, 2008). Early diagnosis and treatment can prevent up to 98% of severe VI (Access Economics 2010a). Lack of awareness and communication breakdowns are major impediments to regular screening.

DR often has no early symptoms. If bleeding occurs, the person can see specks of blood, or spots, "floating" in their vision. Occasionally spots clear without treatment, but haemorrhages tend to happen more than once, often during sleep. The earlier treatment is received, the more likely it is to be effective. Control of blood sugar, cholesterol and blood pressure, as well as the length of time a person has had diabetes are related to the risk and severity of DR.

1.2.4 Glaucoma

Glaucoma is a group of diseases that can lead to damage to the eye's optic nerve and result in blindness. It has no symptoms at first, but once detected and with early treatment, eyes may be protected against serious VI and blindness.

The optic nerve comprises over a million nerve fibres connecting the retina with the brain. In the front of the eye is a space called the *anterior chamber* – clear fluid flows in and out of this space, leaving the chamber at the angle where the cornea and iris meet. When the fluid reaches the angle, it flows through a spongy meshwork, like a drain, and leaves the eye.

Open-angle glaucoma, the most common type, occurs when, for unknown reasons, the fluid passes too slowly through the meshwork drain. As the fluid builds up, the pressure inside the eye rises. Unless the pressure at the front of the eye is controlled, it can damage the optic nerve and cause VI. At first, vision is normal and there is no pain. Without

treatment, side vision is reduced, and the remaining forward vision may decrease until there is no vision left.

Increased risk for glaucoma occurs with elevated intraocular pressure, older age, large cup to disc ratio, thin central cornea, family history and ethnicity (particularly people from African-American descent).

Glaucoma is detected through an eye examination including visual acuity, visual field, tonometry and optic nerve examination. Although there is no cure for glaucoma, early diagnosis and treatment are important to control it and thus protect sight.

2 PREVALENCE OF VISION IMPAIRMENT AND BLINDNESS

SUMMARY BOX

The prevalence of blindness in the ROI was estimated using NCBI register data (of people registered as blind) and from this, the prevalence of mild and moderate vision impairment was imputed using ratios from a study on vision impairment in the UK.

Overall, it is estimated that in the ROI in 2010, there were:

* 12,995 blind people;

* 157,156 people with mild vision impairment;

* 54,681 people with moderate vision impairment; and

* 224,832 people with total (mild and moderate) vision impairment and blindness.

Total vision impairment and blindness is projected to grow to 271,996 people by 2020, including 187,928 people with mild vision impairment, 66,070 people with moderate vision impairment and 17,997 blind people.

The burden of disease methodology in this study is based on a prevalence approach to cost measurement, as the data sources lend themselves to such an approach. Prevalence approaches measure the number of people with a given condition (in this case mild VI, moderate VI, or blindness) in a base period (in this case calendar year 2010) and the costs of treating them, as well as other financial and non-financial costs (productivity losses, carer burden, loss of quality of life) in that year, due to the condition. When the aim of a study is to estimate the economic burden of a disease during a specified period of time (e.g. one year) a prevalence approach is recommended. If the aim is to illustrate the economic consequences of various interventions, an incidence approach is preferable (Wimo et al, 2006).

One advantage of a prevalence approach is that where results are reported for a series of years, trends in the disease burden can be examined. This method also avoids the uncertainty surrounding estimates of future treatment costs associated with an incidence approach. It is recognised that given the chronic nature of VI some of the total prevalence of VI in each year may include the same individuals. However, to calculate the burden of disease using a prevalence based approach all that is required are prevalence rates for the population of interest and average annual costs per person with VI.

In this study, the prevalent numbers of people with mild VI, moderate VI, and blindness in the ROI were calculated by multiplying national population data by estimated prevalence rates according to VI severity and age-gender group. An overview of the method used to project population prevalence to the year 2020 is provided below.

2.1 Population data

Current population estimates and projections were obtained from the Central Statistics Office (CSO) Ireland (CSO, 2008). The CSO (2008) projected the ROI population to the year 2041 based on 2006 national census data.

CSO projection scenarios are based on two fertility variants and three migration variants:

- High fertility variant (F1): the total fertility rate (TFR) to remain at its 2006 level of 1.9 for the lifetime of the projections.
- Low fertility variant (F2): the TFR to decrease to 1.65 by 2016 and to remain constant thereafter.
- Low migration variant (M0): based on zero net migration.
- High migration variant (M1): based on immigration continuing at recently-observed high levels and then moderating.
- Mid migration variant (M2): based on immigration continuing at more moderate levels.

The latest CSO publication (CSO, 2010a) noted that in the twelve months to April 2010, the natural increase in the population remained strong while negative net migration was recorded due to the high net outward migration. If the trend of high emigration continues, the ROI may be left with a relatively elderly population. Given this information, the M2F1 scenario projections were selected for this study, based on expected moderate future immigration, continuing high emigration, and continuing high fertility. From the six possible projection scenarios, the M2F1 scenario represented one of the two mid-estimate scenarios (with M2F2 producing slightly lower population estimates).

Population projections for the M2F1 scenario for the years 2010, 2015 and 2020 are presented in Table 2.1.

Table 2.1: ROI population projections

Age-group	2010	2015	2020
Male			
0-4	171,242	189,411	193,680
5-9	158,582	176,761	193,750
10-14	150,108	162,540	179,846
15-19	143,411	150,875	162,620
20-24	158,710	145,870	149,617
25-29	215,744	188,588	167,718
30-34	205,225	237,184	204,748
35-39	186,560	216,646	245,577
40-44	165,097	192,853	221,170
45-49	151,508	168,154	194,956
50-54	135,505	153,074	169,119
55-59	121,561	134,948	152,188
60-64	108,331	119,032	132,389

Age-group	2010	2015	2020
65-69	81,171	103,430	114,362
70-74	61,466	74,340	95,932
75-79	44,965	52,432	65,090
80-84	27,305	33,915	41,467
85-89	13,789	17,498	23,443
90+	5,007	8,013	11,984
Total males	**2,305,287**	**2,525,564**	**2,719,656**
Female			
0-4	162,139	178,722	182,610
5-9	151,634	167,747	183,097
10-14	141,992	155,394	170,635
15-19	136,415	142,898	155,552
20-24	160,354	144,754	146,270
25-29	209,597	190,023	166,282
30-34	195,130	225,617	201,922
35-39	177,620	202,594	231,014
40-44	158,311	181,376	205,240
45-49	150,383	160,789	183,103
50-54	133,384	151,107	161,152
55-59	119,529	132,976	150,400
60-64	107,329	118,333	131,546
65-69	81,914	104,616	115,514
70-74	66,375	77,779	99,786
75-79	54,231	60,082	71,267
80-84	41,347	44,797	50,816
85-89	25,920	28,801	32,718
90+	12,893	17,264	21,545
Total females	**2,286,497**	**2,485,669**	**2,660,469**
Total population	**4,591,784**	**5,011,233**	**5,380,125**

Source: CSO (2008) scenario M2F1

2.2 Prevalence sources

Data sources for the prevalence of VI in the ROI include published studies and the NCBI register of people registered as blind. As demonstrated in Section 2.2.1, there have been few past studies on VI and blindness in the ROI. The best data source for estimating the current prevalence rates and causes of blindness in the ROI is the NCBI register. However, as noted by the Vision Impaired Service Providers Alliance (VISPA) (Jackson et al, 2008), these data should not be used in isolation, in particular due to under-registration of blind people in the ROI (Kelliher et al, 2006).

The ROI does not have a national register of people with partial vision (mild or moderate VI). However, a range of published studies have estimated the prevalence of partial vision loss within communities in the ROI and similar countries using survey data and modelling approaches.

A variety of these sources have been used in this study to model prevalence rates for VI in the ROI.

2.2.1 Past prevalence studies for Ireland

There have been few past studies on VI and blindness in the ROI. The VISPA found only six of 138 studies referencing blindness/VI and Ireland referred to overall prevalence of VI in the ROI or Northern Ireland (Jackson et al, 2008).

A literature search was undertaken for this report to identify studies reporting the prevalence of blindness and VI in the ROI, with key search terms based on VA cut-off scores (e.g. 6/12, 6/18, 6/60, 3/60), and a range of terms for VI, blindness and causes of vision loss. Medical databases searched included Medline, EMBASE and PubMed, and general internet search engines. Due to a paucity of studies identified for the ROI in this search (five studies identified), the search was expanded to include Northern Ireland studies.

In total, only nine studies were identified that reported the prevalence of blindness and/or low vision in communities within the ROI or Northern Ireland. These included the six studies identified by VISPA (Jackson et al, 2008), the VISPA report itself, and two additional studies (O'Donoghue et al, 2010; Donnelly et al, 2005). Five of the studies cover the ROI, and four studies were undertaken in Northern Ireland.

A summary of the nine published studies reporting the prevalence of blindness and/or low vision in communities within the ROI or Northern Ireland is presented in Table 2.2

Table 2.2: Past studies on blindness and VI - ROI and Northern Ireland

Study	Region	Age group (years)	Causes analysed	Blindness definition	VI definition	Limitations (a)
Coffey et al (1993)	ROI	50+	Glaucoma	BCVA <3/60	BCVA <6/18	Specifically focuses on glaucoma, no age-gender breakdown for prevalence of overall VI and blindness in sample.
Munier et al (1998)	ROI	16+	All causes contributing to blind registration	BCVA <6/60 or visual field ≤ 20 degrees	n/a	Analyses older blind register data and no analysis of mild/moderate VI.
Kelliher et al (2006)	ROI	16+	All causes contributing to	BCVA <6/60 or	n/a	Updates Munier et al (1998) with

Study	Region	Age group (years)	Causes analysed	Blindness definition	VI definition	Limitations (a)
			blind registration	visual field ≤ 20 degrees		analysis of newer 2003 blind register data. No age-gender breakdown for prevalence and no analysis of mild/moderate VI.
Khan et al (2007)	ROI	<16	Break-up by primary ophthalmic diagnosis	BCVA <3/60 or visual field ≤ 20 degrees	n/a	Only covers the broad <16 years age group and no analysis of mild/moderate VI.
Canavan et al (1997)	N. Ireland	All ages	Glaucoma, myopia, DR, macular degeneration, senile cataracts	UK legal definition of blindness	n/a	Covers Northern Ireland not ROI, age-breakdown only provided for incidence.
Flanagan et al (2003)	N. Ireland	<19	Break-up by primary ophthalmic diagnosis	No perception of light	Various	Covers Northern Ireland not ROI, no breakdown by specific age-groups (broad <19 years), various VI definitions employed.
Donnelly et al (2005)	N. Ireland	8-9	Strabismus, anisometropia, ametropia, organic defects	n/a	<6/18	Covers Northern Ireland not ROI, narrow age-group focus.
O'Donoghue et al (2010)	N. Ireland	6-7, 12-13	Uncorrected refractive error	n/a	VA <6/12	Covers Northern Ireland not ROI, specifically focuses on URE (presenting VA), narrow age-group focus,

Source: Deloitte Access Economics

Abbreviations: n/a = not applicable (prevalence of blindness or less severe VI was not examined in the study)

(a) Limitations with using study to estimate age-gender specific prevalence of overall VI and blindness in the ROI.

A comprehensive picture of VI in the ROI cannot be gained from any one study, since each study focuses on a particular age group or other population bracket. For example, four studies (O'Donoghue et al, 2010; Donnelly et al, 2005 Flanagan et al, 2003; Khan et al, 2007) look specifically at VI and blindness in children only. Additionally, comparability of the

results between studies is restricted due to different VI and blindness definitions, and differing focus on specific causes and eye conditions.

Of those papers that do reference the overall prevalence of VI and blindness in adults, nearly all draw on data from the blind registers in the ROI and Northern Ireland (Canavan et al, 1997; Kelliher et al, 2006; Munier et al, 1998). The exception is a study by Coffey et al (1993) which studied the prevalence of glaucoma in the west of Ireland. This study recruited 2,186 people aged over 50 years from County Roscommon and derived estimates for the overall prevalence of VI and blindness in the sample, using ophthalmologist-measured BCVA measurements. However, these prevalence rates were not disaggregated by age and gender and their application is therefore limited.

Due to limitations with these past studies, the prevalence of blindness in the ROI was estimated directly from the NCBI's latest register data as described in Section 2.2.2. The methods for adjusting these data for under-reporting and modelling the prevalence of mild and moderate VI using these data and other sources are described in Section 2.4.

2.2.2 Republic of Ireland blind register

The ROI maintains a national, centralised database of registered blind people in the country through the NCBI. The criteria for registration is legal blindness, defined as an ophthalmologist-measured visual acuity of 6/60 or less in the better eye, or a visual field restricted to 20 degrees or less. Eligible blind patients are registered with the NCBI by the assessing ophthalmologist or optometrist. Registration is voluntary but entails the incentive of practical and monetary benefits including the Blind Welfare Allowance.

The register is valuable for assessing the prevalence of blindness in the country. However, it is noted that data obtained specifically from national registers of blindness can significantly underestimate the true national prevalence of VI and blindness (Bunce et al, 1998; Kelliher et al, 2006; Robinson et al, 1994).

Previous UK studies have found 45% to 60% non-registration rates amongst those who are eligible for blind or partial sight registration (Barry and Murray, 2005; Bunce et al, 1998; Charles 2007; Robinson et al, 1994). For example, a recent study, Barry and Murray (2005) found 45% of eligible patients were not registered; 28% for blind registration, and 72% for partial sight registration.

Kelliher et al (2006) examined under-registration in the ROI context and found that 21% of eligible blind patients at an outpatient clinic were not appropriately registered. While this is lower than estimates from the English studies, it nonetheless suggests that under-registration is a concern with applying register data to directly estimate blindness prevalence in the ROI.

As with previous English studies, Kelliher et al (2006) also found that people with temporary causes of blindness (i.e. cataract) were more likely to be non-registered. Robinson et al (1994) and Bunce et al (1998) found that patients with permanent diseases undergoing active treatment were more likely to be non-registered. This was not found in the Irish study (Kelliher et al, 2006).

Analysis of current blind register data

Current blind register data (i.e. for 2010) was requested from the NCBI by age group and gender disaggregated by the following registered health conditions (primary causes of blindness):

- AMD;
- cataracts;
- DR;
- glaucoma; and
- other causes.

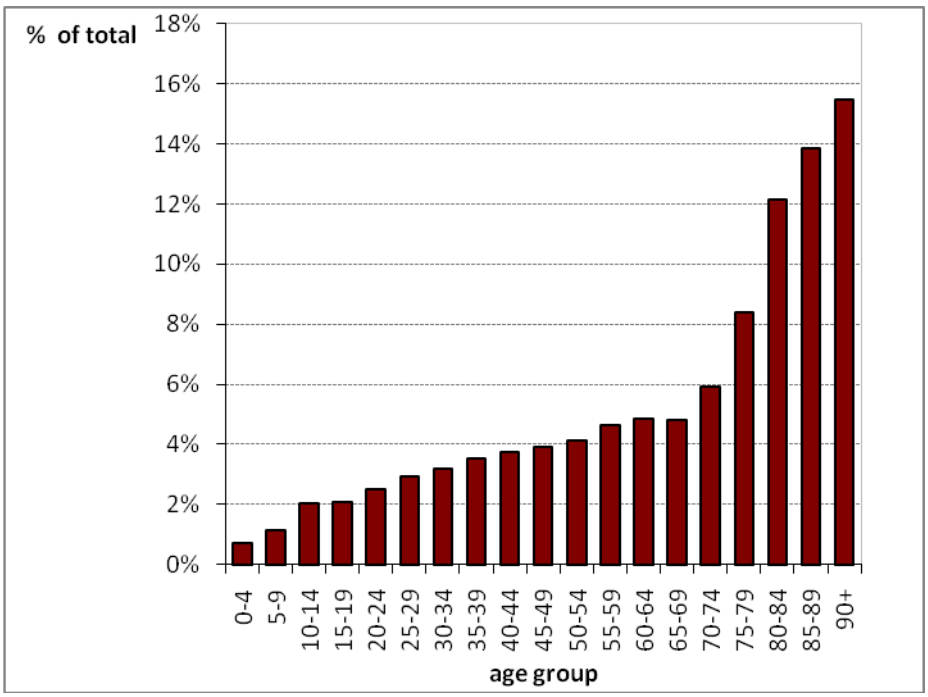
There were 10,223 registered blind people meeting the blind criteria (VA of <6/60 in the better eye, or visual field of 20 degrees or less) in the ROI in 2010. Approximately 57% of these were female.

An additional 1,909 people were registered blind by an ophthalmologist but had no further details of their VA recorded. Discussions with the NCBI revealed that, historically, people may have been registered without a formal assessment of their VA. Therefore, to accurately estimate the prevalence of blindness according to the definitions used in this study, people without a VA record in the register were excluded from the estimates of blindness prevalence. This produces a conservative estimate of the number of people who are registered blind in the ROI and meet the blindness criteria for this study.

The 10,223 people with recorded visual acuity and visual field data represent approximately 0.22% of the estimated population of the ROI in 2010 (CSO, 2008). This is similar to the estimate of blindness prevalence for adults aged 16 years and older (0.23%) obtained from 2003 blind register data by Kelliher et al (2006).

The age breakdown of registered blind people is presented in Chart 2.1. A rising age distribution is noted, with the 90 years plus age group representing the largest proportion (15%) of total registered blind people.

Chart 2.1: Age distribution: % of total registered blind people in age group



Source: Deloitte Access Economics using NCBI register data (special request, 2010)

Blindness by cause

There were 10,203 registered blind people having a recorded 'primary cause of vision loss' as assessed by an ophthalmologist. The cause breakdown for people on the blind register is presented in Chart 2.2, focusing on those conditions related to the interventions evaluated in Chapter 7 of this report – AMD, cataracts, DR and glaucoma. People whose primary cause of blindness was not coded as any of these four causes were coded as having blindness due to 'other causes'.

The majority of people on the register (62%) fell into the 'other causes' category. As shown below, this proportion is higher for younger age groups, and is consistent with blindness being caused by a wider range of pathologies than just AMD, cataracts, DR and glaucoma (particularly in younger people). Kelliher et al (2006) assessed the three most common 'other causes' in 2003 to be retinitis pigmentosa (7% of all blindness), myopia (5% of all blindness), and optic atrophy (4% of all blindness). In total, Kelliher distinguished 15 primary causes of blindness, and included an 'other causes' category.

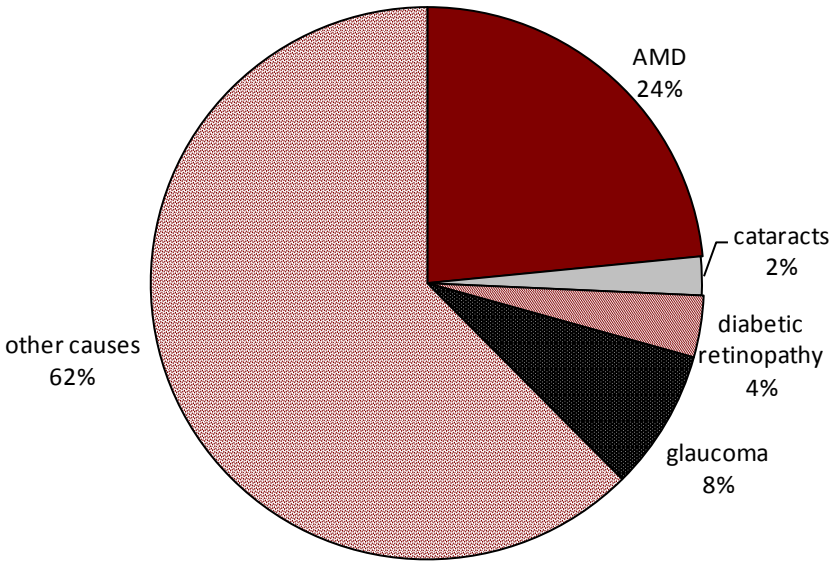
Other reasons for the high proportion of blindness due to 'other causes' are: (1) some older people registered many years ago may not have had their cause of blindness recorded at that time; (2) potential miscoding of primary cause in some NCBI register data.

The largest specific cause category was AMD, comprising 24% of registered people with a recorded cause of blindness. Glaucoma and DR were identified as the primary causes for 8% and 4% of registered blindness, respectively. Cataracts comprised the smallest specific cause category (2% of people with recorded cause). These figures for 2010 are similar to Kelliher et al's (2006) analysis of the NCBI register in 2003, which reported the proportions by primary cause to be: 25% AMD; 12% glaucoma; 5% DR; 4% cataracts; and, hence, 54%

other causes. Kelliher noted that glaucoma and cataracts decreased as a proportion of registered blindness between 1996 and 2003. The data presented here suggest these trends have continued.

The figures reported below are less consistent with UK estimates. Access Economics (2009) estimated the proportion of all blindness due to AMD, glaucoma, DR and cataracts to be 51%, 17%, 9% and 13%, respectively. The differences may be partly due to the modelling assumptions in the UK study, where data were taken from a variety of sources (including UK data for the causes of blindness in people aged 75 years and older only) compared with ROI data derived directly from the NCBI register for all ages.

Chart 2.2: Registered blind people - % breakdown by cause



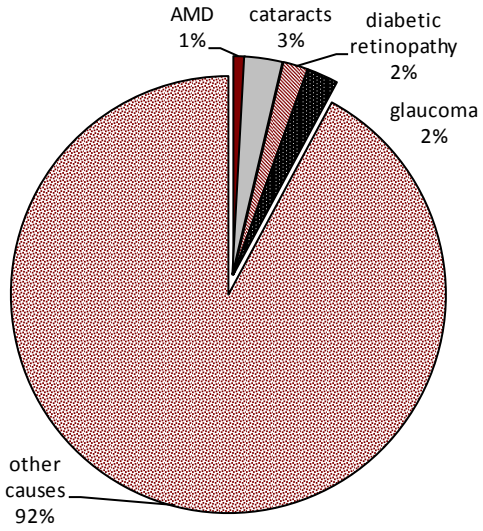
Source: Deloitte Access Economics using NCBI register data (special request, 2010)

It is useful to analyse cause distributions by age groups to see how causes differ, and how certain causes (i.e. AMD) are primarily age-related or progressive (i.e. DR).

Approximately 97% of blindness for the age group 0-19 years can be attributed to 'other causes'. Glaucoma and cataracts represent 1.5% and 1.3% of blindness, respectively. For 0.2% of this group their cause of blindness is coded as AMD. This may be due to miscoding including cases of juvenile macular degeneration. There were no people registered with DR as the primary cause of blindness in this age group.

For people aged 20 to 44 years, 'other causes' again account for the largest portion of registered blindness at 92% (see Chart 2.3). Cataracts comprise 3% of total blindness. Glaucoma and DR form roughly similar shares of total blindness (around 2% each). In this age group, AMD constitutes only 1% of total registered blindness.

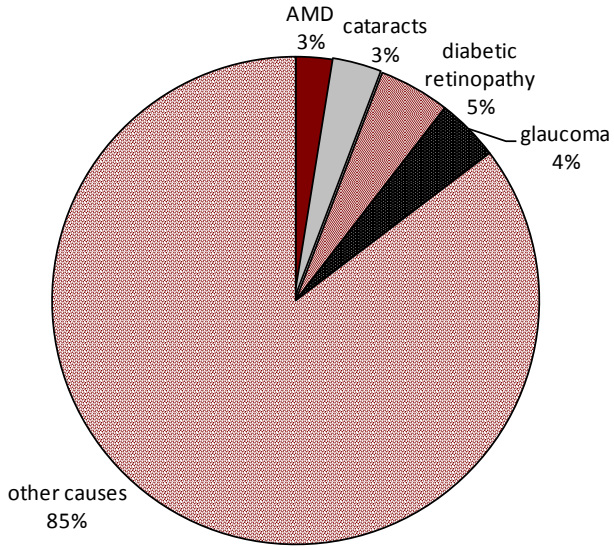
Chart 2.3: Registered blind people - % breakdown by cause for age 20-44 years



Source: Deloitte Access Economics using NCBI register data (special request, 2010)

For people aged 45 to 59 years, there are slight increases in the proportions of blindness due to AMD, glaucoma and DR relative to the younger age groups (see Chart 2.4). 'Other causes' continue to account for the largest proportion of blindness (85%), with DR being the largest single cause (5%).

Chart 2.4: Registered blind people - % breakdown by cause for age 45-59 years

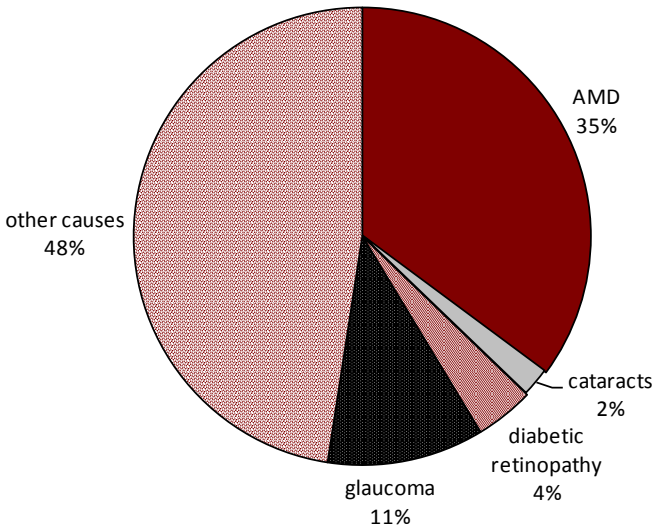


Source: Deloitte Access Economics using NCBI register data (special request, 2010)

For people aged 60 years or older, there is a notable jump in the proportion of blindness caused by AMD relative to younger age groups (see Chart 2.5 and Chart 2.4). AMD is the primary cause of 35% of registered blindness cases in people aged 60 years or older. Glaucoma comprises 11% of total blindness (also a large increase from the younger age groups), with DR and cataracts comprising 4% and 2% of cases, respectively.

These figures for people aged 60 years and older are consistent with UK data that show the proportions of partial sight and blindness (VA < 6/18) by cause to be 36% AMD, 8% glaucoma, and 2% diabetic eye diseases in people aged 75 years and older (Access Economics, 2009). However, the UK data reported 25% of partial sight and blindness being due to cataracts in people aged 75 years and older. This substantially higher proportion may reflect a greater incidence of cataracts in people aged 75 years and older than in people aged 60-74 years.

Chart 2.5: Registered blind people - % breakdown by cause for age 60+ years



Source: Deloitte Access Economics using NCBI register data (special request, 2010)

The results above show that, as expected, the proportions of registered cases of blindness due to AMD, cataracts and glaucoma increase with age. These three eye conditions are all related with aging. The proportion of blind cases due to DR shows less marked increases with age and is 4% for the total population registered blind in the ROI.

2.3 Blindness

In this section, the numbers of blind people in the ROI are estimated using the data from the blind register and population forecasts described above, and published study data reporting the likely extent of under registration of blind people in the ROI.

2.3.1 Current prevalence rates

2.3.1.1 Total blindness

Estimates of age/gender specific prevalence rates were derived from the NCBI register data for 2010, as described above, and were applied to population estimates from the CSO (2008).

There were 10,223 registered blind people who met the blind criteria, in 2010. To account for under-registration of blind people in the ROI, an adjustment factor was derived from a study by Kelliher et al (2006), which was the only study identified that estimated the extent

of under-registration. Kelliher et al (2006) conducted an additional 9-week study of a tertiary referral ophthalmology department in the ROI and ascertained the registration status of all eligible patients. Over the study period, 75 of 2,320 attending outpatients (3.2%) fulfilled the blind registration criteria, and 16 of 75 (21.3%) had not been appropriately registered. This implies that the number of people who are actually blind is 27.1% greater than the number who are registered i.e. 1 ÷ (1 – 0.213) = 1.271. Therefore, an adjustment factor for under-registration of 1.271 was applied in this study.

It should be noted that many people with deteriorating vision do not seek advice from health care professionals and consequently are never referred to hospital for their vision loss. Therefore, the adjustment factor estimated from hospital data is likely to be conservative (Kelliher et al 2006), and the resulting prevalence rates of mild and moderate VI, which are estimated from blindness prevalence (see below), are also likely to be conservative.

This adjustment factor applied to total registered people gives an estimate of 12,995 (1.27 x 10,223) blind people in the ROI in 2010. This represents a total blindness prevalence rate of approximately 0.28% when divided by the total population of the ROI in 2010 (4,591,784 people from Table 2.1 in Section 2.1).

The derived age-gender prevalence rates for blindness are presented in Table 2.3. These were estimated by multiplying the number of people on the NCBI register by the adjustment factor for under-reporting, and dividing this number by the population size of that group in the ROI in 2010 (see Table 2.1 in Section 2.1). A rising age-distribution for blindness prevalence is apparent, and the total prevalence of blindness is higher for females than for males.

Table 2.3: Prevalence rates for blindness(a) in the ROI, by age and gender(b)

Age group	Male	Female	Total
0-4	0.025%	0.031%	0.028%
5-9	0.051%	0.045%	0.048%
10-14	0.096%	0.086%	0.091%
15-19	0.099%	0.091%	0.095%
20-24	0.103%	0.102%	0.102%
25-29	0.088%	0.090%	0.089%
30-34	0.104%	0.104%	0.104%
35-39	0.129%	0.122%	0.126%
40-44	0.145%	0.157%	0.151%
45-49	0.171%	0.164%	0.168%
50-54	0.202%	0.197%	0.200%
55-59	0.247%	0.255%	0.251%
60-64	0.320%	0.265%	0.293%
65-69	0.418%	0.346%	0.382%
70-74	0.623%	0.584%	0.603%
75-79	1.074%	1.125%	1.102%
80-84	2.300%	2.303%	2.302%

Age group	Male	Female	Total
85-89	4.185%	4.718%	4.533%
90+	12.034%	10.905%	11.221%
All ages	**0.245%**	**0.321%**	**0.283%**

Source: Deloitte Access Economics estimates using NCBI register data (special request, 2010), ROI population estimates (CSO, 2008) and Kelliher et al (2006)

(a) Blindness defined as VA <6/60 in better eye or central visual field ≤ 20 degrees.

(b) Total people on NCBI register in 2010 adjusted upwards by 1.27 adjustment factor to account for under-registration (Kelliher et al, 2006).

2.3.1.2 Blindness by cause

Derived age-gender prevalence rates of blindness by cause of blindness are presented in Table 2.4. These were calculated by applying the age-gender specific cause distributions from the NCBI register data to the prevalence rates in Table 2.2.

Table 2.4: Prevalence rates for blindness (a) in the ROI, by cause, age and gender (b)

Age group	AMD (c)	Cataracts	DR	Glaucoma	Other cause
Males					
0-4	-	-	-	0.001%	0.024%
5-9	-	0.002%	-	-	0.049%
10-14	0.001%	0.003%	-	-	0.092%
15-19	-	-	-	0.002%	0.098%
20-24	0.002%	-	-	0.002%	0.099%
25-29	0.001%	0.001%	0.001%	-	0.085%
30-34	0.001%	0.004%	0.001%	0.003%	0.095%
35-39	0.001%	0.005%	0.001%	0.005%	0.117%
40-44	0.003%	0.003%	0.007%	0.007%	0.125%
45-49	0.002%	0.008%	0.004%	0.005%	0.152%
50-54	0.004%	0.006%	0.010%	0.008%	0.174%
55-59	0.004%	0.005%	0.017%	0.021%	0.200%
60-64	0.016%	0.011%	0.032%	0.031%	0.231%
65-69	0.030%	0.008%	0.049%	0.044%	0.288%
70-74	0.096%	0.016%	0.072%	0.084%	0.354%
75-79	0.226%	0.017%	0.071%	0.175%	0.585%
80-84	0.805%	0.051%	0.070%	0.368%	1.006%
85-89	1.733%	0.083%	0.111%	0.691%	1.567%
90+	5.230%	0.152%	0.102%	2.615%	3.935%
Total males	**0.041%**	**0.005%**	**0.011%**	**0.026%**	**0.161%**
Females					
0-4	-	-	-	0.001%	0.031%
5-9	-	-	-	0.001%	0.044%
10-14	-	0.003%	-	0.003%	0.081%

Age group	AMD (c)	Cataracts	DR	Glaucoma	Other cause
15-19	-	-	-	0.001%	0.090%
20-24	0.001%	0.005%	-	0.003%	0.094%
25-29	0.001%	0.001%	0.001%	-	0.088%
30-34	-	0.002%	0.004%	0.002%	0.096%
35-39	0.001%	0.006%	0.002%	0.003%	0.110%
40-44	-	0.007%	0.004%	0.002%	0.143%
45-49	0.001%	0.007%	0.004%	0.004%	0.148%
50-54	0.009%	0.004%	0.012%	0.006%	0.167%
55-59	0.014%	0.010%	0.012%	0.009%	0.212%
60-64	0.017%	0.007%	0.023%	0.012%	0.207%
65-69	0.034%	0.015%	0.030%	0.021%	0.247%
70-74	0.100%	0.015%	0.061%	0.046%	0.362%
75-79	0.394%	0.021%	0.052%	0.110%	0.549%
80-84	1.070%	0.031%	0.037%	0.184%	0.981%
85-89	2.408%	0.074%	0.069%	0.392%	1.775%
90+	5.196%	0.237%	0.138%	0.937%	4.397%
Total females	**0.092%**	**0.007%**	**0.010%**	**0.020%**	**0.192%**
Total	**0.066%**	**0.006%**	**0.010%**	**0.023%**	**0.177%**

Source: Deloitte Access Economics estimates using NCBI register data (special request, 2010), ROI population estimates (CSO, 2008) and Kelliher et al (2006). Categories containing no people are marked by a dash.

(a) Blindness defined as VA <6/60 in better eye or central visual field ≤ 20 degrees.

(b) Total people on NCBI register in 2010 adjusted upwards by 1.27 adjustment factor to account for under-registration (Kelliher et al, 2006).

(c) Based on NCBI register data; blindness due to AMD in younger people is likely to reflect juvenile macular degeneration or other miscoding

2.3.2 Population estimates and projections

2.3.2.1 Estimates by age and gender

Blindness prevalence rates were applied to population projections from the CSO (2008) to estimate future numbers of blind people in the ROI. Estimates of the numbers of blind people in the ROI are presented by age-gender group in Table 2.5. It is estimated that there were nearly 13,000 blind people in the ROI in 2010, which is expected to grow to nearly 18,000 people by 2020.

Table 2.5: Projections of blind people in the ROI, by age and gender

Age group	2010	2015	2020
Males			
0-4	43	48	49
5-9	80	89	98
10-14	144	156	172
15-19	142	150	161

Age group	2010	2015	2020
20-24	163	150	153
25-29	189	166	147
30-34	214	247	213
35-39	240	279	316
40-44	239	279	320
45-49	259	288	334
50-54	273	309	341
55-59	300	333	376
60-64	347	381	424
65-69	339	432	478
70-74	383	463	597
75-79	483	563	699
80-84	628	780	954
85-89	577	732	981
90+	603	964	1,442
Total males	**5,647**	**6,809**	**8,256**
Females			
0-4	51	56	57
5-9	69	76	83
10-14	122	134	147
15-19	125	130	142
20-24	164	148	150
25-29	189	172	150
30-34	202	234	209
35-39	217	248	283
40-44	248	284	321
45-49	247	264	300
50-54	263	298	318
55-59	305	339	384
60-64	285	314	349
65-69	283	362	400
70-74	388	454	583
75-79	610	676	802
80-84	952	1,032	1,170
85-89	1,223	1,359	1,544
90+	1,406	1,883	2,349
Total females	**7,349**	**8,462**	**9,741**
Total (a)	**12,995**	**15,270**	**17,997**

Source: Deloitte Access Economics estimates using NCBI register data (special request, 2010), ROI population estimates (CSO, 2008) and Kelliher et al (2006)

(a) Totals may differ from summed components due to rounding.

2.3.2.2 Estimates by cause

Estimates of the numbers of blind people in the ROI for each year are presented by primary cause of blindness in Table 2.6. These numbers were derived by applying the cause-based prevalence rates (in Table 2.4) to population projections from the CSO (2008) for the years 2010, 2015 and 2020.

Table 2.6: Projections of blind people in the ROI by cause

	2010	2015	2020
AMD	3,046	3,742	4,628
Cataracts	294	345	403
DR	473	556	654
Glaucoma	1,073	1,329	1,657
Other cause	8,110	9,299	10,655
Total blind people (a)	**12,995**	**15,270**	**17,997**

Source: Deloitte Access Economics estimates using NCBI register data (special request, 2010), ROI population estimates (CSO, 2008) and Kelliher et al (2006)

(a) Totals may differ from summed components due to rounding.

2.4 Mild and moderate vision impairment

In this section, the numbers of people with mild and moderate VI in the ROI are estimated using the numbers of blind people in the ROI derived above, and information from similar countries on the relative prevalence rates of blindness and less severe vision loss.

2.4.1 Method for imputing prevalence

2.4.1.1 Studies reporting the prevalence rates of mild and moderate visual impairment relative to blindness

Only one study identified in the literature review above reported the respective prevalence rates of blindness and less severe vision loss in an ROI population (Coffey et al 1993). In a Roscommon County sample of 2,186 people aged 50+ years, Coffey estimated the prevalence of blindness (BCVA <3/60) as 0.55% (12/2,186), and the prevalence of moderate VI (3/60 ≤ BCVA < 6/18) as 1.51% (33/2,186). Thus, the ratio of moderate VI to blindness in the Roscommon sample was **2.75** (1.51% ÷ 0.55%).

Unfortunately, Coffey et al (1993) only report data for people aged 50 years and older, whereas the ratio of low vision to blindness is hypothesised to vary between age groups. For example, the ratio may be lower in older people if they are more likely to go blind than younger people.

A number of other studies conducted in Australia, Finland, Iceland, Italy, Netherlands, and the UK have also reported prevalence rates for blindness and less severe vision loss (Access Economics, 2010a; Cedrone et al, 1997; Gudmundsdottir et al, 2000; Klaver et al, 1998; Rouhiainen et al, 1990; Wormald et al, 1992). However, these studies have been similarly restricted age groups ranging from 45 years and older to 76 years and older.

A previous Access Economics (2009) study estimated the prevalence rates of blindness, mild VI, and moderate VI in the UK by age group. The epidemiology of vision loss in the UK and the ROI are hypothesised to be similar with regard to the relative likelihood of having blindness as compared with less severe vision loss. The UK study estimated the prevalence of blindness (BCVA <6/60) to be 1.00%, and the prevalence of moderate VI (6/60 ≤ BCVA < 6/18) to be 1.91% in people aged 50+ years, giving a ratio of moderate VI to blindness of **1.91** (1.91% ÷ 1.00%).

The ratios derived from Coffey and Access Economics (2.75 and 1.91, respectively) are not directly comparable since the studies define blindness and moderate VI differently. Expert opinion suggests no standard method to convert prevalence rates based on WHO definitions to prevalence rates using the definitions in this study (Access Economics 2010b). Access Economics (2010b) conducted a review of international population-based studies reporting moderate VI prevalence rates for both sets of definitions, and estimated the average ratio for the current study definition versus the WHO definition to be **0.72**, based on BCVA in people aged 50 years and older (consistent with Coffey et al 1993). Applying this finding to the ratio derived from Coffey et al (1993) gives an adjusted ratio of **1.55**:

$$[2.75 \times 0.72] \div [1 + (1 - 0.72)] = 1.55$$

This adjusted ratio is relatively similar to the ratio of 1.91 derived from Access Economics (2009), suggesting the ratio of moderate VI to blindness in the UK is similar to the ROI for people aged 50 years and older. To place the degree of similarity in context, the ratio of moderate VI to blindness (using BCVA and WHO definitions) ranged between 2.60 and 5.00 in Italian, Dutch and Australian studies of people aged over 45 years. Thus, it was assumed that, for the wider population, the ratios and mild VI to blindness and moderate VI to blindness in the ROI would be similar to the UK.

Table 2.7 reports ratios for the number of times by which the prevalence of mild (or moderate) VI is greater than the prevalence of blindness for that age/gender group. For example, the prevalence of mild VI in males aged 55-59 years is 7.7 times the prevalence of blindness in that population.

Table 2.7: UK ratios - mild and moderate VI to blindness, by age and gender

Age group	mild VI : blindness *6/18≤BCVA<6/12 : <6/60*	moderate VI : blindness *6/60≤BCVA<6/18 : <6/60*
Males		
0-4	56.1	18.1
5-9	56.1	18.1
10-14	56.1	18.1
15-19	56.1	18.1
20-24	52.2	16.9
25-29	46.5	15.1
30-34	19.4	6.7
35-39	8.8	3.4
40-44	7.8	2.6
45-49	9.8	3.3

Age group	mild VI : blindness *6/18≤BCVA<6/12 : <6/60*	moderate VI : blindness *6/60≤BCVA<6/18 : <6/60*
50-54	5.9	2.3
55-59	7.7	2.6
60-64	7.2	2.6
65-69	7.5	2.9
70-74	8.4	2.8
75-79	3.8	1.5
80-84	3.8	1.5
85-89	3.8	1.5
90+	4.0	1.4
Females		
0-4	56.1	18.1
5-9	56.1	18.1
10-14	56.1	18.1
15-19	56.1	18.1
20-24	49.9	16.2
25-29	41.5	13.7
30-34	28.0	9.7
35-39	18.2	6.8
40-44	13.8	4.5
45-49	16.8	5.4
50-54	10.4	3.9
55-59	12.2	4.2
60-64	10.0	3.7
65-69	10.3	3.8
70-74	8.3	4.1
75-79	3.7	1.6
80-84	3.8	1.5
85-89	3.8	1.5
90+	3.9	1.4

Source: Derived from Access Economics (2009)

2.4.1.2 Estimated prevalence rates

The UK age-gender ratios of mild and moderate VI to blindness (Access Economics, 2009) presented in Table 2.7 were applied to blindness prevalence rates derived from the NCBI register (from Section 2.3.1.1). This approach was used to estimate the prevalence rates of mild VI and moderate VI by age and gender group in the ROI.

This approach differs to the prevalence estimations reported by Jackson et al (2008), which applied prevalence rates of moderate VI from studies undertaken in the Netherlands and Australia. The advantage of the approach used in the current study is that the prevalence rates of mild VI and moderate VI are directly linked to the extent of known VI in the ROI (i.e. blindness as assessed through register data). Another key advantage of applying ratios

from the UK study, are that ratios were estimated for all age groups, whereas other published studies have only estimated relative prevalence rates for older populations.

Table 2.8 and Table 2.9 present the estimated mild and moderate VI prevalence rates for the ROI. An overall prevalence rate of 3.4% for mild VI and 1.2% for moderate VI was derived for the ROI.

Table 2.8: Prevalence rates for mild VI in the ROI, by age and gender

Age group	Male	Female	Total
0-4	1.4%	1.8%	1.6%
5-9	2.8%	2.5%	2.7%
10-14	5.4%	4.8%	5.1%
15-19	5.6%	5.1%	5.4%
20-24	5.4%	5.1%	5.2%
25-29	4.1%	3.8%	3.9%
30-34	2.0%	2.9%	2.4%
35-39	1.1%	2.2%	1.7%
40-44	1.1%	2.2%	1.6%
45-49	1.7%	2.7%	2.2%
50-54	1.2%	2.1%	1.6%
55-59	1.9%	3.1%	2.5%
60-64	2.3%	2.7%	2.5%
65-69	3.1%	3.6%	3.3%
70-74	5.3%	4.8%	5.0%
75-79	4.1%	4.2%	4.2%
80-84	8.7%	8.7%	8.7%
85-89	16.0%	17.9%	17.3%
90+	47.7%	42.4%	43.9%
All ages	**3.1%**	**3.7%**	**3.4%**

Source: Deloitte Access Economics estimates using Access Economics (2009), NCBI register data (special request, 2010), ROI population estimates (CSO, 2008) and Kelliher et al (2006)

Table 2.9: Prevalence rates for moderate VI in the ROI, by age and gender

Age group	Male	Female	Total
0-4	0.5%	0.6%	0.5%
5-9	0.9%	0.8%	0.9%
10-14	1.7%	1.6%	1.6%
15-19	1.8%	1.7%	1.7%
20-24	1.7%	1.7%	1.7%
25-29	1.3%	1.2%	1.3%
30-34	0.7%	1.0%	0.8%
35-39	0.4%	0.8%	0.6%
40-44	0.4%	0.7%	0.5%

Age group	Male	Female	Total
45-49	0.6%	0.9%	0.7%
50-54	0.5%	0.8%	0.6%
55-59	0.7%	1.1%	0.9%
60-64	0.8%	1.0%	0.9%
65-69	1.2%	1.3%	1.3%
70-74	1.8%	2.4%	2.1%
75-79	1.6%	1.8%	1.7%
80-84	3.5%	3.6%	3.6%
85-89	6.3%	7.2%	6.9%
90+	16.6%	15.8%	16.0%
All ages	**1.1%**	**1.3%**	**1.2%**

Source: Deloitte Access Economics estimates using Access Economics (2009), NCBI register data (special request, 2010), ROI population estimates (CSO, 2008) and Kelliher et al (2006)

2.4.2 Population estimates and projections

2.4.2.1 Estimates by age and gender

Prevalence rates were applied to population estimates from the CSO (2008) to obtain projections of people with mild and moderate VI in 2010, 2015 and 2020.

Table 2.10 presents projections of people with mild VI in the ROI by age and gender group. It is estimated that there were over 157,000 people with mild VI in the ROI in 2010. This is estimated to increase to 188,000 people by 2020.

Table 2.10: Projections of people with mild VI, by age and gender

Age group	2010	2015	2020
Males			
0-4	2,425	2,683	2,743
5-9	4,494	5,009	5,490
10-14	8,060	8,728	9,657
15-19	7,989	8,405	9,059
20-24	8,496	7,809	8,009
25-29	8,809	7,701	6,848
30-34	4,150	4,797	4,141
35-39	2,107	2,447	2,773
40-44	1,861	2,174	2,493
45-49	2,549	2,829	3,280
50-54	1,613	1,822	2,013
55-59	2,311	2,565	2,893
60-64	2,496	2,743	3,051
65-69	2,531	3,225	3,566
70-74	3,228	3,904	5,039

Age group	2010	2015	2020
75-79	1,845	2,151	2,670
80-84	2,384	2,961	3,620
85-89	2,208	2,802	3,753
90+	2,388	3,821	5,715
Total males	71,945	78,574	86,814
Females			
0-4	2,853	3,145	3,213
5-9	3,852	4,261	4,651
10-14	6,848	7,494	8,229
15-19	6,990	7,323	7,971
20-24	8,180	7,384	7,461
25-29	7,864	7,130	6,239
30-34	5,650	6,533	5,847
35-39	3,964	4,522	5,156
40-44	3,426	3,926	4,442
45-49	4,132	4,418	5,031
50-54	2,734	3,098	3,304
55-59	3,719	4,138	4,680
60-64	2,856	3,149	3,500
65-69	2,917	3,726	4,114
70-74	3,211	3,762	4,827
75-79	2,285	2,531	3,002
80-84	3,608	3,909	4,434
85-89	4,651	5,168	5,871
90+	5,470	7,324	9,140
Total females	85,212	92,940	101,114
Total (a)	**157,156**	**171,514**	**187,928**

Source: Deloitte Access Economics estimates using Access Economics (2009), NCBI register data (special request, 2010), ROI population estimates (CSO, 2008) and Kelliher et al (2006)

(a) Totals may differ from summed components due to rounding.

Table 2.11 presents projections of people with moderate VI in the ROI by age and gender group. It is estimated that there were nearly 55,000 people with moderate VI in the ROI in 2010. This is estimated to grow to over 66,000 people by 2020.

Table 2.11: Projections of people with moderate VI, by age and gender

Age group	2010	2015	2020
Males			
0-4	781	864	884
5-9	1,448	1,614	1,769
10-14	2,597	2,812	3,111

Age group	2010	2015	2020
15-19	2,574	2,707	2,918
20-24	2,744	2,522	2,587
25-29	2,858	2,498	2,222
30-34	1,424	1,646	1,421
35-39	805	935	1,060
40-44	631	737	845
45-49	854	948	1,099
50-54	627	708	782
55-59	794	882	995
60-64	909	999	1,111
65-69	971	1,237	1,368
70-74	1,083	1,309	1,690
75-79	734	856	1,063
80-84	969	1,203	1,471
85-89	873	1,108	1,485
90+	829	1,327	1,985
Total males	24,505	26,913	29,864
Females			
0-4	919	1,013	1,035
5-9	1,241	1,373	1,498
10-14	2,206	2,414	2,651
15-19	2,252	2,359	2,568
20-24	2,660	2,401	2,426
25-29	2,601	2,358	2,063
30-34	1,960	2,266	2,028
35-39	1,479	1,687	1,923
40-44	1,111	1,273	1,440
45-49	1,338	1,430	1,629
50-54	1,030	1,167	1,244
55-59	1,288	1,433	1,621
60-64	1,050	1,158	1,287
65-69	1,090	1,392	1,537
70-74	1,591	1,864	2,392
75-79	973	1,078	1,278
80-84	1,475	1,598	1,813
85-89	1,877	2,086	2,369
90+	2,036	2,726	3,402
Total females	30,176	33,076	36,206
Total (a)	**54,681**	**59,989**	**66,070**

Source: Deloitte Access Economics estimates using Access Economics (2009), NCBI register data (special request, 2010), ROI population estimates (CSO, 2008) and Kelliher et al (2006)

(a) Totals may differ from summed components due to rounding.

2.4.2.2 Estimates by cause

No studies identified in the literature review (Section 2.2.1) estimated the prevalence of VI in the ROI or Northern Ireland using a comprehensive cause breakdown, other than presenting causes of blindness using NCBI register data. For example, Coffey et al (1993) estimated cause-specific VI in those aged 50 years and over in ROI for glaucoma only.

A number of studies conducted for other countries (Access Economics, 2010a; 2009; 2008a; 2008b; 2006; 2004) report VI prevalence rates by cause. However, due to differences in epidemiology and underlying risk factors for VI between countries, there are limitations in applying these data to the ROI. Resnikoff et al (2004) have reported a lack of international data that can be used to quantify the relative causes of low vision at either a regional or global level.

In the absence of available data for VI by cause, and consistent with Access Economics' global VI study (2010b), this study assumes the cause distributions of mild and moderate VI to be the same as the cause distribution for blindness (from Section 2.3.1.2). There are limitations with this approach, however it is the best approach permitted, in the absence of comprehensive data on causes of VI in the ROI.

Table 2.12 and Table 2.13 present estimates of mild and moderately vision impaired people by cause. These were estimated by applying the derived cause distribution for blindness from the NCBI register to estimated people with mild and moderate VI.

Table 2.12: Projections of people with mild VI, by cause

	2010	2015	2020
AMD	13,396	16,312	20,027
Cataracts	3,320	3,696	4,100
DR	3,810	4,398	5,014
Glaucoma	6,712	7,973	9,542
Other cause	129,918	139,136	149,246
Total mild VI (a)	**157,156**	**171,514**	**187,928**

Source: Deloitte Access Economics estimates using Access Economics (2009), NCBI register data (special request, 2010), ROI population estimates (CSO, 2008) and Kelliher et al (2006)

(a) Totals may differ from summed components due to rounding.

Table 2.13: Projections of people with moderate VI, by cause

	2010	2015	2020
AMD	5,222	6,080	7,758
Cataracts	1,168	1,306	1,455
DR	1,425	1,648	1,889
Glaucoma	2,485	2,956	3,544
Other cause	44,381	47,746	51,424
Total moderate VI (a)	**54,681**	**59,989**	**66,070**

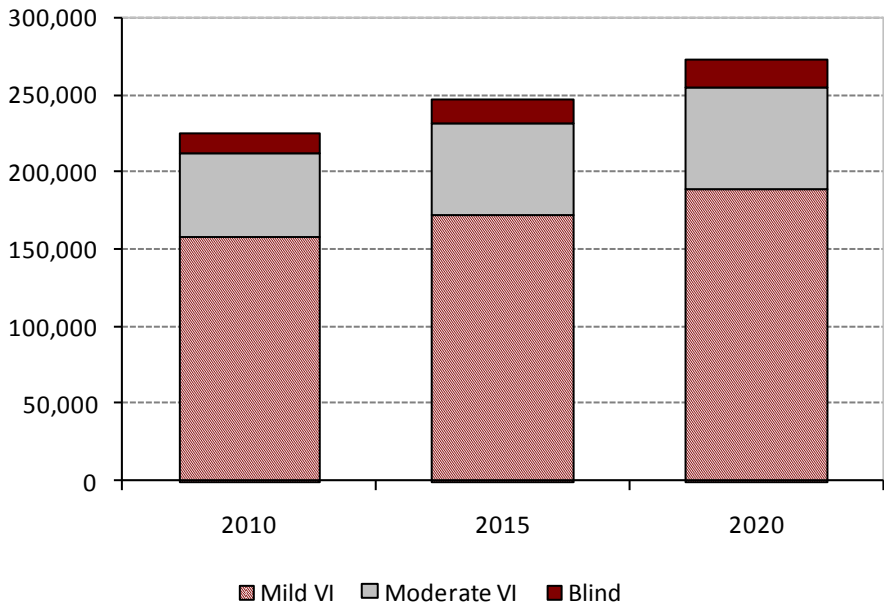
Source: Deloitte Access Economics estimates using Access Economics (2009), NCBI register data (special request, 2010), ROI population estimates (CSO, 2008) and Kelliher et al (2006)

(a) Totals may differ from summed components due to rounding.

2.5 Total population with vision impairment and blindness

Projections of total VI (mild and moderate) and blindness in the ROI are presented in Chart 2.6. In 2010, it was estimated that there were nearly 224,832 people with VI and blindness in the ROI. By 2020, this is estimated to grow to nearly 271,996 people, or approximately 5% of the projected population in that year.

Chart 2.6: Projections - people with VI and blindness in the ROI



Source: Deloitte Access Economics estimates using Access Economics (2009), NCBI register data (special request, 2010), ROI population estimates (CSO, 2008) and Kelliher et al (2006)

3 HEALTH CARE COSTS

SUMMARY BOX

Health care costs of vision impairment and blindness are those incurred within the health care system by the government or other payers (including patients), as a result of treating these conditions. In 2010, health care costs included:

* hospital expenditure of €57.5 million for public hospitals and €12.5 million for private hospitals, estimated using data on hospital activity in the ROI and costs per diagnostic related group;

* prescription drug expenditure of €16.6 million, estimated from data on prescriptions for AMD and glaucoma treatments;

* expenditure on general ophthalmic services for people with vision impairment of €15.7 million, estimated from data on eye examinations in the ROI; and

* expenditure on assessment and care of the visually impaired of €14.4 million (a proxy for outpatient expenditure, community care and residential care), estimated from past data on the Disability Programme in the ROI.

The total health care costs of vision impairment and blindness summed to €116.7 million in 2010. These are projected to rise to €127.4 million by 2015 and €136.8 million by 2020.

This section estimates the direct health care costs of VI and blindness in the ROI. These include costs to the Irish health care system that are associated with treatment of partial sight and blindness. Health care costs estimated in this study, for which data are available, include:

- hospital inpatient and day patient expenditure;
- expenditure on prescription drugs;
- general ophthalmic services (eye examinations and corrective vision aids); and
- capital and non-capital public expenditure on assessment and care of the vision impaired (as part of the ROI's Disability Programme).

There are no available top-down data on total health care expenditure in the ROI by disease category (unlike some other countries such as Australia and the UK). For this reason, the direct cost components for which data are available were estimated separately and summed to estimate the total health care cost of VI and blindness in the ROI. There are likely to be other elements in the total health care cost of VI and blindness for which data are not available, however these could not be estimated without relevant data. Regardless, the costs estimated in this section are expected to comprise the vast majority of direct costs in the ROI.

3.1 Hospital expenditure

3.1.1 Public hospitals

Acute public hospital activity data are collected and reported by the Economic and Social Research Institute of Ireland (ESRI, 2010). Specifically, the ESRI reports inpatient and day patient data on average discharges and length of stay by Australian Refined Diagnosis Related Groups (AR-DRGs) within a given year (2009 in the most recent publication). These data are collected from the Hospital In-Patient Enquiry (HIPE) scheme.

Acute public hospital activity data for the year 2009 (ESRI, 2010) contained 19 AR-DRG codes specifically related to eye conditions. These are AR-DRGs beginning with the letter C and relate to 'diseases and disorders of the eye'. Not all 19 AR-DRGs, however, are associated with VI (e.g. C11Z eyelid procedures, C13Z lacrimal procedures). Following the UK cost-of-illness study (Access Economics 2009) the AR-DRGs were mapped, where relevant, to conditions associated with VI and blindness. The allocation followed (as closely as possible) the methodology used by Access Economics (2009) for UK Health Resource Groups (HRGs). It was determined that nine AR-DRGs were relevant to VI and blindness, and the eye conditions in this study. Table 3.1 presents the mapping by AR-DRG code, description and condition area assigned.

Table 3.1: AR-DRG mapping to eye condition within acute public hospital activity data

AR-DRG	Description	Assigned condition area
C02Z	Enucleations and orbital procedures	Other eye conditions
C03Z	Retinal procedures	DR
C04Z	Major corneal, scleral and conjunctival procedures	Refractive error
C12Z	Other corneal, scleral and conjunctival procedures	Refractive error
C15A	Glaucoma and complex cataract procedures	Glaucoma/Cataract
C15B	Glaucoma and complex cataract procedures, same-day	Glaucoma/Cataract
C16Z	Lens procedures	Cataract
C61A	Neurological and vascular eye disorders with complications and comorbidities	AMD
C61B	Neurological and vascular eye disorders without complications and comorbidities	AMD

Source: Deloitte Access Economics' analysis of ESRI (2010)

The ten excluded AR-DRGs were related to physical injury or complications of the eye and infections of the eye. Additionally the categories 'other eye procedures' and 'other disorders of the eye' were excluded as it could not be determined what proportion of these admissions were related to specifically to VI. The excluded AR-DRGs are listed below:

- **C01Z:** Procedures for penetrating eye injury,
- **C05Z:** Dacryocystorhinostomy,
- **C10Z:** Strabismus procedures,
- **C11Z:** Eyelid procedures,

- **C11Z:** Lacrimal procedures,
- **C14Z:** Other eye procedures,
- **C60A:** Acute and major eye infections with complications and comorbidities;
- **C60B:** Acute and major eye infections without complications and comorbidities;
- **C62Z:** Hyphema and medically managed eye trauma; and
- **C63Z:** Other disorders of the eye.

Average public hospital discharges and average length of stay (ALOS) in 2009 were reported for each AR-DRG (ESRI, 2010). These data cover both public and private patients treated in public hospitals. However, the average hospital cost per AR-DRG was not reported in the data and was not identified elsewhere. Therefore, the average hospital cost per bed day is estimated for each AR-DRG using 2008-09 Australian public hospital cost data (DoHA, 2009) and an adjustment for likely health care price differences between the ROI and Australia.

The average cost per bed day in 2008-09 in Australia was attained by dividing the average public hospital cost per AR-DRG separation by the ALOS for that separation (DoHA 2009). These costs were inflated to 2010 Australian dollars using average annual health inflation growth in Australia from 1997-98 to 2007-08, which was 3.4% per annum (AIHW, 2009). From these Australian data, the Irish costs per bed day for each AR-DRG were imputed using the approach applied in a global cost of dementia study (Wimo et al, 2006). Under this approach, differences between country health care unit costs (e.g. hospital care, pharmaceuticals) are assumed to be reflected by differences in Gross Domestic Product (GDP) per capita. Furthermore, differences in GDP per capita are assumed to also reflect differences in health care resource use, so countries with a higher GDP per capita utilise more costly resources, such as long-term care.

Following this method, average costs per bed day in the ROI were imputed using the ratio of GDP per capita between the ROI and Australia. On a purchasing power parity (PPP) basis, the GDP per capita ratio between the ROI and Australia is 1.05 (World Bank, 2010). Australian dollars were converted to euros at the average exchange rate in 2010 of €1 = $A1.44 (ECB, 2011).

Table 3.2 presents the costs per bed day for each DRG for the ROI and Australia.

Table 3.2 : Average public hospital cost per bed day ($A and €) in 2010, selected AR-DRGs

AR-DRG	Description	Australia $A	ROI € (a)
C02Z	Enucleations and orbital procedures	$2,713	€1,979
C03Z	Retinal procedures	$2,817	€2,055
C04Z	Major corneal, scleral and conjunctival procedures	$2,422	€1,767
C12Z	Other corneal, scleral and conjunctival procedures	$2,500	€1,824
C15A	Glaucoma and complex cataract procedures	$2,505	€1,828
C15B	Glaucoma and complex cataract procedures, same-day	$2,924	€2,133
C16Z	Lens procedures	$3,406	€2,485
C61A	Neurological and vascular eye disorders with	$1,207	€881

AR-DRG	Description	Australia $A	ROI € (a)
	complications and comorbidities		
C61B	Neurological and vascular eye disorders without complications and comorbidities	$1,207	€881

Source: Deloitte Access Economics calculations using DoHA (2009), AIHW (2009) and World Bank (2010).

(a) Estimated by applying the ratio of PPP-adjusted GDP per capita (World Bank, 2010) between the ROI and Australia (1.05) to Australian costs, and then converting to euros at an exchange rate of €1 = $A1.44 (ECB, 2011).

Discharges in 2010, 2015 and 2020 were estimated by applying population growth for the ROI from 2009 onwards (CSO, 2008) to the number of discharges in 2009 data.

Discharges and ALOS for each DRG are presented in Table 3.3.

Table 3.3: ALOS and estimated discharges by year for selected AR-DRGs

AR-DRG	Description	ALOS (days)	Discharges 2010 (a)	Discharges 2015 (b)	Discharges 2020 (c)
C02Z	Enucleations and orbital procedures	3.5	152	166	178
C03Z	Retinal procedures	1.4	8,705	9,500	10,199
C04Z	Major corneal, scleral and conjunctival procedures	4.6	153	167	179
C12Z	Other corneal, scleral and conjunctival procedures	2.5	278	303	325
C15B	Glaucoma and complex cataract procedures	3.8	368	402	432
C16Z	Glaucoma and complex cataract procedures, same-day	1.0	510	557	598
C61A	Lens procedures	1.2	7,711	8,415	9,034
C61B	Neurological and vascular eye disorders w CC	6.2	164	179	193
C02Z	Neurological and vascular eye disorders w/o CC	2.1	744	812	872

Source: Deloitte Access Economics calculations using ESRI (2010) and CSO (2008).

(a) Estimated by applying 2009-2010 ROI population growth of 2.0% to discharges in 2009 (ESRI, 2010).

(b) Estimated by applying 2009-2015 ROI population growth of 11.4% to discharges in 2009 (ESRI, 2010).

(c) Estimated by applying 2009-2020 ROI population growth of 19.6% to discharges in 2009 (ESRI, 2010).

The ROI costs per AR-DRG discharge presented in Table 3.2 were multiplied by the ALOS and total estimated discharges for each AR-DRG in 2010, 2015 and 2020 to attain total public hospital costs. Costs in 2015 and 2020 conservatively assume that public hospital costs per bed day and ALOS in 2010 remain constant.

Table 3.4 presents total public hospital costs by DRG. Overall, public hospital costs were estimated to be over €57.5 million in 2010. This is estimated to rise to nearly €67.4 million by 2020.

Table 3.4: Estimated public hospital costs (€) by selected AR-DRGs

AR-DRG	2010	2015	2020
Enucleations and orbital procedures	€1,053,158	€1,149,361	€1,233,969
Retinal procedures	€25,048,061	€27,336,145	€29,348,441
Major corneal, scleral and conjunctival procedures	€1,244,187	€1,357,841	€1,457,796
Other corneal, scleral and conjunctival procedures	€1,265,738	€1,381,360	€1,483,046
Glaucoma and complex cataract procedures	€2,558,400	€2,792,104	€2,997,639
Glaucoma and complex cataract procedures, same-day	€1,088,449	€1,187,877	€1,275,320
Lens procedures	€22,991,088	€25,091,272	€26,938,316
Neurological and vascular eye disorders w CC	€897,121	€979,070	€1,051,143
Neurological and vascular eye disorders w/o CC	€1,375,878	€1,501,562	€1,612,096
All eye disorders associated with VI or blindness	**€57,522,081**	**€62,776,592**	**€67,397,767**

Source: Deloitte Access Economics calculations using ESRI (2010), CSO (2008), DoHA (2009), AIHW (2009) and World Bank (2010).

3.1.2 Private hospitals

A limitation of the HIPE data is that it does not include patients treated in private hospitals. Further, no other data were identified reporting private hospital activity in the ROI.

Colombo and Tapay (2004) present the estimated proportions of public and private beds in public and private hospitals in the ROI. Their study estimates 78% of the total bed stock in the ROI to be within public hospitals and 17% within private hospitals (with 5% of total bed stock not allocated to either category). From these data, the ratio of private hospital beds to public hospital beds in the ROI is estimated to be 0.22 (17/78). This ratio is applied to public hospital expenditure (Section 3.1.1) to estimate private hospital expenditure for the same treatments/procedures. Using this approach it is estimated that private hospital activity for the AR-DRGs reported in Section 3.1.1 accounted for €12,536,864 million in private hospital costs in the ROI in 2010 (17/78 × 57,522,081).

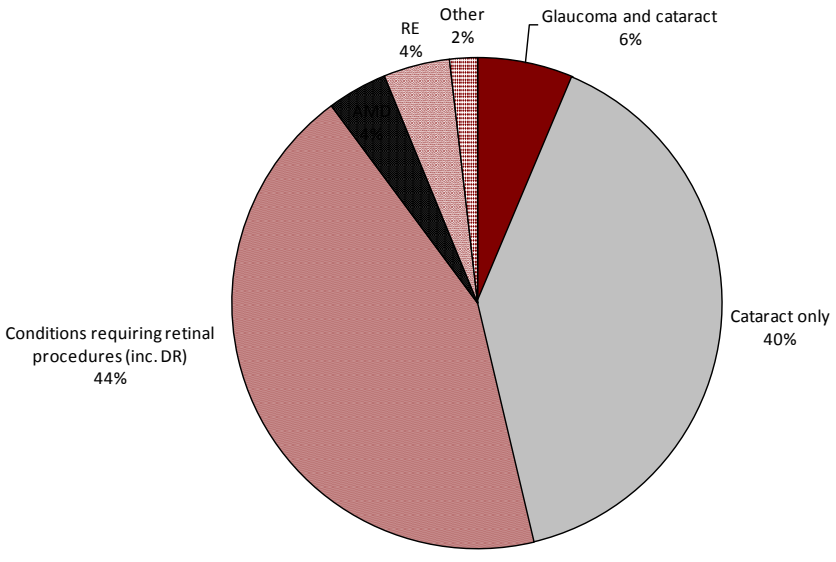
One limitation of this method are that it assumes the cost per discharge for each AR-DRG to be the same in both public and private hospitals, whereas private hospitals may actually cost less (due to greater efficiencies) or more (due to higher fees). A further limitation is that it assumes the same mix of procedures to occur in public and private hospitals, whereas patients with no private health insurance may be more susceptible to certain types of eye disease. However, in the absence of private hospital activity data, this approach was used as a best proxy.

3.1.3 Estimated hospital expenditure by condition

Total public and private hospital expenditure on VI was estimated to be €70.1 million in 2010 (Section 3.1.1 and Section 3.1.2). The distribution of expenditure by eye condition (Chart 3.1) was estimated by applying the AR-DRG condition mapping presented in Table 3.1 to each AR-DRG (Section 3.1.1). This distribution assumes the same mix of hospital activity occurs in public or private hospitals.

It should be noted that 44% of hospital expenditure is associated with AR-DRG C03Z (retinal procedures). The large volume of activity in this DRG is unlikely to be solely associated with patients having DR, and may also include patients with AMD, cataract, and retinal detachment who undergo retinal procedures. However, in the absence of further data the conditions associated with the expenditure coded under AR-DRG C03Z can only be defined very broadly.

Chart 3.1: Distribution of public and private hospital expenditure by eye condition related to vision impairment



Source: Deloitte Access Economics analysis using ESRI (2010), CSO (2008), DoHA (2009), AIHW (2009) and World Bank (2010).

3.2 Prescription drugs

For this study, it is important only to account for prescription drug expenditure associated with the treatment of VI, and not the costs of all drugs used to treat eye conditions (e.g. preparations for acute eye infections and chronic conditions such as dry eye that may not cause VI).

It was hypothesised that the key prescription drugs associated with VI would include treatments for glaucoma, and recent treatments for AMD such as ranibizumab (Lucentis). Annual expenditure data on ophthalmic drugs in the ROI were obtained for the 12 months to November 2010 (IMS Health, data on file 2010). Specifically, the cost of prescription drugs for glaucoma included all expenditure on drug class S01E (anti-glaucoma preparations and miotics), and the cost of prescription drugs for AMD included all expenditure in drug class S01P (ocular anti-neovascular products). Annual expenditure totalled €10.79 million on drugs for glaucoma and €5.79 million on drugs for AMD. This is the total expenditure incurred by all health care payers, including both the government and patients.

The only previous study identified that reported prescription drug cost for VI in the ROI, was by Knox et al (2006) who analysed the cost and volume of public and private glaucoma drug prescriptions for the period 1996-2003. Knox et al (2006) estimated that €6.14 million was spent on glaucoma drugs in 2003, also using IMS Health data. The increased expenditure reported for 2010 is likely to represent increases in patient numbers and drug prices.

Access Economics (2009) found that, in the UK, treatment of glaucoma accounts for 71% of all prescriptions costs for eye therapy in 2008. When it is further considered that the remaining 29% of prescription costs may not be associated with the treatment of VI, then treatment of glaucoma is expected to account for the vast majority of prescription drug costs for VI.[1]

Expenditure on prescriptions for glaucoma and AMD in 2010, 2015 and 2020 was estimated by applying estimated ROI population growth from 2010 (CSO 2008) to 2010 expenditure.

As presented in Table 3.5, expenditure on glaucoma drugs was estimated to be nearly €16.6 million in 2010 and is projected to rise to €19.4 million by 2020.

Table 3.5: Estimated expenditure on glaucoma drugs by all health care payers (€)

	2010	2015	2020
ROI population growth rate from 2010	-	9.1%	17.2%
Estimated expenditure on glaucoma drugs	€10,785,233	€11,770,440	€12,636,897

[1] Access Economics (2009) associated the other 29% of prescription drug expenditure with anti-infective eye preparations, corticosteroids and other anti-inflammatory preparations, mydriatics and cycloplegics, local anaesthetics, and miscellaneous ophthalmic preparations. Many of these drugs are used in people with eye disorders who are not visually impaired

	2010	2015	2020
Estimated expenditure on AMD drugs	€5,794,054	€6,323,328	€6,788,807
Estimated expenditure on glaucoma and AMD drugs	**€16,579,287**	**€18,093,767**	**€19,425,704**

Source: Deloitte Access Economics calculations using IMS Health data and population growth reported by the CSO (2008; 2010b)

It should also be considered that pharmaceutical development may lead to increased prescription drug costs for AMD, glaucoma and other conditions associated with VI. However, this may in part be offset by a reduced prevalence of eye conditions for which more effective drugs become available.

3.3 General ophthalmic services

General ophthalmic services include eye tests, services provided by ophthalmic medical practitioners and corrective vision aids such as spectacles. Expenditure on general ophthalmic services was estimated via an analysis of primary care claims and payments in the ROI. The Primary Care Reimbursement Service (PCRS), part of the ROI Health Service Executive (HSE) Finance Directorate, has a national role in making payments to Primary Care Contractors for services provided by them under the Community Drug Schemes. Almost all payments in the community provided by optometrists and ophthalmologists are made by the PCRS.

The latest available PCRS claims and payments data is for the year 2008 (HSE, 2008). In 2008, payments to optometrists and ophthalmologists totalled €20,997,766. The volume of treatments in 2008 included 225,403 eye examinations and 304,879 appliances.

Table 3.6 presents the 2008 scale of fees for eye examinations payable under the HSE Community Ophthalmic Services Scheme.

Table 3.6: Eye examination scale of fees (HSE Community Ophthalmic Services Scheme)

Examination	Fee as at 31st December, 2008
Eye Examination by Ophthalmic Optician (optometrist)	€23.35
Eye Examination by Ophthalmologist / Ophthalmic Medical Practitioner	€26.50
Medical Eye Examination by Ophthalmologist	€53.01
Eye Examination for Contact Lenses (Grant)	€70.98
Eye Examination Ophthalmic (Dilation)	€46.70

Source: As presented by HSE (2008)

In the absence of more detailed data, the unweighted average eye examination fees (€44.11) was multiplied by the number of eye examinations in 2008 (225,403) to approximate the total expenditure on all eye examinations in 2008 (€9,942,076). This

comprises 47% of total payments to optometrists and ophthalmologists in 2008 (€20,997,766).

There was no breakdown of eye tests by condition available for the ROI. As such, using the approach in the UK cost-of-illness study (Access Economics, 2009), a distribution was inferred from Scottish data published by the Information Services Division for the year ending 31 March 2010 (ISD, 2010). These data recorded General Ophthalmic service activity in Scotland, including the numbers of eye tests carried out by the National Health Service. Patient details including eye conditions were recorded by the opticians undertaking the eye tests.

The distribution of eye tests by eye condition is presented in Table 3.7 using the Scottish data. This distribution was applied to expenditure on eye tests in the ROI. These eye conditions are associated with VI and eye examination costs for those patients were included in the cost of illness calculations. It was conservatively assumed that all eye tests for 'none of the above' were conducted in people who were not vision impaired. The 'none of the above' category was therefore excluded from the calculation of total expenditure on VI.

Table 3.7: Eye tests in Scotland 2010 – distribution by eye condition

Eye condition	Proportion of total eye tests
Cataracts	14%
DR	6%
Glaucoma	2%
AMD	6%
Other eye condition associated with VI	13%
None of the above	59%
Total	**100%**

Source: ISD (2010). AMD includes the categories 'AMD' and 'macula problems'

Expenditure on appliances in 2008 was estimated by deducting estimated expenditure on all eye tests in 2008 (€9,942,076 including those for people who are not VI) from total payments to ophthalmologists and optometrists in 2008 (€20,997,766). All estimated expenditure on appliances (€11,055,690 in 2008) was assumed to be for correction of refractive error and was thus allocated to the 'other eye condition' category.

Total expenditure on ophthalmic services for VI people in 2010, 2015 and 2020 was estimated by applying the estimated ROI population growth (CSO, 2008) from 2008 to total expenditure in 2008.

Estimates of total expenditure on general ophthalmic services are presented by condition in Table 3.8. Total expenditure on general ophthalmic services for VI people in 2010 was estimated to be nearly €15.1 million, and is projected to increase to €18.5 million by 2020.

Table 3.8: Estimated total expenditure on general ophthalmic services

Condition	2008	2010 (a)	2015 (b)	2020 (c)
Cataracts	€ 1,391,891	€1,449,492	€1,581,900	€1,698,348

DR	€ 596,525	€621,211	€677,957	€727,864
Glaucoma	€ 198,842	€207,070	€225,986	€242,621
AMD	€ 596,525	€621,211	€677,957	€727,864
Other eye condition	€ 12,348,160	€12,859,171	€14,033,827	€15,066,900
Total	**€ 15,131,941**	**€15,758,155**	**€17,197,627**	**€18,463,596**

Source: Deloitte Access Economics calculations using HSE (2008), ISD (2010) and CSO (2008).

(a) Estimated by applying 2008-2010 ROI population growth of 4.1% to expenditure in 2008 (HSE, 2008).

(b) Estimated by applying 2008-2015 ROI population growth of 13.7% to expenditure in 2008 (HSE, 2008).

(c) Estimated by applying 2008-2020 ROI population growth of 22.0% to expenditure in 2008 (HSE, 2008).

3.4 Other direct healthcare costs

There are a range of additional direct healthcare costs associated with VI and blindness that have not been identified above. These include the costs of outpatient expenditure, residential care, and community care.

Health care expenditure data for these services and people with eye conditions could not be identified for the ROI. The best proxy data were identified within ROI health care expenditure statistics for 2004, which report non-capital expenditure on the Disability Programme; specifically for 'assessment and care of the visually impaired', non-capital expenditure was €12.22 million (DOHC, 2005). Since the reorganisation of the Irish health care system in 2004, expenditure for the previous Department of Health and Children budget categories (including the Disability Programme) have not been reported, and the 2004 data therefore represent the most recent estimates.

It is assumed that non-capital Disability Programme expenditure on the vision impaired includes a large proportion of health care expenditure remaining after accounting for hospital, prescription drug, and general ophthalmic service expenditure above. Unfortunately, the Disability Programme data are not reported by condition associated with VI and therefore no breakdown by condition could be estimated.

Population growth from 2004 onwards (CSO, 2008; 2010b) was applied to non-capital expenditure on the 'assessment and care of the visually impaired' (DOHC, 2005) to estimate non-capital expenditure in 2010, 2015 and 2020 (Table 3.9).

Non-capital expenditure was scaled up to account for capital expenditure. In 2003, non-capital expenditure on the Disability Programme (including 'assessment and care of the visually impaired' and all other patient categories) was €1.16 billion, and capital expenditure on the Disability Programme was €40.26 million (DOHC, 2005). The ratio of capital to non-capital expenditure on the Disability Programme in 2003 (0.03) was applied to estimated non-capital expenditure on 'assessment and care of the visually impaired' in 2010, 2015 and 2020, assuming that (1) the ratio is similar for the 'assessment and care of the visually impaired' and the overall Disability Programme, and (2) the ratio would remain constant in the future.

Estimates of capital and non-capital expenditure on 'assessment and care of the visually impaired' in 2010, 2015 and 2020 are presented in Table 3.9. Total expenditure on

'assessment and care of the visually impaired' was estimated to be nearly €14.4 million in 2010, and is projected to rise to €16.8 million by 2020.

Table 3.9: Estimated expenditure on 'assessment and care of the visually impaired'

	2010	2015	2020
Population growth 2004	13.5%	23.9%	33.0%
Non-capital expenditure (a)	€ 13,874,561	€ 15,141,971	€ 16,256,617
Capital expenditure (b)	€ 483,220	€ 527,361	€ 566,181
Total expenditure	**€ 14,357,781**	**€ 15,669,332**	**€ 16,822,798**

Source: Deloitte Access Economics calculations using DOHC (2005) and CSO (2008).

(a) Estimated by applying growth rate of the ROI population from 2004 onwards to total non-capital expenditure on 'assessment and care of the visually impaired' in 2004, €12.22 million (DOHC, 2005).

(b) Estimated by applying the ratio of capital to non-capital expenditure on the Disability Programme in 2003 to estimated non-capital expenditure in each year. This ratio was 0.03 (DOHC, 2005).

Unfortunately, no publicly available data were identified to estimate residential and community care services directly paid by patients and not funded by the government.

3.5 Summary of direct health care costs

The health care costs of VI and blindness were estimated to be nearly €116.8 million in 2010, and are projected to rise to nearly €136.8 million by 2020. These estimates should be considered conservative, since some health care cost components may have been excluded due to limited health care activity and expenditure data for the ROI.

A summary of the direct health care costs of VI and blindness in the ROI is presented in Table 3.10 by included component.

Table 3.10: Summary of direct health care costs of VI and blindness

Component	2010	2015	2020
HOSPITAL			
Public hospital costs	€57,522,081	€62,776,592	€67,397,767
Private hospital costs	€12,536,864	€13,682,078	€14,689,257
Total hospital costs (a)	**€70,058,945**	**€76,458,670**	**€82,087,024**
PRESCRIPTIONS			
Glaucoma drug costs	€10,785,233	€11,770,440	€12,636,897
AMD drug costs	€5,794,054	€6,323,328	€6,788,807
Total drug costs (b)	**€16,579,287**	**€18,093,767**	**€19,425,704**
GENERAL OPHTHALMIC SERVICES			
Eye examinations for people with VI	€4,244,941	€4,632,706	€4,973,734
Appliances	€11,513,214	€12,564,920	€13,489,862

Total ophthalmic services costs (c)	**€15,758,155**	**€17,197,627**	**€18,463,596**
OTHER COSTS: 'Assessment and care of the visually impaired'			
Total non-capital expenditure	€13,874,561	€15,141,971	€16,256,617
Total capital expenditure	€483,220	€527,361	€566,181
Total expenditure (d)	**€14,357,781**	**€15,669,332**	**€16,822,798**
TOTAL HEALTH CARE COSTS (a) + (b) + (c) + (d)	**€116,754,169**	**€127,419,396**	**€136,799,122**

Source: Deloitte Access Economics calculations.

4 INDIRECT COSTS

SUMMARY BOX

The indirect costs of vision impairment and blindness include the economic impacts of these conditions on wider society outside the health care system. In 2010, indirect costs included:

* productivity losses of €56.7 million including lost earnings from lower employment and premature death;

* informal care costs of €108.3 million;

* deadweight welfare losses of €104.4 million from government-funded health care costs, welfare payments to the blind and lost taxation revenue.

Total indirect financial costs of vision impairment and blindness summed to €269.3 million in 2010. These are projected to rise to €292.3 million by 2015 and €312.2 million by 2020.

This chapter explores the indirect financial costs of VI and blindness in the ROI. Unlike direct costs, these do not reflect the health care costs of treating VI and blindness, but rather the economic losses that result from the indirect impacts of VI and blindness on society.

In this report, the following indirect costs are estimated:

- productivity losses from reduced labour market participation through lower employment and premature mortality associated with low vision and blindness;
- costs to informal carers from providing care to someone with low vision or blindness; and
- deadweight welfare loss (DWL) associated with raising additional tax revenue to publicly fund health care services and direct payments to people with low vision and blindness.

It is important to distinguish between real costs and transfer costs. A real cost is incurred when economic resources (such as land, labour and capital) are used in the production process of goods and services. When resources are put to a certain productive use, this reduces the opportunity for production in other areas of the economy. This is known as an opportunity cost, and includes productivity and informal care costs.

Transfer payments are payments from one economic agent to another, without a good or service being provided in return and include taxes, subsidies and pensions. These are not a net cost to society as they represent a shift in consumption power from one group of individuals to another. Transfer payments in the context of this study include:

- welfare payments provided to those who are vision impaired or blind;
- the taxation paid by society to the government to fund health care for those who are vision impaired or blind; and
- lost taxation revenue to the government arising from the productivity losses of vision impaired and blind people, and their carers.

Transfer payments have not been presented as an economic cost within this report. Rather, they have been used to estimate associated DWL (lost efficiency) to the economy.

4.1 Productivity losses

A loss in productivity of an individual due to sight loss will only equate to a loss in productivity to the economy under fairly strict conditions. These are:

- the economy is at full employment so any reduction in hours worked due to sight loss, or any permanent reduction in labour force participation through early retirement or death, cannot be replaced by employing or increasing hours of other workers; and
- the income of an individual is proportional to the total value added to production.

The first condition will fluctuate over time as the economy moves into, and out of, full employment. A reduction in labour when labour is scarce will have a greater impact on productivity compared to an economy with an abundant labour supply. In this situation, a temporary or permanent reduction in working hours due to partial sight and blindness cannot be replaced by another worker. Consequently, a loss in productivity due to VI and blindness is expected to represent a real cost to an economy operating at a low level of unemployment.

The second condition will occur if there is a perfect labour market such that the marginal benefit from an additional hour of work (the value added) is equal to the marginal cost (the wage). In reality, labour markets are imperfect for a number of reasons, for example asymmetric information in the market, and labour market restrictions imposed by government regulation and natural barriers. In addition, synergy created between labour, capital and land means a reduction in working hours may also impact the productivity of other factors of production. Consequently the value of productivity from labour will be larger than the wage provided to an individual so using lost income from partial sight and blindness as a proxy for lost productivity will tend to underestimate the true cost. It is likely that in the absence of sight loss, people with VI and blindness would participate in the labour force and obtain employment at the same rate and average weekly earnings as others. The implicit assumption is that the numbers of such people would not be of sufficient magnitude to substantially influence the overall clearing of labour markets, and average wages remain the same.

In this report, productivity losses are estimated using the lower than average employment rates for people out of work due to a seeing disability, and lost lifetime earnings due to premature death attributed to VI.

Productivity losses may also occur as a result of higher absenteeism, and lower productivity at work ('presenteeism costs'). However, these components could not be estimated due to lack of available data for the ROI and similar countries. Thus, productivity losses presented in this report are conservative, and do not reflect the full magnitude of lost productivity from VI and blindness.

Deloitte Access Economics adopts a human capital approach to the estimation of productivity losses in developed countries such as the ROI, which is most consistent with the first condition above of an economy at, or close to, full employment. It is assumed the

ROI operates at sufficiently low unemployment to incur a permanent loss in productivity. The unemployment rate is defined as the proportion of the labour force (people employed plus people unemployed but seeking work) without jobs. Unemployment averaged approximately 5.3% from the beginning of 2000 to the end of 2009 (CSO, 2010c). However, the current seasonally adjusted, standardised unemployment rate for the ROI is 13.5%. This may or may not be sufficiently low to incur a permanent productivity loss, and the productivity losses presented in this report should therefore be interpreted with caution.

Calculation of productivity losses is restricted to people aged between 15-64 years in the ROI.

4.1.1 Productivity loss due to disability

The productivity loss due to a disability is dependent on a number of factors:

- the likelihood of someone with that disability being employed;
- the likelihood of someone with that disability needing time off work due to the disability; and
- the value of lost production.

The 'employment gap', that is, the lower employment of people with seeing disabilities that can be attributed to their seeing disability, can be estimated directly from the ROI National Disability Survey (NDS) data. The NDS was a country-wide, cross-sectional survey conducted in the ROI in 2006 by the CSO with the main sample drawn from people who had indicated they had a disability in the 2006 Census (approximately 8% of the ROI population in 2006). From this population, 12,661 people were interviewed for the NDS. The results of the NDS sample were grossed-up by the CSO to the full population of 325,800 people who indicated they had a disability in 2006, using a weighting system.

The results of the NDS were used to estimate that 50,600 people in the ROI had a seeing disability in 2006. Disabilities were self-reported to the survey interviewer by participants, and the NDS included no formal testing of VA. This may lead to an overestimation or underestimation of VI when defined as a VA below 6/12.

Of these 50,600 people, it was estimated that 13,200 were adults living in private households. In total the results of the NDS estimated that 2,368 adults in private households were unable to work due to a seeing disability in 2006 (CSO, 2010d).

In the absence of age group specific data from the NDS, it was assumed that all adults reporting they are unable to work due to a seeing disability are primarily of current workforce age (18 to 64 years). Therefore, growth rates of the ROI population aged 18 to 64 years from 2006 were applied to this figure to estimate the numbers of adults unable to work due a seeing disability in 2010, 2015 and 2020 (CSO, 2008).

As shown in Table 4.1, it is estimated that in 2010, 2,576 adults were unable to work due to their seeing disability. This increases to 2,890 people by 2020.

Table 4.1: Estimated adults in private households unable to work due to seeing disability

	2010	2015	2020
Working age (18 to 64 years) population growth rate from 2006	8.8%	16.2%	22.1%
Estimated adults unable to work due to seeing disability (a)	2,576	2,751	2,890

Source: Deloitte Access Economics calculations using CSO (2008; 2010d)

(a) Estimated by applying population growth rate of the population aged 18 to 64 years from 2006 onwards to the number of adults unable to work due to a seeing disability in 2006 from the NDS (CSO, 2010d).

The estimates above for 2015 and 2020 are not implicated by the ROI State Pension age being increased to 66 years in 2014 (the current transition pension at 65 years is due to be abolished then), since the numbers are based on the NDS responses for all adults. A person of any age who wishes to work but cannot work due to a seeing disability (as assessed in the NDS) constitutes a productivity loss regardless of their age.

People who report being unable to work due to a seeing disability may not necessarily have been employed even in the absence of that disability. This response in the NDS is interpreted as the individual being unable to seek work. Therefore, the number of people unable to work due to a seeing disability is multiplied by the employment-to-population ratio (employment probability). For the ROI working age population, this ratio in quarter two of 2010 (the most recent quarter for which data were available) was 60.4% (CSO, 2010e). The employment-to-population ratio is assumed to remain constant to the year 2020.

Salaries are applied as a proxy for the value of lost production. Estimated average weekly earnings in the ROI in quarter two of 2010 (the most recent quarter for which data were available) were €690.48 (CSO, 2010f). This equates to average annual earnings of €35,904 in the year 2010.

In the absence of age-specific data for people unable to work due to disability, total productivity losses for the ROI due to VI were estimated as the product of people unable to work due to a seeing disability, the employment-to-population ratio, and average annual earnings for the entire ROI working-age population. This produced an estimated productivity loss of €55.8 million due to seeing disabilities in 2010. To estimate productivity losses in 2015 and 2020, constant wages were conservatively assumed and the employment-to-population ratio in 2010 was applied up to the year 2020.

The estimated productivity losses due to seeing disabilities in the ROI for years 2010, 2015 and 2020 are presented in Table 4.2.

Table 4.2: Estimated productivity losses due to seeing disabilities in the ROI

	2010	2015	2020
Number of people unable to work due to a seeing disability (a)	2,576	2,751	2,890
Employment-to-population ratio	60.4%	60.4%	60.4%

	2010	2015	2020
(b)			
Average annual earnings (b)	€35,905	€35,905	€35,905
Total estimated productivity losses due to seeing disabilities (€'000)	**€55,872**	**€59,664**	**€62,682**

Source: Deloitte Access Economics calculations using CSO data (2008; 2010d; 2010e; 2010f)

(a) Calculated by applying estimated population growth from 2006 onwards (CSO, 2008) to estimated people unable to work due to seeing disability in 2006 (2,368 people).

(b) For quarter two, 2010.

4.1.2 Lost lifetime earnings from premature mortality

VI and blindness are associated with a higher than average risk of mortality because they are correlated with a higher risk of falls, fractures, motor vehicle accidents and depression. However, only a proportion of the additional deaths in the vision impaired can be specifically attributed to low vision and blindness rather than associated co-morbidities. Premature death due to VI and blindness results in a future stream of productivity losses due to lost potential earnings.

The number of deaths due to low vision and blindness in the ROI were estimated using the following data:

- the number of people with mild VI, moderate VI and blindness in the ROI (Chapter 2);
- mortality rates in the general ROI population;
- the relative risk of death in people with VI or blindness; and
- the aetiological fraction – the proportion of additional deaths in people with VI specifically attributable to VI rather than co-morbidities.

As described below, the relative mortality risk was estimated using studies in people with VA less than 6/12. Therefore, in this study, deaths due to VI are estimated for all people with mild VI, moderate VI or blindness.

In estimating the increased risk of mortality with VI and blindness, it is important to control for age and gender (Anstey et al, 2001; Globe et al, 2005) as well as comorbidities. Klein et al (1995) reported that people with specific vision conditions had an increased mortality risk of 1.57 times for the presence of sight loss and of 1.28 times for any cataract. However, when accounting for the presence of cardiovascular disease none of the conditions causing sight loss showed a statistically significant odds ratio for decreased survival.

An improved level of statistical control was achieved in the Melbourne Visual Impairment Project (MVIP) where partial sight and blindness was found to be significantly associated with an increased mortality risk of 2.34 times (McCarty et al, 2001). The result accounted for the confounding presence of age and age-related co-morbidities, such as basic cardiac risk factors. Similarly, Wang et al (2001) report an increased mortality risk of 1.7 times with the presence of any sight loss. Their analysis accounted for co-morbidities such as a history of cancer, stroke, gout and diabetes, some of which result from basic cardiovascular risk factors such as hyperlipidemia and hypertension.

Following previous international Access Economics studies on the burden of disease of VI and blindness, and in the absence of Ireland-specific studies on the relative mortality risk with VI and blindness, the relative risk of death was derived from the MVIP and Australian mortality data (Access Economics, 2010a; 2008b; 2009; 2006; 2004). Using MVIP data, the odds ratio of mortality for the vision impaired (VA < 6/12) compared with the general population is estimated to be 2.34 (95% confidence interval: 1.03-5.32) for people aged 40 years and older, based on approximately five years' follow-up for urban participants (McCarty et al, 2001) and standardising for age, male sex, smoking duration, duration of high blood pressure and arthritis.

The odds ratio of 2.34 was used to proxy the relative risk of death in the population with VI and blindness aged 40 years and older. The age/gender specific numbers of deaths in the VI and blind population in each year, were estimated as the product of the odds ratio, the most recent (2009) age and gender specific mortality rates for the general ROI population (CSO, 2010g), and age/gender specific population estimates for 2010, 2015 and 2020 (CSO, 2008).

As detailed above, incremental deaths in the vision impaired are not all due to VI and blindness but also due to co-morbidities. An aetiological fraction of 1.38% has previously been estimated using Australian Bureau of Statistics (ABS) mortality data for the years 2003 to 2008 (ABS, 2010; Access Economics, 2010a). These data show a ratio of 72.4:1 between people for whom 'diseases of the eye and adnexa' was one of multiple causes of death (3,040 deaths) and the underlying cause (42 deaths). Factors that combine with VI and blindness to cause death include conditions such as osteoporosis, events such as falls or motor vehicle accidents, and risk factors such as poor light or roads. Thus, 1.38% (1 ÷ 72.4) of deaths due to eye disease are specifically caused by the eye disease.

Deaths attributable to VI and blindness were estimated by applying the aetiological fraction of 1.38% to calculated total deaths in the VI and blind population aged 40 years and over.

Estimates of the numbers of deaths attributable to VI and blindness in the ROI for 2010, 2015 and 2020 are presented in Table 4.3. It is estimated that there were 193 deaths from VI and blindness in 2010, which is projected to rise to 319 deaths by 2020. The majority of deaths from VI and blindness are estimated to occur in people aged over 64 years.

Table 4.3: Estimated deaths attributable to VI and blindness in the ROI

Age-gender group	2010	2015	2020
Males			
40-44	0.16	0.18	0.21
45-54	0.66	0.73	0.83
55-64	1.93	2.14	2.39
65-74	6.24	7.73	9.31
75-84	15.22	18.40	22.64
85-94	29.51	40.80	57.18
95+	20.93	33.50	50.10
Total male deaths	**74.64**	**103.29**	**142.46**

Age-gender group	2010	2015	2020
Females			
40-44	0.14	0.16	0.18
45-54	0.69	0.76	0.84
55-64	1.60	1.77	1.99
65-74	4.06	4.95	5.94
75-84	14.22	15.55	17.96
85-94	51.30	61.27	72.41
Total female deaths	46.04	61.65	76.94
Total deaths	**192.71**	**249.59**	**318.92**

Source: Deloitte Access Economics calculations using ABS (2010), CSO (2008; 2009; 2010f), Department of Finance (2010) and McCarty et al (2001).

The productivity loss, or future stream of lost income, is assumed to be incurred until the assumed retirement age of 65 years. Transition and Contributory State Pensions are available for people aged 65 years, and 66 years and older, respectively. Thus, productivity losses were not estimated for people aged 65 years and over. In the ROI, average life expectancy exceeds 64 years and was therefore not incorporated into these calculations (CSO, 2009).

The annual productivity loss due to death was valued using 2007 average annual earnings data by workforce age group (CSO, 2010h) adjusted to 2010 using the change in average weekly earnings between 2007 and 2010 (CSO, 2010i). Age/gender specific wage data were applied since, in contrast to the productivity loss calculations in Section 4.1.1, age/gender specific data were available for deaths.

It is important to discount future streams of costs and benefits to a present value when expressing results for a specific year such as 2010. For cost effectiveness studies, there have been numerous international debates regarding both the discount rate and whether the same rate should be applied to both costs and health benefits (Drummond et al, 2005). This study does not synthesise economic costs and DALYs, and the issue of differential discount rates for costs and benefits is not relevant. A 4% discount rate was applied to future productivity losses in this study; this rate is commonly used in cost benefit and cost effectiveness analyses of public sector projects in the ROI (Department of Finance, 2010).

Similar to productivity losses from disability, productivity losses from premature mortality also need to be adjusted by the likelihood that someone with VI or blindness is employed. This is estimated using gender-specific employment-to-population ratios for quarter two of 2010 in the ROI (CSO, 2010e), being 64.5% for males and for 56.4% for females.

Productivity losses from premature mortality were calculated as the product of deaths attributable to VI or blindness in each age group (Table 4.3), the gender-specific employment-to-population ratio (CSO, 2010e) and estimated (discounted) remaining lifetime earnings for that age group.

Table 4.4 shows that five people aged between 40 and 64 years are estimated to have died due to VI and blindness in 2010. Of these, three would have been employed. Total lost

lifetime earnings from the premature mortality of these people were estimated to total over €847,230 in 2010.

Table 4.4: Estimated cost of premature mortality from VI and blindness in the ROI, 2010

Age group	No. of people with VI and blindness	No. of people who die due to VI and blindness	No. who would have been employed (a)	Assumed years to retirement (b)	Lost lifetime earnings per person € (c)	Total cost €
Male						
40-44	2,731	0.16	0.10	23.0	676,041	67,827
45-54	6,175	0.66	0.42	15.5	526,738	223,079
55-64	7,158	1.93	1.25	5.5	218,220	272,178
Female						
40-44	4,785	0.14	0.08	23.0	445,051	35,425
45-54	9,744	0.69	0.39	15.5	336,176	130,797
55-64	9,504	1.60	0.90	5.5	130,572	117,923
Total	**40,097**	**5.18**	**3.14**	**n/a**	**n/a**	**€847,230**

Source: Deloitte Access Economics calculations using ABS (2010), CSO (2008), CSO (2010e; 2010g; 2010h; 2010i), Department of Finance (2010) and McCarty et al (2001).

Abbreviations: n/a = not applicable

(a) Estimated by applying the gender-specific employment-to-population ratio in the ROI in 2010 (CSO, 2010e) to the number of people who die due to mild/moderate VI and blindness.

(b) Estimated as the difference between the midpoint of the age group and 65 years

(c) Discounted to present day at a 4% discount rate (Department of Finance, 2010).

Estimated productivity losses account for the foregone future streams of income due to death are substantially lower than productivity losses due to disability, primarily because of low attributable mortality risk. Although the risk of death in the vision impaired is 2.34 times that of the general population, only 1.38% of the additional deaths is attributed to VI in the model. Furthermore, general mortality is low in the ROI, and the greatest additional risk of death due to VI and blindness is therefore experienced by those people aged over 65 years to whom productivity losses are not applied.

Productivity losses due to mortality were also estimated for the years 2015 and 2020, accounting for population growth (CSO, 2008) and increased subsequent deaths in the VI population (Table 4.3), and multiplying this by current annual earnings and gender-specific employment-to-population ratios (CSO, 2010e; 2010h). Estimates for 2015 and 2020 assumed constant wages and the same employment-to-population ratio as 2010.

The summary of productivity losses for each year is presented in Table 4.5. Productivity losses from premature mortality from VI and blindness of those aged between 40 and 64 years are estimated to rise to over €1.0 million by 2020.

Table 4.5: Estimated productivity losses from premature mortality (€)

	2010	2015	2020
Estimated deaths due to VI in those aged 40 to 64 years	3.14	3.49	6.44
Estimated productivity losses	€847,230	€943,348	€1,061,481

Source: Deloitte Access Economics calculations using ABS (2010), CSO (2008), CSO (2010e; 2010g; 2010h; 2010i), Department of Finance (2010) and McCarty et al (2001).

In 2014, the ROI State Pension age will be raised to 66 years (i.e. the transition pension at 65 years will be abolished). This is likely to increase the number of people choosing to work to the age of 66 years, and hence the productivity losses due to premature mortality may be slightly underestimated for 2015 and 2020.

4.2 Informal care costs

Informal carers are people who provide care to others in need of assistance or support on an unpaid basis. Generally, informal care is provided by family or friends of the person receiving care.

Informal care is distinguished from services provided by people employed in the health and community sectors (formal care) because the care is generally provided free of charge and is not regulated by the government. While informal care is provided free of charge, it is not free in an economic sense, as time spent caring is time that cannot be directed to other activities such as paid work, unpaid work or leisure.

The level of informal care associated with VI or blindness depends on whether the person is able to live independently while maintaining an appropriate quality of life. Using Northern Ireland data, Stevenson et al (2004) showed that the ability for a person with sight loss to care for themselves is adversely influenced by sight loss. In a study of individuals with AMD recruited through a hospital eye clinic in Northern Ireland, Ke et al (2007) found that the level of formal and informal care services utilised by an individual depends on the level of VA in the better eye, the age of the individual, and the level of access to informal care, for example, whether the person lives alone or not. Studies in Australia and the US have also found a positive relationship between the level of informal care and the prevalence of partial sight and blindness (Wang et al, 1999; Schmier et al, 2006).

To estimate the total cost of informal care, the time spent providing care to people with VI and blindness is required along with a monetary figure representing the value of informal care. It is often difficult to separate the level of informal care provided due to VI and blindness when the person receiving care has co-morbidities that also require informal care. For example, a person may receive informal care for dementia and sight loss at the same time.

This study estimates the value of informal care time for people with VI and blindness. However, it is recognised that there are further significant costs in addition to the value of lost time. For example, Carmichael and Charles (2003) note that informal carers in the UK also forgo significant earnings because they have less opportunity to undertake higher paid employment and therefore earn less than equally qualified non-carers. This is because

informal carers may require more flexible working arrangements, which make them less likely to be promoted. These additional costs are not estimated here due to a lack of data.

Three potential methodologies can be used to place a monetary value on informal care:

- **The opportunity cost method** values earnings foregone by the carer, in caring for the person with VI or blindness.
- **The replacement valuation method** estimates the cost of buying a similar amount of services from the formal care sector.
- **The self-valuation method** sums the costs of what carers themselves feel they should be paid for the care provided to the person with VI or blindness.

The replacement valuation method may overestimate the value of informal care as it assumes the person receiving care, or society, is willing to pay for the services typically provided by a family or friend. This may not be the case due to budget constraints faced by individual and community service funders. Additionally, this method does not account for differences in quality of care and may overestimate value if formal care is of a higher quality. There may also be differences in time utilisation during caring, if a formal carer is more efficient. If an informal care receive utility or satisfaction from providing care which this method does not account for in valuation.

The self-valuation method also has weaknesses, being subject to issues with valuation subjectivity, inconsistency and respondent biases.

From a theoretical perspective, the opportunity cost method is the benchmark (Van den Berg et al, 2006). The opportunity cost method measures the value in alternative use of time spent caring, which is typically valued by productivity losses (or value of leisure time) associated with caring. This is based on the assumption that time spent providing informal care could be alternatively used within the paid workforce or in leisure activities. The value of informal care using the opportunity cost method can be represented as $t_i \times w_i$, where t_i is the time provided by individual i on providing care, and w_i is the net market wage rate of individual i (van den Berg et al, 2006).

For those who provide informal care but are not in paid work (for example, children or those who have retired) the value of providing informal care is the value of the lost opportunity of undertaking leisure time. This can be approximated by the willingness to pay to undertake leisure, or to avoid work. Therefore, the value of leisure time is often proxied by an average age and sex specific wage rate (Brouwer and Koopmanschap, 2000; Heitmueller, 2007). If the value of non-work is more (or less) than the average wage rate, the opportunity cost method will under (or over) estimate the value of informal care.

The opportunity cost method is applied in this study given the availability of earnings data for the ROI.

4.2.1 Opportunity cost method of valuing informal care

Informal care costs in the ROI for VI and blindness were estimated using data from the 2006 NDS reporting the number of people with a seeing disability receiving help with everyday activities such as taking a bath or shower, dressing, eating, getting in and out of bed and going to the toilet (CSO, 2010d). In total, there were reported to be 7,304 people with a

seeing disability in private households in the ROI receiving help with everyday activities. However, this includes both paid and unpaid help.

NDS estimates of people in private households receiving help with everyday activities from different sources in 2006 are presented in Table 4.6. These data include people indicating multiple sources of help, and hence the total number of sources (9,770) is greater than the total number of people receiving help (7,304).

Table 4.6: People with a seeing disability in private households indicating help with everyday activities, by source in 2006

Source of help	Estimated number of people with a seeing disability receiving help from source
Family – living in	2,545
Family – not living in	2,565
Friend or neighbour	1,277
Carer or personal assistant	457
Home help	1,112
Public health nurse	1,179
Other person or voluntary organisation	634
Total sources of help (a)	**9,770**

Source: Derived from CSO (2010d)

(a) Total includes multiple sources of help and so exceeds the number of people with a seeing disability receiving help (7,304)

Since a breakdown of whether help was paid or unpaid was not reported in the NDS, this study assumes unpaid help categories to be family (living in and not living in) and friend or neighbour. However, a key issue is that informal care costs must be estimated using the total number of people receiving care and the number of hours of informal care received from all sources. Some people will receive informal care from more than one source. Therefore, lower and upper estimates of people receiving informal care were derived from the data reported above.

The lower estimate assumes that 2,565 people with a seeing disability received informal care in 2006. This was based on 2,565 people indicating that they received help from family not living in, and assuming these individuals also all received help from family living in and friends/neighbours.

The upper estimate assumes that each person only receives informal care from a single source. In this case, the three categories of live-in family, family not living in and friends or neighbours (Table 4.6) were summed. This resulted in an upper estimate of 6,388 people with a seeing disability receiving informal care in 2006.

For this study, a 'most likely' estimate was the average of these lower (2,565) and upper (6,388) estimates, being 4,477 people with a seeing disability receiving informal care in 2006. Estimated growth rates of the ROI population from 2006 to 2010, 2015 and 2020 were applied to this figure to estimate the numbers of people with a seeing disability receiving informal care in these years (CSO, 2008).

As shown in Table 4.7, it is estimated that 4,856 people with a seeing disability received informal care in 2010, increasing to 5,690 people by 2020.

Table 4.7: Estimated people with a seeing disability receiving informal care

	2010	2015	2020
Population growth rate from 2006	8.5%	18.4%	27.1%
Estimated adults receiving informal care for VI (a)	4,856	5,300	5,690

Source: Deloitte Access Economics calculations using CSO (2008; 2010d)

(a) Estimated by applying population growth rate of the ROI population from 2006 onwards to the estimated number of people receiving informal care in 2006 (4,477 people).

Data on the number of informal care hours per person with a seeing disability are not available for the ROI. However, data are available for the hours of unpaid care provided by carers aged over 15 years in the ROI for all conditions (CSO, 2007).

Hours of unpaid care provided by carers aged over 15 years in the ROI for all conditions are reported in Table 4.8. This was defined by the CSO as regular, unpaid personal help provided to a friend or family member with a long-term illness, health problem or disability for tasks such as feeding or dressing. A weighted average of 19.7 hours per week was calculated from these data, assuming the midpoint number of hours for each 'hours per week' category.

Table 4.8: Carers aged 15 years and over in the ROI in 2006

Hours per week (range)	Total carers	Percentage of all carers	Assumed hours per week (midpoint)
1-14 hours a week	93,363	58%	7.5
15-28 hours a week	17,093	11%	21.5
29-42 hours a week	9,578	6%	35.5
43+ hours a week	40,883	25%	43
Total	**160,917**	**100%**	**19.7**

Source: Deloitte Access Economics calculations using CSO (2007)

Although the calculation of 19.7 hours is not specific to people with VI, it is similar to the estimated 24.4 hours of weekly unpaid care provided by primary carers to people with a disease of the eye and adnexa in Australia (Access Economics, 2010a). The Australian estimate was derived from 2004 data reported by the Survey of Disability Ageing and Carers (ABS, 2004). This data provided estimates of numbers of carers for those with a primary condition of disease of the eye and adnexa in each weekly hours of care range. The weighted average of 24.4 hours was derived by weighting weekly hours of care by the proportion of total carers in that category.

It is further assumed here that these 19.7 hours of unpaid care apply to only one care recipient. This assumption may be supported by the format of the underlying survey question which asks whether the subject "provide(s) regular unpaid personal help for a

friend or family member with a long term illness, health problem or disability" (implicitly referring to one recipient).

The total cost of informal care was estimated as the product of:

- the best estimate of the total number of people with a seeing disability receiving unpaid care in the ROI;
- the average number of annual unpaid care hours per carer (19.7 hours per week x 52); and
- average hourly earnings in 2010 for all people in the ROI (€21.79; CSO, 2010f).

Table 4.9 presents the estimated value of informal care for the years 2010, 2015 and 2020. Using the data above, the annual cost of informal care for people with VI and blindness is valued at approximately €108.3 million in 2010, increasing to €126.8 million by 2020.

Table 4.9: Estimated value of informal care for people with a seeing disability in the ROI

Year	Estimated unpaid care recipients in 2010 with seeing disability (a)	Estimated value of informal care (b)
2010	4,856	€108,249,563
2015	5,300	€118,137,914
2020	5,690	€126,834,403

Source: Deloitte Access Economics calculations using CSO (2007; 2008; 2010d; 2010f).

(a) Estimated by applying projected population growth in the ROI from 2006 onwards (CSO, 2008)

(b) Calculated using an estimated average of 19.7 unpaid care hours per week (derived from CSO, 2007) and average hourly earnings of €21.79 (CSO, 2010f)

4.3 Deadweight welfare loss

Public funding of health care, welfare payments, and lost taxation revenue for people with partial sight and blindness mean that governments must increase tax revenue to achieve a budget neutral position. Consequently tax rates must be higher than they would have otherwise been. As noted previously, taxation and welfare payments are not economic costs but a transfer of payments from one individual to another. However, increasing tax revenue is not frictionless as tax reduces the efficiency with which the economy's resources are used. For example, an increase in income tax rates increases the relative price of work compared to leisure and therefore creates a disincentive to work. Alternatively, an increase in taxes on goods and services results in a loss in sales. Consequently there is an associated reduction in consumer and producer surplus, which is the deadweight welfare loss (DWL), or excess burden, of tax. This represents lost efficiency.

The size of the DWL will depend on the method used to raise additional taxes and the proportion of health care costs funded by the government. The usual assumption in program evaluation, and applied in this study, is that additional taxes are raised through income tax rate changes.

DWL is estimated in the model using the following variables:

- the total health care system costs of VI and blindness (from Chapter 3);

- the proportion of health care system costs funded by the Irish government; and
- welfare payments to people with sight loss in the ROI;
- lost taxation revenue to the Irish government from productivity losses of people with VI and their carers;
- the marginal cost of public funds (MCPF), or efficiency loss per additional euro of tax raised, in the ROI.

The total health care system costs of VI and blindness in the ROI were estimated in Chapter 3. The public share of health care expenditure in the ROI was 80.7% in 2007 (OECD, 2009). This funding ratio was applied to estimated health care costs on VI and blindness under the assumption that it will remain constant in future years to estimate government funded health care costs.

Estimates of the government funded health care costs of VI and blindness are presented in Table 4.10.

Table 4.10: Government-funded health care costs on VI and blindness

	2010	2015	2020
Estimated health care costs on VI and blindness	€116,754,169	€127,419,396	€136,799,122
Government funding ratio applied	80.7%	80.7%	80.7%
Estimated government-funded health costs on VI and blindness	€94,220,614	€102,827,452	€110,396,892

Source: Deloitte Access Economics calculations using total health care costs from Section 3.5 and OECD (2009).

Lost taxation revenue from reduced employment among people with VI includes lost income tax and lost consumption tax. Therefore, total taxation losses were estimated by applying the current average income tax rate of 20% and value-added taxation (VAT) rate of 21% (Citizens Information Board, 2010) to productivity losses and informal care costs (Section 4.1 and Section 4.2). Lost taxation revenue from people with VI and blindness and their carers amounted to €67.6 million in 2010.

Estimates and calculations of lost taxation revenue are presented in Table 4.11. These calculations assume that the 2010 income taxation and VAT rates remain constant to 2015 and 2020.

Table 4.11: Calculated taxation losses – people with a seeing disability and their carers

	2010	2015	2020
Average income taxation rate 2010	20%	20%	20%
Standard VAT rate 2010	21%	21%	21%
Productivity losses from disability and mortality in VI and blind	€56,719,003	€60,607,068	€63,743,444

	2010	2015	2020
Informal care costs	€108,249,563	€118,137,914	€126,834,403
Lost taxation revenue – VI and blind (a)	€23,254,791	€24,848,898	€26,134,812
Lost taxation revenue – informal care (b)	€44,382,321	€48,436,545	€52,002,105
Total lost taxation revenue (a) + (b)	**€67,637,112**	**€73,285,443**	**€78,136,917**

Source: Deloitte Access Economics calculations using Citizens Information Board (2010), productivity losses from Section 4.1 and informal care costs from Section 4.2.

(a) Calculated by applying the average income (20%) and standard VAT (21%) taxation rates to estimated productivity losses from Section 4.1.1 and Section 4.1.2.

(b) Calculated by applying the average income (20%) and standard VAT (21%) taxation rates to estimated informal care costs from Section 4.2.

People with VI or blindness may be eligible for a number of government benefits and allowances in the ROI. Some of these payments, including eligibility criteria, are listed below (NCBI, 2010):

- **Companion free travel pass:** Must fulfil blind or VI registration criteria.
- **Disabled persons' parking card:** Must fulfil blind or VI registration criteria.
- **Blind person's tax credits:** Must fulfil blind or VI registration criteria and be working. Registered owners of guide dogs are also entitled to an annual tax credit.
- **Disability Allowance:** Must have an injury, disease or disability that has continued for at least one year substantially restricting undertaking work, be aged between 16 and 66 years, satisfy a means test and habitual residence condition.
- **Blind Pension:** Must be registered with the NCBI as being blind or vision impaired, be over 18 years and satisfy a means test.
- **Blind Welfare Allowance:** Must be blind or vision impaired, over 18 years and satisfy a means test. Those receiving the Blind Pension may qualify for the Blind Welfare Allowance.
- **Household benefits package:** Must be aged 70 years and over or be receiving a carer's allowance, Blind Pension or old age contributory and non-contributory pension.
- **Invalidity Pension:** A weekly payment to people who cannot work because of a long-term illness or disability and are covered by social insurance.

Additionally, people caring for people with VI may qualify for the **Carer's Allowance** or **Carer's Benefit**. The Carer's Allowance is for carers on low income aged 18 years or over providing full-time care and living with the person being cared for. The Carer's Benefit is payable to those who temporarily leave their job to care for a person in need of full-time care.

Data were only available for the number of recipients of the Blind Pension and Blind Welfare Allowance. Therefore, this study only includes these two payments in the calculation of DWL from transfer payments. Carer-related payments were also excluded due to the absence of data for the numbers and income distributions of informal carers for

people with VI and blindness in the ROI (Section 4.2 included only the number of recipients of informal care).

There were 1,467 recipients of the Blind Pension in 2009 (CSO, 2010j). People receiving the Blind Pension are registered with the NCBI as being blind or vision impaired, over 18 years, and satisfied a means test. The number of Blind Pension recipients has been declining since 1999 but was relatively constant between 2006 and 2009 (CSO, 2010j). Given the degree of uncertainty in this trend over the next ten years, the number of Blind Pension recipients is assumed to increase due only to population growth.

Table 4.12 presents the estimated numbers of Blind Pension recipients in 2010, 2015 and 2020.

Table 4.12: Estimated people receiving the Blind Pension

	2010	2015	2020
18+ years population growth rate from 2009	2%	11%	19%
Estimated people receiving Blind Pension (a)	1,499	1,631	1,752

Source: Deloitte Access Economics calculations using CSO (2008; 2010j)

(a) Estimated by applying population growth rate of the 18+ years population from 2009 onwards to the 1,467 recipients of the Blind Pension in 2009 (CSO, 2010j).

Blind Welfare Allowance recipient numbers were only identified for the years 2002-2004, during which there was an increase from 2,030 recipients in 2002 to 2,548 recipients in 2004 (DOHC, 2005). This compares with 2,027 Blind Pension recipients in 2004 (CSO, 2010j). Thus, the number of Blind Welfare Allowance recipients is estimated to be 26% greater than the number of people receiving only the Blind Pension. This ratio (1.26) was assumed to remain constant over time and was applied to the estimated numbers of Blind Pension recipients in 2010, 2015 and 2020.

Table 4.13 reports the projected numbers of Blind Welfare Allowance recipients in the years 2010, 2015 and 2020. The number of recipients in 2010 is lower than the DOHC (2005) reported number of recipients in 2004 (1,884 vs. 2,548). However, in the absence of data for 2005-2009 it is unclear whether recipient numbers increased or decreased during this period. It is therefore possible that the numbers of Blind Welfare Allowance recipients, and hence the DWLs due to blindness, have been underestimated in this study.

Table 4.13: Estimated people receiving the Blind Welfare Allowance

	2010	2015	2020
Ratio applied to Blind Pension recipients (a)	1.26	1.26	1.26
Estimated people receiving Blind Welfare Allowance	1,884	2,050	2,202

Source: Deloitte Access Economics calculations using CSO (2005; 2008) and DOHC (2005)

(a) Ratio of people receiving the Blind Welfare Allowance to people receiving the Blind Pension in 2004.

The maximum weekly rates in 2010 were €196 for the Blind Pension and €61 for the Blind Welfare Allowance (Citizens Information Board, 2010). In the absence of further information, this study conservatively assumes weekly payments to remain constant to the year 2020. Applying these weekly rates to estimated recipient numbers, total estimated expenditure on the Blind Pension was nearly €15.3 million, and total estimated expenditure on the Blind Welfare Allowance was nearly €6.0 million in 2010 (nearly €21.3 million in total).

Kleven and Kreiner (2003) estimated the standard MCPF for Ireland under a progressive tax reform as 1.57. This represents an efficiency loss of 57 cents for every euro raised by the government from taxation. Since the ROI has a progressive taxation system, this MCPF was applied to government funded health care costs, productivity losses, informal care costs, and the total cost of Blind Pensions and Blind Welfare Allowances. The MCPF aligns with the simple average of MCPFs for Ireland under proportional, regressive and progressive tax reforms of 1.58 as reported by Kleven and Kreiner (2003).

As presented in Table 4.14, DWL is valued at €104.4 million in 2010, increasing to €121.6 million by 2020.

Table 4.14: Total DWL by component (a)

DWL from government-funded health care costs (b)	€53,705,750	€58,611,648	€62,926,228
DWL from lost taxation revenue (c)	€38,553,154	€41,772,702	€44,538,043
DWL from welfare payments to the blind (d)	€12,112,770	€13,183,100	€14,160,387
Total DWL	**€104,371,674**	**€113,567,451**	**€121,624,658**

Source: Deloitte Access Economics calculations using Kleven and Kreiner (2003), CSO (2008; 2010j), OECD (2009) and Citizens Information Board (2010).

(a) Calculated by applying a MCPF of 1.57 from Kleven and Kreiner (2003) to each component.

(b) Government funded health care costs estimated in Table 4.10

(c) Lost taxation from productivity losses and informal care costs estimated in Table 4.11

(d) Blind Pension and Blind Welfare Allowance recipients reported in Table 4.12 and Table 4.13.

4.4 Summary of indirect costs

A summary of the indirect costs of VI and blindness is presented in Table 4.15, by component. The indirect costs of VI and blindness were estimated to be €269.3 million in 2010. This is projected to rise to €312.2 million by 2020.

Table 4.15: Summary of indirect costs of VI and blindness

Component	2010	2015	2020
PRODUCTIVITY LOSSES			
Lower employment	€55,871,774	€59,663,720	€62,681,963
Premature death	€847,230	€943,348	€1,061,481

Component	2010	2015	2020
Total productivity losses (a)	**€56,719,003**	**€60,607,068**	**€63,743,444**
INFORMAL CARE			
Total costs of informal care (b)	**€108,249,563**	**€118,137,914**	**€126,834,403**
DWL			
From government-funded health care	€53,705,750	€58,611,648	€62,926,228
From lost taxation revenue	€38,553,154	€41,772,702	€44,538,043
From welfare payments	€12,112,770	€13,183,100	€14,160,387
Total DWL (c)	**€104,371,674**	**€113,567,451**	**€121,624,658**
TOTAL INDIRECT COSTS (a) + (b) + (c)	**€269,340,241**	**€292,312,433**	**€312,202,505**

Source: Deloitte Access Economics calculations.

5 BURDEN OF DISEASE

SUMMARY BOX

The burden of disease from vision impairment and blindness is a measure of the loss of wellbeing from disability and premature death due to these conditions (intangible costs). The burden of disease is measured using the non-financial metric of disability-adjusted life years (DALYs). This are further converted to a financial equivalent using the monetary value of a statistical life year.

In 2010, it was estimated that vision impairment and blindness resulted in 18,537 DALYs in the ROI, including 510 DALYs from premature death due to vision impairment and blindness and 18,027 DALYs from disability due to impaired vision. It is estimated that this burden will rise to 20,804 DALYs by 2015 and 23,465 DALYs by 2020.

In financial equivalent terms, the burden of disease from vision impairment and blindness was estimated to be €1.8 billion in 2010, which is projected to rise to nearly €2.0 billion by 2015 and €2.2 billion by 2020.

This chapter presents a quantitative analysis of the intangible costs of disability, loss of wellbeing and premature death from VI and blindness. Disability-adjusted life years (DALYs) are the primary non-financial metric used by the WHO and other organisations for quantifying the burden of disease, and measure the suffering and premature death from an illness or injury.

In this chapter, DALYs are also converted to a financial equivalent using a monetary valuation of a statistical life year (i.e. one DALY).

5.1 Methodology

In the last decade, a non-financial approach to valuing human life has been derived, where loss of wellbeing and premature mortality are measured in DALYs. This approach was developed by the WHO, the World Bank and Harvard University for a study that provided a comprehensive assessment of mortality and disability from diseases, injuries and risk factors in 1990, projected to 2020 (Murray and Lopez, 1996). Methods and data sources are detailed further in Murray et al (2001) and the WHO continually revisits these estimates.

A DALY of 0 represents a year of perfect health, while a DALY of 1 represents a year dead. Other health states are attributed values between 0 and 1 as assessed by experts on the basis of published quality of life data for various health states. For example, the disability weight of 0.02 for mild vision loss can be interpreted as a 2% reduction in a person's quality of life relative to perfect health. The DALY approach has been successful in avoiding the subjectivity of individual valuations and overcomes the problem of comparability between individuals and between nations, although some nations have subsequently adopted variations in weighting systems (e.g. age weighting for older people). This study considers the value of a life year (disability weighting) as equal throughout a person's lifespan (i.e. independent of age).

Under the DALY framework, the total burden of disease for an individual with a condition is the sum of the mortality and morbidity components associated with that condition over time, including the years of healthy life lost due to disability (YLDs), and the years of healthy life lost due to premature death (YLLs). Incorporating time preference for health (and thus discounting), this is represented by:

$$DALY_i = \sum_{t=a}^{a+L} \frac{Dw_{i,t}}{(1+r)^{t-a}}$$

where *Dw* is the disability weight of the condition experienced by individual *i*, *L* is the residual life expectancy of the individual at age *a,* and *t* represents individual years within that life expectancy.

The total burden of disease from a condition on society is the sum of the DALYs for all individuals with the condition. In this study the total DALY burdens for people with mild VI, moderate VI, and blindness are calculated for the years 2010, 2015 and 2020.

5.1.1 Disability weights for vision impairment and blindness

Any weighting exercise for use in burden of disease analysis or economic evaluation should measure preferences for clearly defined and relevant health states. Two key sources of disability weights for VI have been identified: the WHO Global Burden of Disease (GBD) study (Murray and Lopez, 1996) and a Netherlands study (Stouthard et al, 1997).

The 1990 GBD study asked participants in weighting exercises to make a composite judgement on the severity distribution of various health conditions and the preference for time spent in each severity level for those conditions (Lopez et al, 2006). This was to a large extent necessitated by the lack of population information on the severity distribution of most conditions at the global and regional level. The WHO Global Burden of Disease and Risk Factors study has used the GBD study weights to estimate the DALY burden from various causes and risk factors in different regions of the world (Lopez et al, 2006).

GBD study weights for VI and blindness vary by cause of low vision or blindness, according to the disability weights for treated and untreated VI, and the likelihood of treatment. The GBD definitions of VI match the standard WHO levels of VA:

- Low vision (3/60 ≤ VA < 6/18);
  - 0.282 if untreated;
  - 0.227 if treated;
- Blindness (VA < 3/60);
  - 0.6 if untreated; and
  - 0.488 if treated (cataract and diabetes mellitus retinopathy only).

These VA definitions differ from this study, where blindness is defined as a VA less than 6/60. Furthermore, the GBD study did not estimate disability weights for people with a VA less than 6/12 and equal to or greater than 6/18, defined as mild VI in this study.

Netherlands researchers measured disability weights for 53 diseases of public health importance using a methodology consistent with the GBD study (Mathers et al, 1999;

Stouthard et al, 1997). The Netherlands study used more specific disease stages and severity levels so that judgements were not required on the distribution of stages or severities in the population. In addition, the study defined each disease stage by the associated average levels of disability, handicap, mental wellbeing, pain and cognitive impairment using a modified version of the EuroQol health status instrument (Mathers et al, 1999). The Netherlands study weights are:

- 0.02 for mild vision loss (some difficulty reading newspaper, no difficulty recognising faces at 4 meters);
- 0.17 for moderate vision loss (great difficulty reading newspaper, some difficulty recognising faces at 4 meters); and
- 0.43 for severe vision loss (unable to read newspaper or recognise faces at 4 meters).

Netherlands study weights have been used in Australian burden of disease studies undertaken by the government (Begg et al, 2007; Mathers et al, 1999), and by Access Economics in burden of VI studies for five countries and worldwide (Access Economics, 2004; 2006; 2008a; 2008b; 2009; 2010). As with the GBD study weights, the Netherlands study health states do not completely concord with this study, but are used here rather than the GBD weights for three reasons:

- consistency with previous Access Economics studies;
- the Netherlands weights cover three severities of VI, consistent with this study; and
- GBD weights are more likely to overestimate the DALY burden given that low vision and blindness are defined as more severe than in this study (a VA cut-off of 3/60 rather than 6/60). Conversely, the Netherlands definitions may, particularly for mild and moderate VI, include less severe cases of vision loss leading to conservative DALY estimates.

The Netherlands study weights for mild vision loss, moderate vision loss, and blindness were used for mild VI, moderate VI, and blindness, respectively, in this study.

5.1.2 Willingness to pay and the value of a statistical life year

Because DALYs are not a financial metric they are not directly comparable with monetary costs and benefits associated with a specific condition. In an economic evaluation of a public program, a monetary conversion of the loss in healthy life is typically used to ascertain the cost of a condition and, in turn, the net benefit or cost of a health intervention. This allows benefit/cost ratios to be calculated so comparisons can be made across all types of programs, not just those associated with changes in health.

In general there are two ways to estimate the value of a change in the stock of health capital using survey techniques. The first is to directly measure the willingness to pay (WTP) for a change in health status using a choice based approach, such as contingent valuation or discrete choice methods.

The alternative is to model the WTP for a year of healthy life using the value of a statistical life (VSL) currently used in the public arena. The VSL is generally derived from the WTP of individuals to avoid small changes in the risk of various health states, often including death. As this is arguably a similar context to deriving WTP for changes to morbidity, VSL estimates

can be applied to summary health measures such as quality adjusted life years (QALYs) and DALYs.

Since no estimates for the VSL in the ROI could be identified, this study employs the VSL estimated for the UK by Mason et al (2009). This VSL was used by Access Economics (2009) to estimate the burden of sight loss in the UK. Mason et al (2009) derived the VSL from a UK Department for Transport analysis where the public were asked about their WTP for a reduction in death from road safety improvements using a contingent valuation/standard gamble approach (UK Department for Transport, 2007). The VSL was estimated to be £1.43 million in 2005 prices. Adjusting for quality of life, discounting at a rate of 1.5% (the recommended rate of pure time preference by the UK Treasury), and adjusting for the value of consumption forgone due to death, the value of a QALY estimated to be £70,896 in 2005 prices by Mason et al (2009). A QALY is equivalent to a year of perfect health, and the monetary value of a QALY is therefore the value of a statistical life year (VSLY).

As part of their study, Mason et al (2009) conducted an international literature review on the estimated VSLY for different countries. The UK VSLY estimated by Mason et al (2009) was higher than two Swedish studies (Johannesen and Meltzer, 1998; Person and Hjelmgren, 2003) but lower than the median VSLY in an international review of studies calculating the implicit value of a QALY (Hirth et al, 2000). An earlier Australian study (Abelson, 2003) reported a lower VSLY than the UK estimate. Therefore, the UK figure is within the bounds of other international studies.

The UK VSLY reported by Mason et al (2009) was inflated to 2010 prices (£81,318) using the estimated inflation increase from 2005 to 2010 of 14.7% (UK National Statistics, 2010) and then converted to euros at the latest available exchange rate of €1 = £0.86 (ECB, 2011) to attain an estimate of €94,794. This estimate of the current VSLY in the UK has been used as a proxy for the value of a DALY in the ROI in this study.

It should be noted that Access Economics' Australian cost of VI study (Access Economics, 2010a) used a VSLY of AUD$161,751 in 2009, which inflates to AUD$166,604 in 2010. Converting this to VSLY to euros at the latest available exchange rate of €1 = $A1.44 (ECB, 2011) gives a VSLY of €115,512, which is one-fifth higher than the UK VLSY used in this study.

5.2 Estimated YLDs

YLDs due to mild/moderate VI and blindness in the ROI were calculated by multiplying the estimated number of people with vision loss (Chapter 2: Table 2.5, Table 2.10 and Table 2.11) by the disability weight associated with each severity of the sight loss (Stouthard et al, 1997).

Table 5.1 presents the YLDs by severity of vision loss in for the years 2010, 2015 and 2020. The burden of disability due to VI and blindness is estimated to increase from just over 18,000 YLDs in 2010 to over 22,700 YLDs by 2020.

Table 5.1: Estimated YLDs due to VI and blindness

Age-gender group	2010				2015				2020			
	Mild VI	Mod VI	Blind	Total	Mild VI	Mod VI	Blind	Total	Mild VI	Mod VI	Blind	Total
Male												
0-4	49	133	19	200	54	147	21	221	55	150	21	226
5-9	90	246	34	370	100	274	38	413	110	301	42	453
10-14	161	441	62	664	175	478	67	719	193	529	74	796
15-19	160	437	61	659	168	460	64	693	181	496	69	747
20-24	170	466	70	706	156	429	64	649	160	440	66	666
25-34	259	728	173	744	250	705	177	650	220	619	155	578
35-44	79	244	206	417	92	284	240	482	105	324	274	416
45-54	83	252	229	282	93	281	257	328	106	320	290	372
55-64	96	290	278	247	106	320	307	289	119	358	344	331
65-74	115	349	310	308	143	433	385	341	172	520	462	396
75-84	85	289	478	256	102	350	578	290	126	431	711	320
85-94	68	219	378	310	94	301	522	344	132	421	732	388
95 +	24	70	130	354	38	113	207	389	57	169	310	432
Female												
0-4	57	156	22	235	63	172	24	259	64	176	25	265
5-9	77	211	30	317	85	233	33	351	93	255	36	383
10-14	137	375	52	564	150	410	57	618	165	451	63	678
15-19	140	383	54	576	146	401	56	604	159	437	61	657
20-24	164	452	71	686	148	408	64	620	149	412	64	626

Age-gender group	2010				2015				2020			
	Mild VI	Mod VI	Blind	Total	Mild VI	Mod VI	Blind	Total	Mild VI	Mod VI	Blind	Total
25-34	270	775	168	681	273	786	174	617	242	696	155	540
35-44	148	440	200	533	169	503	229	616	192	572	260	552
45-54	137	403	219	424	150	442	242	484	167	488	266	552
55-64	132	398	254	364	146	440	281	417	164	494	315	472
65-74	123	456	289	416	150	554	351	445	179	668	423	507
75-84	118	416	672	343	129	455	734	389	149	526	848	414
85-94	148	492	828	425	177	586	989	472	209	692	1,169	534
95 +	55	173	302	358	73	232	405	395	91	289	505	439
Total	**3,143**	**9,296**	**5,588**	**18,027**	**3,430**	**10,198**	**6,566**	**20,195**	**3,759**	**11,232**	**7,739**	**22,729**

Source: Deloitte Access Economics calculations using Stouthard et al (1997) and prevalence estimates from Chapter 2.

5.3 Estimated YLLs

YLLs were calculated only for deaths that occur within each year. The numbers of deaths associated with partial sight and blindness were calculated using the methodology outlined in Section 4.1.2. The estimated total numbers of deaths due to VI and blindness by age and gender were reported in Table 4.3 (Section 4.1.2) for those aged 40 years and over in 2010, 2015 and 2020.

Life tables for the ROI (CSO, 2009) detail the estimated remaining years of life at different ages i.e. numbers of undiscounted YLLs for someone who dies at each age. Similar to productivity losses due to death, these YLLs were discounted at an annual rate of 4% to estimate the present value of the DALY burden (see Section 4.1.2).

Table 5.2 presents the discounted YLLs due to VI and blindness. The burden of mortality due to VI and blindness is projected to increase from 510 YLLs in 2010 to 736 YLLs in 2020.

Table 5.2: Estimated YLLs due to VI and blindness

Age-gender group	2010	2015	2020
Males			
40-44	3	3	4
45-54	11	12	13
55-64	25	27	31
65-74	55	68	82
75-84	71	86	106
85-94	49	68	96
95+	1	2	2
Females			
40-44	3	3	3
45-54	12	13	14
55-64	23	25	28
65-74	42	52	62
75-84	85	93	108
85-94	120	144	170
95+	11	14	18
Total	**510**	**610**	**736**

Source: Deloitte Access Economics calculations using ABS (2010), CSO (2008; 2009; 2010g), Department of Finance (2010) and McCarty et al (2001).

5.4 Estimated DALYs

Table 5.3 presents the summation of the YLD and YLL components, which results in over 18,500 DALYs due to VI and blindness in 2010. This disease burden is estimated to over to

nearly 23,500 DALYs by 2020. Approximately 56% of the DALY burden is incurred by females. This reflects the higher prevalence of VI and blindness in females resulting in higher YLDs and YLLs for females.

Table 5.3: Estimated DALYs due to VI and blindness

	2010	2015	2020
YLDs	18,027	20,195	22,729
YLLs	510	610	736
DALYs	**18,537**	**20,804**	**23,465**

Source: Deloitte Access Economics calculations using CSO (2005; 2008) and DOHC (2005)

5.5 Monetary equivalent of DALY burden

Multiplying the total number of DALYs by the VSLY in 2010 (€94,794) provides an estimate of the euro value of the burden of disease from vision loss in the ROI. A constant VSLY value was applied to the years 2015 and 2020.

Estimates of the monetary equivalents of the DALY burdens for 2010, 2015 and 2020 are presented in Table 5.4. Burden of disease was valued at nearly €1.8 billion in 2010, and is projected to rise to over €2.2 billion by 2020.

Table 5.4: DALY burden (€'000) from VI and blindness in the ROI

	2010	2015	2020
Estimated DALYs	18,537	20,804	23,465
VSLY applied	€94,794	€94,794	€94,794
Disease burden monetary value (€'000)	**€1,757,158**	**€1,972,114**	**€2,224,365**

Source: Deloitte Access Economics calculations using Stouthard et al (1997), prevalence estimates from Chapter 2, ABS (2010), CSO (2008; 2009; 2010g), Department of Finance (2010), McCarty et al (2001), Mason et al (2009), UK National Statistics (2010) and ECB (2011).

6 THE TOTAL COST OF VISION IMPAIRMENT AND BLINDNESS IN THE ROI

SUMMARY BOX

The total economic cost of vision impairment and blindness includes two components; actual financial costs and the economic valuation of the burden of disease.

The financial cost includes direct health care costs, productivity losses, informal care costs and deadweight welfare losses. It is estimated that the total financial cost of vision impairment and blindness in the ROI in 2010 was €386.1 million. The total cost is projected to rise to €419.7 million by 2015 and €449.0 million by 2020. Direct health care costs accounted for a third of the total financial costs of vision impairment and blindness.

The burden of disease includes the economic value of DALYs from disability and premature mortality due to vision loss. This was valued at €1.8 billion in 2010, which is projected to rise to nearly €2.0 billion by 2015 and €2.2 billion by 2020. The majority of the burden of disease was due to years of healthy life lost due to disability.

Overall, the total economic cost of vision impairment and blindness in the ROI in 2010 was estimated to be €2.1 billion in 2010. This is projected to rise to €2.4 billion by 2015 and €2.7 billion by 2020. The burden of disease comprised over 80% of the total economic cost of vision impairment and blindness.

This chapter sums the total economic costs of VI and blindness presented in the preceding sections, including direct health care costs, indirect costs, and the monetary value of the disease burden. It therefore presents the total cost of VI and blindness in the ROI disaggregated by economic category.

6.1 Summary

The total economic cost of VI and blindness in the ROI was estimated to be €2.14 billion in 2010 among the 224,832 people with mild VI, moderate VI or blindness (as reported in Table 2.5, Table 2.10 and Table 2.11). The total cost of VI and blindness is projected to rise to nearly €2.67 billion by 2020.

The total cost of VI and blindness is comprised of:

- Direct health care costs;
- Indirect costs; and
- The economic value of the disease burden (DALYs).

It is important to distinguish between the direct and indirect costs, which are actual financial costs, and the burden of disease, which is a valuation of the total DALYs using euros as the unit of measurement. The total financial cost of VI and blindness is projected

to increase from €386.1 million in 2010 to €449.0 million in 2020. Direct health care costs comprise approximately 30% of the total financial cost in each year.

The economic value of the disease burden (DALYs) is projected to increase from nearly €1.76 billion in 2010 to nearly €2.22 billion in 2020. As stated above, these figures are not actual financial costs to the economy, but the value of the DALYs measured in euros. The financial cost of VI is correctly interpreted as the sum of the direct and indirect costs only. This is particularly important considering that the value of the total DALY burden comprises 82% of the total economic costs.

The total costs of VI and blindness discussed above are presented by component in Table 6.1.

Table 6.1: The total cost of VI and blindness, by component

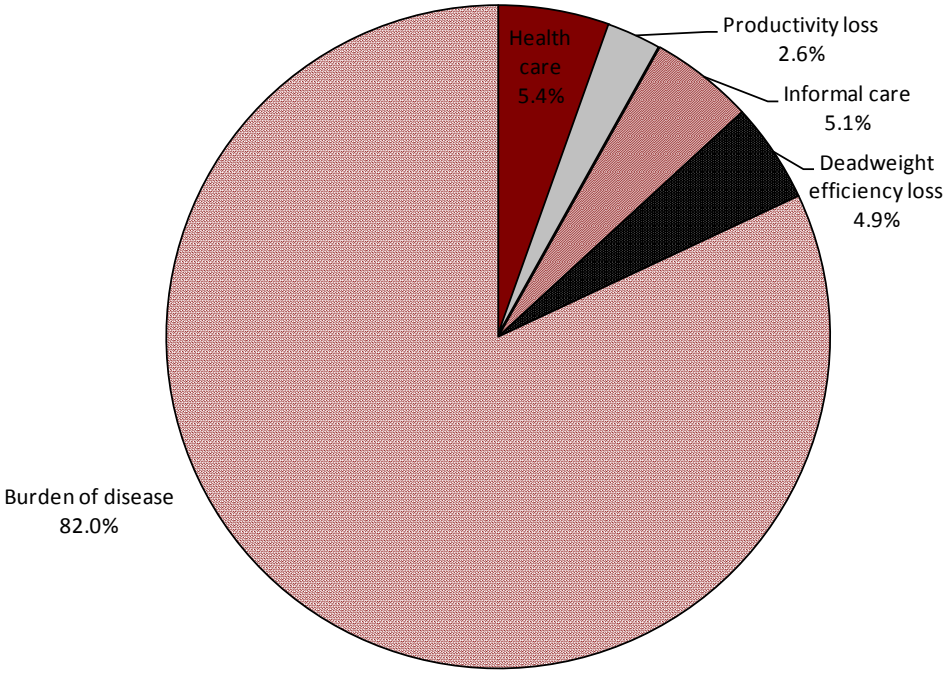
Component	2010	2015	2020
DIRECT HEALTH CARE COSTS			
Hospital costs	€70,058,945	€76,458,670	€82,087,024
Prescriptions	€16,579,287	€18,093,767	€19,425,704
General ophthalmic services	€15,758,155	€17,197,627	€18,463,596
Other	€14,357,781	€15,669,332	€16,822,798
Total health care costs (a)	**€116,754,169**	**€127,419,396**	**€136,799,122**
INDIRECT COSTS			
Productivity losses	€56,719,003	€60,607,068	€63,743,444
Informal care	€108,249,563	€118,137,914	€126,834,403
DWL	€104,371,674	€113,567,451	€121,624,658
Total indirect costs (b)	**€269,340,241**	**€292,312,433**	**€312,202,505**
TOTAL FINANCIAL COST OF VI AND BLINDNESS (a) + (b)	**€386,094,410**	**€419,731,829**	**€449,001,627**
BURDEN OF DISEASE			
Disability DALYs	18,027	20,195	22,729
Economic valuation (disability)	€1,708,826,867	€1,914,318,439	€2,154,584,789
Premature mortality DALYs	510	610	736
Economic valuation (mortality)	€48,331,023	€57,795,499	€69,780,546
Total burden of disease DALYs	**18,537**	**20,804**	**23,465**
Economic value of total DALYs (c)	**€1,757,157,890**	**€1,972,113,938**	**€2,224,365,335**
TOTAL ECONOMIC COST OF VI AND BLINDNESS (a) + (b) + (c)	**€2,143,252,300**	**€2,391,845,767**	**€2,673,366,962**

Source: Deloitte Access Economics calculations.

As stated above, the burden of disease accounted for nearly 82% of the total economic cost of VI and blindness in 2010. The next largest component of the total cost was direct health

care system costs (5.4%). The smallest share of total costs was attributed to productivity losses (2.6%). Informal care and DWL accounted for roughly equal shares of the total cost (close 5.0%). The distribution of costs in 2010 is visually presented in Chart 6.1.

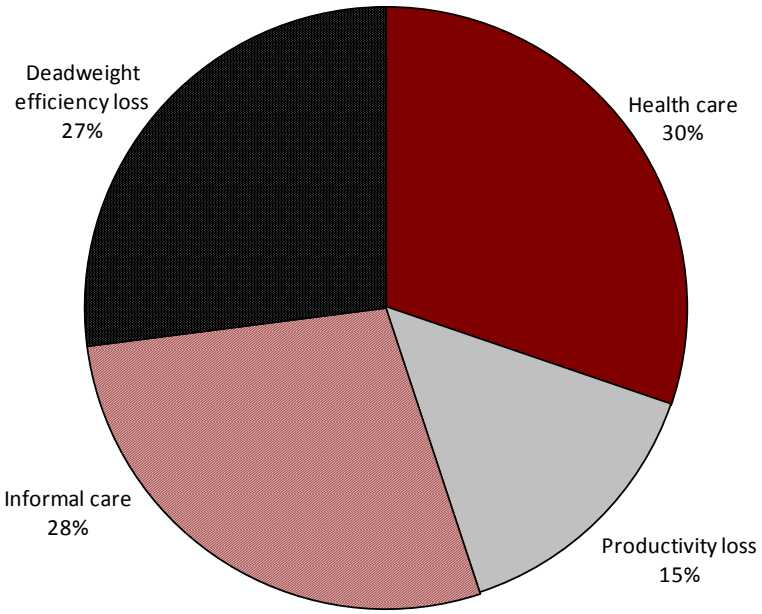
Chart 6.1: Components of the total economic cost of VI and blindness in 2010



Source: Deloitte Access Economics analysis.

A similar breakdown excluding the economic valuation of the DALY burden is presented in Chart 6.2. This shows that direct health care costs accounted for the largest share of total financial costs of VI and blindness (30%). Roughly equal shares are attributed to informal care and DWL (28% and 27%, respectively). Productivity losses accounted for the smallest share of total financial costs (15%).

Chart 6.2: Components of the total financial cost of VI and blindness in 2010



Source: Deloitte Access Economics analysis.

7 COST EFFECTIVENESS ANALYSIS OF THREE EYE CARE INTERVENTIONS

SUMMARY BOX

An assessment of the cost effectiveness of three interventions to address or treat preventable vision impairment in the ROI was conducted. Cost effectiveness analyses were undertaken for: (1) an educational campaign and follow-up screening program in the elderly population; (2) a retinal screening program targeting people diagnosed with diabetes; and (3) a reduction in waiting times for cataract surgery.

The analyses considered the delivery mechanism for each intervention, their effectiveness in reaching the target population, and the effectiveness of related treatment. The analyses incorporated all associated costs and benefits impacted by the intervention.

It was found that an educational program and screening of the elderly population and screening of those with diagnosed diabetes would be cost effective. Because limited data were identified to estimate the cost of reducing cataract surgery waiting lists, the analysis was limited to identifying intervention costs that would result in that intervention being cost effective.

The results for each intervention are detailed in each of the subsections below.

This chapter presents cost effectiveness analyses (CEA) for three hypothetical eye care interventions:

- An educational campaign and screening program targeting the older population, aged 70 years and over;
- An eye screening program targeting people with diagnosed diabetes; and
- A reduction in waiting lists for cataract surgery.

CEAs of the interventions involved an analysis of:

- Program costs, e.g. the cost of screening tests, cost of educational campaign;
- Estimated effects of each intervention, e.g. number of vision loss cases treated, reduced surgery waiting time;
- Outputs from the intervention, e.g. an increase in the number of screening tests, increase in the number of diagnosed vision loss cases; and
- Outcomes associated with outputs, e.g. increase in health care costs associated with diagnosis of additional vision loss cases, avoidance of DALYs from the treatment of detected vision loss cases.

These data are synthesised to estimate the cost effectiveness of each intervention using incremental cost effectiveness ratios (ICER), specifically the cost per DALY averted by the intervention. These ICERs are estimated for two perspectives:

- **health care perspective** – the analysis includes direct health care costs (of the intervention and associated treatment) only; and

- **societal perspective** – the analysis also includes the DWL associated with the health care costs (all interventions), and the productivity and informal care costs averted (reduction in cataract surgery waiting lists only).

The WHO 'Choosing Interventions that are Cost-Effective' (CHOICE) project uses threshold values in its analyses to assess relative cost effectiveness of an intervention (WHO, 2011). Following recommendations of the Commission of Macroeconomics and Health, WHO uses GDP as a readily available indicator to define three categories of cost effectiveness:

- **highly cost effective** – cost per DALY averted less than GDP per capita;
- **cost effective** – cost per DALY averted between one and three times GDP per capita; and
- **not cost effective** – cost per DALY averted more than three times GDP per capita.

GDP per capita in the ROI was most recently estimated to be €35,801 in 2009 (CSO, 2011). Using WHO criteria, this translates to the following cost effectiveness thresholds:

- **highly cost effective** – ICER less than €35,801 per DALY averted;
- **cost effective** – ICER between €35,801 and €107,403 per DALY averted; and
- **not cost effective** – ICER more than €107,403 per DALY averted.

7.1 Screening the older population

SUMMARY BOX

A hypothetical intervention of on an educational program and eye screening for people aged over 70 years would result in:

* costs of €31,844 for the public health educational campaign and €165,092 for the screening tests;

* 482 cases of mild VI being detected through resulting screening tests;

* discounted five-year health care costs of €812,952 to treat detected cases;

* deadweight efficiency losses of €486,204 from government funding of the campaign, eye tests and health care costs; and

* 84 DALYs averted as a result of the intervention.

Under a societal perspective, this intervention would be associated with a cost of €17,738 per DALY averted under a societal perspective and €11,974 under a health care perspective. Therefore, the intervention is highly cost effective using WHO thresholds.

7.1.1 Description

Eye tests are important for detecting eye disease and refractive error, particularly for the elderly population who are at higher risk of developing partial sight and blindness. According to the Royal National Institute of Blind People (RNIB, 2007), a large proportion of elderly people neglect to have regular eye tests due various reasons, including:

- absence of symptoms;
- worries about the cost of glasses and/or lens prescription;

- accessibility restrictions, e.g. lack of coverage of opticians in certain geographic areas and associated travel issues for elderly people;
- lack of awareness of the impact of eye tests and treatments on eye disease; and
- lack of awareness of entitlement to free eye tests and free glasses/lens prescriptions.

The hypothetical intervention assessed in this section is an educational program similar to Vision Initiative, a public health program aimed at preventing avoidable partial sight and blindness for those living in Victoria, Australia (Müller et al, 2007). The cost effectiveness of screening older people in the UK was assessed in Access Economics (2009) and a similar methodology has been applied here.

The hypothetical education program for the ROI is assumed to be similar, would target the population aged over 70 years, and consist of messages and advertisements through national and regional television and radio stations, national and regional newspapers, and alternative publications such as magazines and online media outlets. The aim of the program would be to generate greater awareness and access to services in order to discover mild VI in those who would not have otherwise presented. The education program is expected to increase the numbers of eye tests in the elderly population. It is assumed that people with moderate VI would already be aware of their condition and seek treatment. Detected mild VI is assumed to be treated immediately.

The HSE provides optical services free of charge to Medical card holders, including everyone aged 70 years and over who is normally resident in the ROI (NCBI, 2010). Since this intervention is assumed to target those aged 70 years and over, the increase in resulting eye tests are all assumed to be funded completely by the government.

7.1.2 Target population and reach

There were an estimated 353,298 people aged 70 years and over in the ROI in 2010. The 1998 Survey of Lifestyles, Attitudes and Nutrition in Ireland reported 47.9% of older respondents taking an eye test over the previous five years (National Council on Ageing and Older People, 2004). This translates to an annual non-tested rate of 10.4% ([100%-47.9%]/5). When the number of people aged 70 years and over in 2010 (353,298) is multiplied by this non-tested rate (10.4%) it is estimated that 36,814 older people did not have an eye test in 2010.

Müller et al (2007) reported that the Vision Initiative campaign reached 64% of the target audience, and of the people reached, 27% noted that campaign messages changed their eye health behaviours. In the context of this intervention, this would translate to getting eyes tested. These data were applied to the target population of 36,814 people in 2010 to estimate that 6,361 people aged 70 years and over would get their eyes tested specifically as a result of the public campaign.

7.1.3 Cases of undetected mild VI diagnosed

It is assumed that the VI detected by screening tests would only be in its mild stages ($6/18 \leq VA < 6/12$). As explained above, it is assumed that a person with moderate VI or blindness would visit an optometrist or ophthalmologist since their vision loss would affect their daily life. Some people with comorbidities such as dementia or limited mobility may

not fall into this category. Therefore, the cost effectiveness of the screening program reported here should therefore be considered an under-estimate.

Prevalence rates of mild VI by condition and age (Section 2.4) were applied to the additional number of eye tests generated by the campaign to estimate the additional number of mild VI cases (diagnosed and undiagnosed) within this population subset. However, since it is assumed that screening would detect undiagnosed cases of mild VI, an adjustment was needed to estimate the proportion of cases that would be undiagnosed prior to screening.

A UK study was used to estimate the number of undiagnosed mild VI cases detected through screening (Reidy et al, 1998) was used. This study surveyed people aged 65 and over in the North London area and set out the proportion of people with vision loss not in touch with eye care services. These proportions were also reported by Access Economics (2009).

The proportions of people with partial sight and blindness not in touch with eye care services (based on UK data) are presented in Table 7.1.

Table 7.1: People with partial sight and blindness not in touch with eye care services, UK

Eye disease	Proportion not in touch with eye care services (%)
AMD	86.0%
Cataract	88.0%
DR	88.0%
Glaucoma	74.0%
Other	88.0%

Source: Access Economics (2009) from analysis of Reidy et al (1998).

These proportions were applied to the estimated number of mild VI cases to estimate the portion of cases previously undetected that were picked up by screening.

Estimates of eye tests and previously undetected mild VI diagnosed through screening are presented by condition and age in Table 7.2. Overall, it is estimated that 482 cases of mild VI would be diagnosed through additional eye screening tests resulting from the public campaign based on 2010 population estimates.

Table 7.2: Number of eye tests and undetected mild VI cases diagnosed by screening

Age	Tests	AMD	Cataract	DR	Glaucoma	Other	Total
Male							
70-74	1,107	8	1	6	6	29	50
75-79	810	6	0	2	4	16	28
80-84	492	13	1	1	5	17	37
85-89	248	14	1	1	5	13	34
90+	90	16	0	0	7	12	36
Total	2,746	57	4	10	27	87	185

Age	Tests	AMD	Cataract	DR	Glaucoma	Other	Total
Female							
70-74	1,195	8	1	5	3	32	50
75-79	976	12	1	2	3	18	35
80-84	744	26	1	1	4	24	56
85-89	467	37	1	1	5	28	72
90+	232	40	2	1	6	35	85
Total	3,615	124	6	10	22	136	298
Total	**6,361**	**181**	**10**	**20**	**48**	**223**	**482**

Source: Deloitte Access Economics calculations using CSO (2008), Müller et al (2007), National Council on Ageing and Older People (2004), Reidy et al (1998) and prevalence rates from Section 2.4.

7.1.4 Cost of campaign and eye tests

Following a similar analysis for a UK educational campaign (Access Economics, 2009), the cost of the educational campaign in the ROI was derived from costs of the Vision Initiative in Australia (Müller et al, 2007). Based on the data reported by Muller, Access Economics (2009) estimated the program to have cost $A0.116 per person targeted in 2005. This cost would convert to $A0.130 in 2010 prices (RBA, 2011) and to €0.090 per person targeted at the average exchange rate in 2010, being €1 = $A1.44 (ECB, 2011). This per person cost was multiplied by the number of people aged 70 and over in the ROI (353,298) to estimate a total campaign cost of €31,844.

It should be considered that there may be economies of scale for education campaigns. That is, the cost of a campaign per person may be lower when the fixed costs of a campaign are attributed to a greater population. The relative population sizes (70+ years) in the ROI (353,298 people in 2010 from CSO, 2008) and Australia (2.1 million people from Deloitte Access Economics' Demographic Model) differ, therefore suggesting that per person costs may be higher in the ROI than estimated using Australian campaign data, and hence cost effectiveness results should be interpreted with caution.

The cost of a screening test was estimated as the average of the fees for an eye examination by an ophthalmologist/ophthalmic medical practitioner (€26.50) and ophthalmic optician (€23.35) in 2008 (from Table 3.6, Section 3.3). These were assumed to be the most representative fees for a standard eye test for the elderly amongst all eye examinations listed in Table 3.6 (Section 3.3).

This cost (€24.93 in 2008 prices) was inflated to 2010 prices using the annual change in the health consumer price index in the ROI, which was 3.5% between 2008 and 2009, and 0.6% between 2009 to 2010 (CSO, 2011). The resulting fee was €25.95 per examination. This fee was multiplied by the 6,361 additional screening tests in the elderly population to estimate a total screening cost of €165,092 generated by the campaign.

7.1.5 Treatment effectiveness and compliance

Effectiveness is defined here as the percentage of vision loss that can be avoided through timely clinical intervention, given the current prevalence of VI. **Compliance** is the percentage of people who are likely to adhere to recommended timely clinical intervention.

Estimates of compliance were needed to calculate the health care treatment costs of mild VI resulting from screening. Estimates of treatment effectiveness were also needed to determine the number of DALYs averted by successful treatment.

In the absence of ROI specific data, treatment effectiveness and compliance were estimated from Access Economics' study on eye care interventions in Australia (Access Economics, 2005). As reported previously by Access Economics (2005), compliance and treatment parameters were derived from applicable international and Australian studies detailed below.

- The effectiveness of treatments for cataract, refractive error and other causes, were derived from Australian MVIP data on presenting VA at follow-up and expert opinion from Eye Research Australia ophthalmologists on conservative estimates.
- The effectiveness of DR treatment was derived from a UK study of the proportions of severe, moderate and mild DR prevented by control of blood pressure to avoid diabetic complications (Turner et al, 1998).
- The effectiveness of glaucoma treatment was derived from a US study (Kass et al, 2002) and a Swedish study (Heijl et al, 2002), which both assessed the effectiveness of medication interventions for primary open angle glaucoma. Similar effectiveness was reported for surgery in later stage glaucoma patients in the US (Van Veldhuisen et al, 2000).
- Standard treatment for AMD is currently ranibizumab. The effectiveness of AMD treatment was measured by the proportion of MARINA trial patients who were no longer vision impaired after starting ranibizumab treatment, using the definition of VI in this study (VA > 20/40 as a proxy for VA > 6/12). Rosenfeld et al (2006) reported these proportions to be 40% and 42.1% at 12 months and 24 months of treatment, respectively. Ranibizumab's effectiveness at two years was assumed to remain constant to the end of year five.
- Compliance parameters for each condition were derived from expert opinion from Eye Research Australia ophthalmologists.

The five-year effectiveness parameter was applied to estimate DALYs, since this report assumes that each elderly person with undetected mild VI would seek an eye test and subsequent treatment of their own accord after five years (Taylor et al, 2004).

Table 7.3 presents the treatment effectiveness and compliance parameters by eye condition.

Table 7.3: Treatment effectiveness and compliance parameters

	AMD	Cataract	DR	Glaucoma	Other cause
Effectiveness - 1 year	40.0%	99.0%	95.9%	99.7%	50.0%
Effectiveness - 2 year	42.1%	98.0%	91.8%	98.5%	50.0%
Effectiveness - 3 year	42.1%	97.0%	87.8%	97.6%	50.0%
Effectiveness - 5 year	42.1%	95.0%	79.6%	95.2%	50.0%
Effectiveness - lifetime	42.1%	95.0%	53.0%	82.9%	50.0%
Compliance	95.0%	90.0%	80.0%	66.7%	80.0%

Source: Access Economics (2005).

7.1.6 Treatment costs for diagnosed mild VI

The health care cost per person diagnosed with mild VI was calculated from total health care costs in 2010 (Section 6.1). Health care costs of €116.8 million were divided by the total prevalence of VI and blindness in 2010 (224,832 from Section 2.5) to estimate a per person cost of €519.29. This would be an overestimate for the cost of mild VI only and hence is likely to overestimate the cost per DALY averted through screening.

Similar to Access Economics' UK study (2009), each elderly person with undetected mild VI is assumed to seek an eye test and subsequent treatment within the next five years of their own accord (Taylor et al, 2004).[2] This is because the condition will worsen to a point where vision loss starts affecting daily life.

Therefore, the assumed impact of the intervention is to bring an eye test forward by five years. Treatment costs resulting from the intervention were thus calculated over a five year period, by applying the per person annual health care cost (€519.29) and 4% discount rate commonly used in CEAs of public sector projects in the ROI (Department of Finance, 2010).

Discounted five-year treatment costs incorporated life expectancy (CSO, 2009) using the assumed age of each diagnosed case (the midpoint of each age group) and compliance to treatment by condition. Compliance was incorporated by multiplying the compliance rate by condition (from Table 7.3) by the discounted treatment costs.

Discounted five-year treatment costs by condition are presented in Table 7.4. Overall, the total five-year health care cost of treating mild VI diagnosed through the intervention is estimated to be €812,952 based on the population size in 2010.

Table 7.4: Discounted five-year treatment costs for all diagnosed cases

Age group	AMD	Cataract	DR	Glaucoma	Other	Total
Male						
70-74	€16,859	€2,790	€10,984	€8,939	€53,857	€93,429
75-79	€13,207	€960	€3,556	€6,180	€29,446	€53,349
80-84	€28,391	€1,750	€2,121	€7,828	€30,545	€70,635
85-89	€25,351	€1,176	€1,394	€6,107	€19,753	€53,781
90+	€21,997	€621	€368	€6,641	€14,262	€43,890
Total	**€105,804**	**€7,298**	**€18,424**	**€35,696**	**€147,862**	**€315,084**
Female						
70-74	€18,615	€2,776	€9,871	€5,188	€58,300	€94,751
75-79	€27,194	€1,412	€3,069	€4,594	€32,639	€68,908
80-84	€57,006	€1,588	€1,694	€5,935	€45,028	€111,251
85-89	€65,830	€1,950	€1,617	€6,477	€41,822	€117,696

[2] This represents an average length of time. In reality, many people will seek an eye test of their own accord in less than five years while others will wait substantially longer. The timing will depend on the disease pathway and the barriers to accessing services by the individual.

Age group	AMD	Cataract	DR	Glaucoma	Other	Total
90+	€55,252	€2,439	€1,265	€6,014	€40,293	€105,264
Total	**€223,898**	**€10,165**	**€17,516**	**€28,208**	**€218,082**	**€497,868**
Total	**€329,702**	**€17,463**	**€35,939**	**€63,903**	**€365,944**	**€812,952**

Source: Deloitte Access Economics calculations using Access Economics (2005), Department of Finance (2010), Taylor et al (2004) and health care cost estimate from Section 3.5.

7.1.7 DWL

As additional tax revenue would need to be raised to fund additional sight tests, the campaign and treatment, there will be an associated DWL to the economy. Using a MCPF of 57 cents for every euro raised from taxation (Kleven and Kreiner, 2003, see Section 4.3), the DWL was estimated to be €486,204. This assumes that 80.7% of treatment costs are government funded (OECD, 2009), and that all eye tests are government funded as the targeted group solely consists of people aged over 70 years (NCBI, 2010).

7.1.8 DALYs averted from successfully treated cases

There is a personal health cost attached to those who fail to take a regular eye test as their health will deteriorate without detection and treatment. This reduction in health is measured using DALYs. The 0.02 disability weight for mild sight loss (Stouthard et al, 1997) was multiplied by the number of undetected mild VI cases diagnosed through screening tests in 2010 to estimate the gain in DALYs specifically due to the screening program.

This annual number of DALYs was then applied over a five-year period and multiplied by five-year effectiveness parameters (from Table 7.3) to estimate total DALYs averted as a result of the intervention each year. A discount rate of 4% was applied to DALYs (Department of Finance, 2010).

It is assumed that after five years, a person with undetected mild VI would seek any eye test and treatment on their own accord (Taylor et al, 2004). Thus DALYs avoided through screening only apply for the first five years after detection by screening.

Overall, it is estimated that 84 DALYs would be averted as a result of the intervention.

7.1.9 Cost effectiveness results

Societal costs of the intervention including DWL are estimated to total nearly €1.5 million. Excluding DWL, total costs of the intervention would be just over €1.0 million (health care perspective).

The total costs associated with the older population screening intervention described above are summarised in Table 7.5.

Table 7.5: Total costs associated with intervention

Component	Amount
Eye screening tests	€165,092

Component	Amount
Public health educational campaign	€31,844
Discounted treatment costs	€812,952
DWL	€486,204
Total costs (health care perspective)	**€1,009,888**
Total costs (societal perspective)	**€1,496,092**

Source: Deloitte Access Economics estimates.

Under a societal perspective, the hypothetical screening program for the older population is associated with a cost of **€17,738 per DALY averted**. Under a health care perspective, cost effectiveness is estimated to be **€11,974 per DALY averted**. The intervention is therefore highly cost effective under both perspectives, using WHO thresholds.

7.2 Screening people with diabetes

SUMMARY BOX

A hypothetical intervention of an annual, mobile retinal screening service for people aged 10 years and older with registered diabetes in the ROI would result in:

* a total screening cost of €1.6 million;

* 1,090 cases of mild VI being detected through screening tests, including 449 cases of DR;

* discounted five-year health care costs of €2.1 million to treat detected cases;

* deadweight welfare losses of €1.8 million from government funding of the intervention, eye tests and health care costs; and

* 600 DALYs being averted as a result of the intervention.

Under a societal perspective, this intervention would be associated with a cost of €9,090 per DALY averted under a societal perspective and €6,031 under a health care perspective. Therefore, this intervention is highly cost effective using WHO thresholds.

7.2.1 Description

People with diabetes mellitus are at risk of developing a number of complications, including DR which can potentially result in blindness. Timely and appropriate care for people with diabetes can significantly reduce vision loss over time, improve quality of life and reduce financial costs associated with VI. Screening people with diabetes, followed by treatment of identified DR has been found to be effective in previous studies (HSE and Irish College of Ophthalmologists, 2008).

There is currently no standardised nationally-based screening program in Ireland, with screening determined by various factors including local policy, historical activity and funding issues (Dervan et al, 2008). This may lead to many patients not receiving any screening.

Borrowing elements from a national framework for DR screening designed by the HSE and Irish College of Ophthalmologists (2008) and a previous CEA for DR screening in Australia (Access Economics, 2005), the hypothetical intervention evaluated in this section would

target people in the ROI with diagnosed (registered) diabetes aged 10 years and older and deliver free eye tests via an annual, mobile retinal screening service. Although the HSE and Irish College of Ophthalmologists (2008) propose screening for people aged 12 years and above, a minimum age of 10 years has been used to fit with reported population data by age group. Under this hypothetical intervention, all people with previously diagnosed diabetes aged 10 years and older would be offered screening each year.

The screening method would be digital retinal photography, which provides reproducible and quality assured results. This method has been identified as being the optimal method of performing retinopathy screening (HSE and Irish College of Ophthalmologists, 2008).

7.2.2 Target population and reach

Prevalence rates of type 1 and type 2 diabetes in the ROI have been estimated by the Institute of Public Health in Ireland (2006) estimated and are presented in Table 7.6. Prevalence rates for type 2 diabetes were only reported by the Institute for people aged 20 years and older. These prevalence rates were applied to the ROI population in 2010 (CSO, 2008) to estimate 161,438 people with diagnosed or undiagnosed diabetes in that year aged 10 years and over.

There are few studies in the ROI on the percentage of diabetes cases that are diagnosed (Institute of Public Health in Ireland, 2006). A study by Smith et al (2003) examined 41 general practices in the ROI and concluded that 23.5% of diabetes were undiagnosed prior to the study. In the absence of other data, this percentage was applied to diabetes prevalence estimates for each age group to estimate the prevalence of diagnosed diabetes as 123,738 people aged 10 years and over.

Prevalence rates and estimated people with diabetes are presented in Table 7.6.

Table 7.6: Prevalence of diabetes in the ROI in people aged 10 years and older

Age group	Type 1 diabetes	Type 2 diabetes	People with diabetes (a)	People with diagnosed diabetes (b)
Males				
10-14	0.30%	-	450	344
15-19	0.30%	-	430	329
20-24	0.30%	0.00%	476	364
25-29	0.50%	0.00%	1,079	825
30-39	0.70%	0.00%	2,742	2,098
40-49	0.60%	3.20%	12,031	9,204
50-59	0.50%	4.60%	13,110	10,029
60-69	0.30%	11.00%	21,414	16,382
70-79	0.10%	12.00%	12,878	9,852
80+	0.10%	9.30%	4,333	3,315
Females				
10-14	0.30%	-	426	326

Age group	Type 1 diabetes	Type 2 diabetes	People with diabetes (a)	People with diagnosed diabetes (b)
15-19	0.40%	-	546	417
20-24	0.30%	0.30%	962	736
25-29	0.40%	0.30%	1,467	1,122
30-39	0.50%	0.00%	1,864	1,426
40-49	0.40%	3.20%	11,113	8,501
50-59	0.30%	5.70%	15,175	11,609
60-69	0.10%	11.50%	21,952	16,793
70-79	0.10%	19.40%	23,518	17,991
80+	0.10%	19.20%	15,471	11,835
Total	**0.35%**	**3.18%**	**161,749**	**123,738**

Source: Institute of Public Health in Ireland (2006).

(a) Diagnosed and undiagnosed.

(b) Estimated by applying a percentage of 76.5% (100%-23.5%), derived from Smith et al (2003), to the total prevalence of diabetes (diagnosed and undiagnosed) in each age group.

An Irish study (Dervan et al, 2008) estimated that 80.9% of people with diabetes had an annual eye examination to test for DR. The inverse of this percentage (19.1% having no annual eye examination) was applied to the total number of people with diagnosed diabetes aged 10 years and over to estimate a target population for screening of 23,636 people.

As part of their framework for a national DR screening program, the HSE and Irish College of Ophthalmologists (2008) specify a minimum performance standard whereby 70% of eligible people will take up an initial eye screen. This percentage was applied to the target population to estimate 16,545 screening tests resulting from the intervention.

7.2.3 Cases of undetected mild VI diagnosed

Fundus photography involves the use of a retinal camera to photograph regions of the vitreous, retina, choroid and optic nerve. Digital retinal photography can document abnormalities related to disease processes affecting the eye, including DR, macular degeneration, glaucoma, abnormal retinal function and defects (Aetna, 2010) and cataract (Mann et al, 2008). Thus, the DR screening intervention is assumed to be able to also pick up other eye conditions.

As explained in Section 7.1, VI detected by screening is assumed to be undiagnosed mild VI. Prevalence rates of mild VI by condition and age (Section 2.4) were applied to the additional number of screening eye tests in people with diabetes, to estimate the number of diagnosed and undiagnosed mild VI cases. However, DR, by definition, is only prevalent in people with diabetes. Therefore, prevalence rates for DR were re-estimated by dividing the prevalence of DR in each age/gender group by the number of people with diabetes in each age/gender group. For example, the prevalence of mild DR was estimated to be 3.3% among males with diabetes aged 60-69 years compared with 0.3% among males aged 60-69 years in the general population.

The proportion of mild VI that is undiagnosed was presented in Section 7.1.3 and is applied in this CEA also.

Estimates of diabetic eye tests and previously undetected mild VI diagnosed through screening are presented by condition and age in Table 7.7. Overall, it is estimated that 1,090 cases of mild VI would be diagnosed through additional eye screening tests in people with diabetes, including 449 cases of DR, based on the population size in 2010.

Table 7.7: Number of eye tests and undetected mild VI cases diagnosed by screening

Age	Tests	AMD	Cataract	DR	Glaucoma	Other	Total
Male							
10-14	46	0	0	0	0	2	2
15-19	44	0	0	0	0	2	2
20-24	49	0	0	0	0	2	2
25-29	111	0	0	14	0	4	18
30-39	281	0	0	7	0	4	11
40-49	1,233	0	1	18	0	13	32
50-59	1,344	0	0	28	1	15	45
60-69	2,195	3	1	64	4	36	109
70-79	1,320	9	1	58	7	31	107
80+	444	23	1	18	9	22	73
Total	**7,066**	**36**	**5**	**207**	**22**	**132**	**402**
Female							
10-14	44	0	0	0	0	2	2
15-19	56	0	0	0	0	2	3
20-24	99	0	0	0	0	4	4
25-29	150	0	0	12	0	5	17
30-39	191	0	0	33	0	4	38
40-49	1,139	0	1	23	0	22	47
50-59	1,555	2	1	40	1	29	73
60-69	2,250	5	2	58	3	45	113
70-79	2,410	23	2	52	7	55	139
80+	1,586	113	4	23	17	96	253
Total	**9,479**	**143**	**11**	**242**	**28**	**264**	**688**
Total	**16,545**	**179**	**16**	**449**	**50**	**396**	**1,090**

Source: Deloitte Access Economics calculations using Institute of Public Health in Ireland (2006) and mild VI prevalence from Section 2.4.

7.2.4 Cost of screening

HSE Primary Care Services Dublin North East area provides a mobile retinal screening service to patients in the Diabetes Watch Programme (HSE and Irish College of Ophthalmologists, 2008). This involves screening by digital retinal photography and three

stage grading with internal and external quality assurance. Three people are involved in the screening program including an ophthalmologist, photographer and one primary grader/administrator (optometrist). The cost of this screening service was €90 per person screened in 2008.

Since this is very similar to the hypothetical screening intervention, its cost was used in the CEA. The cost per person screened is €94 in 2010 prices, applying annual changes in the health consumer price index (CPI) (CSO, 2011)[3].

This cost was applied to the additional number of screening tests resulting from the intervention (16,545) to estimate a total screening cost of just over €1.5 million.

7.2.5 Treatment effectiveness and compliance

Estimated parameters for treatment effectiveness and compliance were presented in Section 7.1.5 and applied in this CEA also.

7.2.6 Treatment costs of diagnosed cases

Future treatment costs of VI cases diagnosed through screening were estimated using the same approach as for the older person screening intervention (see Section 7.1.6). It was assumed that each person with diabetes who has not received an annual eye test but has undetected mild VI would seek an eye test and treatment within the next five years of their own accord as their vision loss deteriorates.

Discounted treatment costs by condition are presented in Table 7.8. Overall, the total five-year health care cost of treating mild VI diagnosed through the intervention is estimated to be nearly €2.1 million.

Table 7.8: Discounted five-year treatment costs for all diagnosed cases

Age group	AMD (a)	Cataract	DR	Glaucoma	Other	Total
Male						
10-14	€41	€120	€0	€0	€3,891	**€4,053**
15-19	€0	€0	€0	€50	€3,926	**€3,976**
20-24	€77	€0	€0	€70	€4,085	**€4,232**
25-29	€57	€55	€25,783	€0	€7,150	**€33,045**
30-39	€63	€324	€12,953	€163	€6,662	**€20,165**
40-49	€475	€1,173	€33,049	€729	€24,501	**€59,927**
50-59	€683	€899	€52,153	€1,570	€27,717	**€83,021**
60-69	€6,740	€2,750	€117,900	€6,646	€66,826	**€200,861**
70-79	€20,707	€2,583	€108,186	€10,413	€57,373	**€199,262**
80+	€50,706	€2,241	€32,899	€13,896	€41,546	**€141,289**
Total	€79,549	€10,147	€382,923	€33,536	€243,676	**€749,832**

[3] Changes in the health consumer price index (CPI) were 3.5% between 2008 and 2009, and 0.6% from 2009 to 2010

Age group	AMD (a)	Cataract	DR	Glaucoma	Other	Total
Female						
10-14	€0	€120	€0	€75	€3,212	**€3,408**
15-19	€0	€0	€0	€33	€4,616	**€4,650**
20-24	€74	€428	€0	€178	€7,488	**€8,168**
25-29	€72	€69	€23,016	€0	€8,936	**€32,092**
30-39	€45	€274	€61,654	€117	€7,334	**€69,424**
40-49	€148	€2,219	€42,377	€670	€41,164	**€86,578**
50-59	€3,721	€2,165	€74,611	€1,425	€53,999	**€135,922**
60-69	€10,475	€4,391	€107,420	€4,105	€83,387	**€209,778**
70-79	€50,845	€4,649	€96,277	€10,857	€100,936	**€263,564**
80+	€248,688	€8,670	€42,459	€25,845	€176,820	**€502,481**
Total	€314,067	€22,986	€447,814	€43,305	€487,893	**€1,316,066**
Total	€393,616	€33,134	€830,737	€76,841	€731,570	**€2,065,898**

Source: Deloitte Access Economics calculations using Access Economics (2005), Department of Finance (2010), Taylor et al (2004) and health care cost estimate from Section 3.5.

(a) Treatment costs incorporate the distribution of mild VI by eye condition, which is assumed to be the same as for blindness reported in the NCBI register (see Section 2.2.2). As previously described, the few AMD cases reported in younger people is likely to reflect juvenile macular degeneration or other eye conditions miscoded as AMD (but still requiring treatment).

7.2.7 DWL

Following the methodology presented in Section 7.1.7 (MCPF 0.57 cents, 80.7% of health care costs funded by government), the DWL from treatment costs following detection of vision loss in people with diabetes was estimated to be nearly €1.8 million.

7.2.8 DALYs averted from successfully treated cases

Following the methodology presented in Section 7.1.8, it was estimated that 600 DALYs would be averted as a result of the intervention.

7.2.9 Cost effectiveness results

Societal costs of the intervention (including DWL) are estimated to total €5.5 million (societal perspective). Excluding DWL, total costs of the intervention would be €3.6 million (health care perspective). The total costs associated with the diabetes population screening intervention described above are summarised in Table 7.9.

Table 7.9: Total costs associated with intervention

Component	Amount
Eye screening tests	€1,550,460
Discounted treatment costs	€2,065,898
DWL	€1,834,055
Total costs (health care perspective)	**€3,616,358**

Total costs (societal perspective)	**€5,450,412**

Source: Deloitte Access Economics estimates.

Under a societal perspective, the hypothetical screening program for people with diabetes is associated with a cost of **€9,090 per DALY averted**. Under a health care perspective, cost effectiveness is estimated to be **€6,031 per DALY averted**. The intervention is highly cost effective under both perspectives, using WHO cost effectiveness thresholds.

7.3 Reduction of public waiting lists for cataract surgery

SUMMARY BOX

A hypothetical intervention to reduce waiting time for cataract surgery by 1.5 months per patient on the current waiting list would result in:

* a population saving of 225 years spent living with cataracts;

* health care cost savings of €116,675, informal care cost savings of €108,176 and productivity cost savings of €52,670;

* a cost of €35,118 associated with bringing forward cataract surgeries; and

* 50 DALYs being averted as a result of the intervention.

Key intervention costs would be associated with:

* increasing the capacity of public hospitals to undertake more cataract surgeries;

* increasing the number of ophthalmic surgeons trained in cataract surgery; and

* investment in better technology to increase the efficiency of surgery.

Unfortunately, no data were identified to estimate these key intervention costs. Under a societal perspective, this intervention would be considered highly cost effective if the key intervention costs were less than €1.3 million, cost effective if the key intervention costs were between €1.3 million and €3.6 million, and cost saving if the key intervention costs were less than €141,647 (using WHO definitions of cost effectiveness).

Under a health care perspective, this intervention would be considered highly cost effective if the key intervention costs were less than €1.9 million, cost effective if the key intervention costs were between €1.9 million €5.5 million, and cost saving if the key intervention costs were less than €81,557 (using WHO definitions of cost effectiveness).

More research is required on the cost of reducing cataract surgery waiting times by 1.5 months for every patient on the waiting list, to determine whether this intervention is cost effective according to the results above and should therefore be funded.

7.3.1 Description

The burden of waiting for cataract surgery encompasses physical and financial effects. A decline in vision over this waiting time may be associated with adverse events and co-morbidities, including falls, fractures, and depression (Gimbel and Dardzhikova, 2011). Another adverse effect may be disruption to ability to participate in the workforce (productivity loss). Lowering waiting times for cataract surgery has been found to lead to

fewer reported accidents and falls from vision problems, and patients presenting with less severe cataract symptoms (Boisjoly et al, 2010; Freeman et al, 2009).

Possible methods for reducing the number of people on surgery waiting lists include:

- increased funding to the public sector;
- subsidising private sector care to encourage a shift to private care when public sector resources are constrained;
- innovations in cataract surgery procedures and technology that may improve surgeon productivity;
- funding that links provider payment and performance; and
- priority setting to determine patients with the greatest need – in the ROI, public hospital booking systems prioritise cataract surgeries according to clinical assessment criteria (DOHC, 2010).

A cataract surgery efficiency program implemented in Montreal, Canada, in 2003, involved performing surgery in ambulatory care centres, implementing new technology, training surgical technicians and increasing operating room time. This efficiency program doubled the number of cataract surgeries (Boisjoly et al, 2010). Another method to improve waiting times may be to increase the day case rate for cataract surgery (DOHC, 2010). In the ROI, the share of cataract surgeries carried out as day cases increased from 20.7% in 1997 to 60.9% in 2007 (OECD, 2009).

The hypothetical intervention evaluated in this section relates to government initiatives to improve the efficiency and capacity of cataract surgery services in public hospitals. The intervention is assumed to reduce the median waiting time for cataract surgery in the ROI by 50% in line with the impact of the Montreal program (Boisjoly et al, 2010). The national median waiting time for cataract extraction in the ROI is 3 months (NTPF, 2010). An improvement of 50% would reduce the median waiting time to 1.5 months.

Long and O'Brien (2001) analysed HIPE data and reported that in 2001, cataract surgery alone accounted for 82% of common ophthalmic procedures in the ROI (procedures for cataracts, glaucoma, retinal detachment, strabismus and repair of perforating injuries). In the absence of data on the precise number of people waiting for cataract surgery, this percentage was applied to the 2,192 people on the public hospital waiting list for ophthalmological surgical procedures at April 2010 (NTPF, 2010). Thus, it is estimated that 1,797 people were waiting for cataract surgery in public hospitals at April 2010. Throughout this section it is assumed that people on the waiting list for cataract surgery have moderate VI to severe VI (blindness).

7.3.2 Benefits from the intervention

As detailed in Section 7.3.1, the hypothetical intervention would aim to reduce waiting time for cataract surgery by 1.5 months per patient on the waiting list. Multiplying this by the 1,797 people on the cataract waiting list estimates the intervention to save 225 years living with cataracts.

It is assumed that patients on the waiting list would avoid the treatment costs, productivity losses and informal care costs that would have applied over the additional waiting period. These include:

- Annual health care cost per person with VI of €519.29 as estimated in Section 7.1.6.
- Total productivity costs from VI and blindness of €342.23 per person aged under 65 years, estimated as total productivity costs of €56.7 million in 2010 (Section 4.1) divided by total prevalence of moderate VI and blindness in those aged less than 65 years in 2010 (165,732)
- Total informal care costs of €481.47 per person, estimated as total informal care costs of €108.3 million in 2010 (Section 4.2) divided by the total prevalence of moderate VI and blindness (224,832).

Annual health care and informal care costs per person were multiplied by the saving of 225 years living cataract to estimate **€116,675 health care cost savings** and **€108,176 informal care cost savings.** The productivity cost per person was multiplied by 225 years and the 68% of total moderate VI and blindness from cataract that occurs in people aged less than 65 years in the ROI (Chapter 2). **Savings of €52,670 in productivity costs** were estimated to result from the intervention.

Stouthard et al (1997) estimated a disability weight 0.17 for moderate VI and 0.43 for blindness. The shares of moderate VI (80%) and blindness (20%) within the sum of moderate VI and blindness due to cataracts give a combined disability weight of 0.22. This disability weight was multiplied by 225 years to estimate **50 DALYs averted** through the intervention.

7.3.3 Costs of the intervention

Public hospital costs per bed day for 'glaucoma and complex cataract surgery procedures' in the ROI were estimated in Section 3.1.1. These costs were multiplied by ALOS to estimate total costs per surgery.

The resulting costs of cataract surgery in the ROI are presented in Table 7.10. Because costs differ for same-day and overnight procedures, these costs were weighted by the 2007 share of cataract surgeries in the ROI being same-day procedures (60.9% from OECD, 2009). The estimated cost per cataract surgery in the ROI was €4,015.

Table 7.10: Costs of cataract surgery in the ROI

	Cost per bed day	ALOS (days)	Total costs
Glaucoma and complex cataract procedures (39.1%)	€1,828	3.8	€6,945
Glaucoma and complex cataract procedures, same-day (60.9%)	€2,133	1.0	€2,133
All glaucoma and complex cataract procedures (100%)			€4,015

Source: Deloitte Access Economics cost calculations using DoHA (2009), AIHW (2009) and World Bank (2010). ALOS data from ESRI (2010).

Cataract surgery costs for people on the waiting list in 2010 would be incurred at some time regardless of whether the intervention to reduce waiting time was implemented or not. However, with the intervention, waiting time would be reduced by 1.5 months. The earlier surgery costs are incurred, the higher their present value. Using a discount rate of 4%

(Department of Finance, 2010), the cost of bringing forward surgery costs for all people on the waiting list at April 2010 would be €35,118.

However, reducing waiting lists for cataract surgery would primarily include the following 'key intervention costs':

- increasing capacity in public hospitals to perform more cataract surgeries (e.g. additional beds and theatres);
- increasing the number of ophthalmic surgeons trained in cataract surgery (training and recruitment costs); and
- investing in better technology to undertake cataract surgery more efficiently.

A proportion of these costs would be upfront fixed capital costs. Unfortunately, no data were identified to estimate these costs.

7.3.4 Cost effectiveness results

Since the other costs of reducing waiting lists in the ROI are unknown, rather than estimating the cost effectiveness of such an intervention, the CEA estimated the highest key intervention cost for which the intervention would be cost effective. Health care, productivity and informal care cost offsets were deducted from total intervention costs under the societal perspective (key intervention costs plus €35,118 bring-forward surgery costs and DWL) to estimate the highest feasible net cost of the intervention. The DWL of raising tax revenue to fund government expenditure on the intervention (key intervention costs and bring-forward of surgery costs) was estimated using a MCPF of 57 cents for every euro raised from taxation (Kleven and Kreiner, 2003, see Section 4.3).

The health care perspective included health care costs as the only cost offset. The net costs under the societal and health care perspectives were divided by 50 DALYs averted by the intervention to estimate the ICERs.

Hypothetical intervention costs which would meet WHO cost effectiveness thresholds reported at the beginning of this chapter are presented in Table 7.11.

Table 7.11: Hypothetical intervention costs against WHO cost effectiveness thresholds

	Highly cost effective	Cost effective	Cost saving
ICER threshold criteria *(Cost per DALY averted)*	Less than €35,801	Between €35,801 and €107,403	Less than €0
Hypothetical key intervention costs (a) under scenarios:			
- Societal offset	<€1,280,538	Between €1,280,538 and €3,558,320	Less than €141,647
- Health care only offset	<€1,869,816	Between €1,869,816 and €5,445,733	Less than €81,557

Source: Deloitte Access Economics calculations using DoHA (2009), AIHW (2009), ESRI (2010), NTPF (2010), Stouthard et al (1997), WHO (2011) and World Bank (2010).

(a) These costs would be in addition to bring-forward of surgical costs, estimated to be €35,118 and associated DWL under the 'societal' scenario. Cost effectiveness is assessed against total intervention costs, comprised of

hypothetical intervention costs (presented in this table), bring-forward of surgical costs and DWL (in the societal scenario only).

Importantly, the intervention costs estimated here are annual costs. However, a proportion of the cost of interventions to reduce cataract surgery waiting lists is likely to be up front fixed capital costs such as investment in new infrastructure and equipment. Although these costs would be amortised over a period of time they may not be generalisable to all future years. Therefore, it should be considered that the intervention costs presented below include ongoing additional variable costs and amortised fixed costs of reducing waiting lists, rather than the total investment cost associated with the intervention.

Under the **societal perspective**, key intervention costs of less than €1,280,538 would allow the intervention to be considered highly cost effective. With intervention costs of between €1,280,538 and €3,558,320, the intervention would be considered cost effective. With intervention costs of less than €141,647, the intervention would be cost-saving.

Under the **health care perspective**, key intervention costs of less than €1,869,816 would allow the intervention to be considered highly cost effective. With intervention costs of between €1,869,816 and €5,445,733, the intervention would be considered cost effective. With intervention costs of less than €81,557, the intervention would be cost-saving.

References

Australian Bureau of Statistics (ABS) 2010, *Causes of Death, Australia, 2008*, Cat. No. 3303.0, Canberra. Australian Institute of Health and Welfare (AIHW) 2009, *Health expenditure Australia 2007-08*, Health and welfare expenditure series no. 37, Cat no. HWE 46, Canberra: AIHW.

Australian Bureau of Statistics (ABS) 2004, *Disability, ageing and carers, Australia: summary of findings, 2003*, Cat. No 4430.0, Canberra.

Access Economics 2010a, *Clear Focus – the economic impact of vision loss in Australia in 2009,* report for Vision2020 Australia.

Access Economics 2010b, *The global economic cost of vision impairment,* Report for AMD Alliance International.

Access Economics 2009, *The economic impact of partial sight and blindness in the UK adult population,* Report for the Royal National Institute of Blind People.

Access Economics 2008a, *The cost of vision loss in Canada,* report for the Canadian National Institute for the Blind and Canadian Ophthalmological Society.

Access Economics 2008b, *The cost of visual impairment in Japan,* Report for Japan Ophthalmologists Association, National Institute of Sensory Organs, and Juntendo University WHO Collaborating Centre for the Prevention of Blindness.

Access Economics 2006, *The cost of visual impairment in the US,* Report for the University of Southern California School of Medicine.

Access Economics 2005, *Investing in Sight: strategic interventions to prevent vision loss in Australia,* Report for the Centre for Eye Research Australia and the Eye Research Australia Foundation.

Access Economics 2004, *Clear Insight: The economic impact and cost of vision loss in Australia,* Report for the Centre for Eye Research Australia and the Eye Research Australia Foundation.

Aetna 2010, *Clinical Policy Bulletin: fundus photography,* no.0539, http://www.aetna.com/cpb/medical/data/500_599/0539.html, accessed 1 March 2011.

Anstey KJ, Luszcz MA, Giles LC, Andrews GR 2001, 'Demographic health, cognitive and sensory variables as predictors of mortality in very old adults', *Psychology and Ageing*, 16(1): 3-11.

Barry RJ and PI Murray 2005, 'Unregistered partial sight and blindness: is registration a failing system?', *British Journal of Ophthalmology*, 89: 995-998.

Begg S, Vos T, Barker B, Stevenson C, Stanley L, Lopez AD 2007, *The burden of disease and injury in Australia 2003*, Australian Institute of Health and Welfare (AIHW), Canberra.

Boisjoly H, Freeman E, Djafari F, Aubin M, Couture S, Bruen R, Gizicki R, Gresset J 2010, 'Reducing wait time for cataract surgery: comparison of 2 historical cohorts of patients in Montreal', *Canadian Journal of Ophthalmology,* 45: 135-139.

Brouwer WBF, Koopmanschap MA 2000, 'On the economic foundations of CEA. Ladies and gentlemen, take your positions!' *Journal of Health Economics*, 19: 439-459.

Bunce C, Evans J, Fraser S, Wormald R 1998, 'BD8 certification of visually impaired people', *British Journal of Ophthalmology*, 82: 72-6.

Canavan YM, Jackson AJ, Stewart A 1997, 'Visual impairment in Northern Ireland', *The Ulster Medical Journal,* 66(2): 92-95.

Carmichael F and S Charles 2003, 'The opportunity costs of informal care: does gender matter?' *Journal of Health Economics*, 22: 781-803.

Cedrone C, Cullasso F, Cesareo M, Zapelloni A, Cedrone P and Cerruli L 1997, 'Prevalence of glaucoma in Ponza, Italy: a comparison with other studies', *Ophthalmic Epidemiology*¸4(2): 59-72.

Central Statistics Office (CSO) 2011, *Consumer price index January 2011,* http://www.cso.ie/releasespublications/documents/prices/current/cpi.pdf, accessed 9th February 2011.

Central Statistics Office (CSO) 2010a, *Population and migration estimates April 2010,* http://www.cso.ie/releasespublications/documents/population/current/popmig.pdf, accessed 5th October 2010.

Central Statistics Office (CSO) 2010b, *Population estimates (persons in April) (Thousand) by sex, age group and year,* CSO Database Direct for years 2003 and 2004, http://www.cso.ie/px/pxeirestat/database/eirestat/Population%20Estimates/Population%20Estimates.asp, accessed 20th October 2010.

Central Statistics Office (CSO) 2010c, *Seasonally adjusted standardised unemployment rate by month,* CSO Database Direct, http://www.cso.ie/px/pxeirestat/Dialog/varval.asp?ma=LRM03&ti=Seasonally+Adjusted+Standardised+Unemployment+Rate+(%)+by+Month&path=../Database/Eirestat/Live%20Register/&lang=1, accessed 7th November 2010.

Central Statistics Office (CSO) 2010d, *National Disability Survey 2006 Volume 2,* Government of Ireland, http://www.cso.ie/releasespublications/nationaldisabilitysurvey06vol2.htm, accessed 5th October 2010.

Central Statistics Office (CSO) 2010e, *ILO participation, employment and unemployment characteristics by statistic, sex, age group and quarter,* CSO Database Direct, http://www.cso.ie/px/pxeirestat/Dialog/varval.asp?ma=QNQ24&ti=ILO+Participation,+Employment+and+Unemployment++Characteristics+by+Statistic,+Sex,+Age+Group+and+Quarter&path=../DATABASE/Eirestat/Quarterly%20National%20Household%20Survey%20Main%20Results/&lang=1, accessed 9th October 2010.

Central Statistics Office (CSO) 2010f, *Earnings and labour costs Q1 2010 – Q2 2010 (Preliminary estimates),* http://www.cso.ie/releasespublications/documents/earnings/current/earnlabcosts.pdf, accessed 15th October 2010.

Central Statistics Office (CSO) 2010g, *Number of deaths classified by age,* http://www.cso.ie/statistics/deaths_by_age_sex.htm, accessed 6th October 2010.

Central Statistics Office (CSO) 2010h, *Mean annual earnings by age group, year, sex and statistic*, CSO Database Direct for year 2007, http://www.cso.ie/px/pxeirestat/Dialog/varval.asp?ma=NSA44&ti=Mean%20Annual%20Earnings%20by%20Age%20Group,%20Year,%20Sex%20and%20Statistic&path=/px/pxeirestat/DATABASE/Eirestat/National%20Employment%20Survey/&lang=1, accessed 7th October 2010.

Central Statistics Office (CSO) 2010i, *Employment, Hours and Earnings by industry sector NACE Rev 2, type of employee, quarter and statistic*, CSO Database Direct, http://www.cso.ie/px/pxeirestat/Dialog/varval.asp?ma=EHQ03&ti=Employment,%20Hours%20and%20Earnings%20by%20%20Industry%20Sector%20NACE%20Rev%202,%20Type%20of%20Employee,%20Quarter%20and%20Statistic&path=../Database/Eirestat/EHECS%20Earnings%20Hours%20and%20Employment%20Costs%20Survey/&lang=1, accessed 7th October 2010.

Central Statistics Office (CSO) 2010j, *Statistical Yearbook of Ireland 2010,* http://www.cso.ie/releasespublications/documents/statisticalyearbook/2010/Full%20Book.pdf, accessed 9th October 2010.

Central Statistics Office (CSO) 2009, *Period life expectancy by sex, age x, year and statistic,* CSO Database Direct, http://www.cso.ie/px/pxeirestat/Dialog/varval.asp?ma=VSA32&ti=Period+Life+Expectancy+by+Sex,+Age+x,+Year+and+Statistic&path=../Database/Eirestat/Irish%20Life%20Tables/&lang=1, accessed 6th October 2010.

Central Statistics Office (CSO) 2008, *Population and labour force projections 2011-2041,* Stationery Office, Dublin, Ireland, http://www.cso.ie/releasespublications/documents/population/2008/poplabfor_2011-2041.pdf, accessed 30th September, 2010.

Central Statistics Office (CSO) 2007, *Census 2006: volume 11 – Disability, Carers and Voluntary activities,* Dublin, http://www.cso.ie/census/census2006results/volume_11/Volume11_2006.pdf, accessed 6th October 2010.

Charles N 2007, 'Estimates of the number of older people with a visual impairment in the UK', *British Journal of Visual Impairment*, 25(3): 199-215.

Citizens Information Board 2010, *Public service information provided by the Citizens Information Board,* http://www.citizensinformation.ie/en/, accessed 10th October 2010.

Coffey M, Reidy A, Wormald R, Xian WX, Wright L, Courtney P 1993, 'Prevalence of glaucoma in the west of Ireland', *British Journal of Ophthalmology*, 77: 17-21.

Colombo F and Tapay N 2004, *Private health insurance in Ireland: a case study,* Organisation for Economic Cooperation and Development (OECD), Working Paper no.10, http://www.oecd.org/dataoecd/55/29/29157620.pdf, accessed 30th November 2010.

Dandona L, Dandona R 2006, 'Revision of visual impairment definitions in the International Statistical Classification of Diseases', *BMC Medicine*, 4:7.

Department of Finance Ireland 2010, *Project discount and inflation rates,* http://www.finance.gov.ie/Viewtxt.asp?DocID=5387&StartDate=1+January+2010, accessed 22nd November 2010.

Department of Health and Ageing (DoHA) 2009, *National hospital cost data collection,* Australian Government, http://www.health.gov.au/internet/main/publishing.nsf/Content/health-casemix-data-collections-about_NHCDC, accessed 30th November 2010.

Department of Health and Children (DOHC) 2010, *Resource allocation, financing and sustainability in health care: evidence for the expert group on resource allocation and financing in the health sector,* Volume II.

Department of Health and Children (DOHC) 2005, *Health Statistics 2005,* http://www.dohc.ie/statistics/health_statistics_2005.html, accessed 30th November 2010.

Dervan E, Lillis D, Flynn L, Staines A 2008, 'Factors that influence the patient uptake of diabetic retinopathy screening', *Irish Journal of Medical Sciences,* 177: 303-308.

Donnelly U, Stewart N, Hollinger M 2005, 'Prevalence and outcomes of childhood visual disorders', *Ophthalmic Epidemiology,* 12: 243-250.

Drummond MF, Sculpher MJ, Torrance GW, O'Brien BJ, Stoddart GL 2005, *Methods for the economic evaluation of health care programs 3rd ed.*, Oxford University Press, New York.

European Central Bank (ECB) 2011, *ECB reference exchange rate, Australian dollar/Euro*, http://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=120.EXR.A.AUD.EUR.SP00.A, last accessed 3 March 2011.

European Central Bank (ECB) 2011, *ECB reference exchange rate, UK Pound Sterling/Euro*, http://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=120.EXR.A.GBP.EUR.SP00.A, last accessed 10 April 2011.

Economic and Social Research Institute (ESRI) Health Research and Information Division 2010, *Activity in Acute Public Hospitals in Ireland,* ESRI.

Flanagan NM, Jackson AJ, Hill AE 2003, 'Visual impairment in childhood: insights from a community-based survey, *Child: Care, Health & Development,* 29(6): 493:499.

Freeman E, Gresset J, Djafari F, Aubin MJ, Couture S, Bruen R, Laporte A, Boisjoly H 2009, 'Cataract-related vision loss and depression in a cohort of patients awaiting cataract surgery', *Canadian Journal of Ophthalmology,* 44(2): 171-176.

Frick KD, Kymes SM, Lee PP, Matchar DB, Pezzullo ML, Rein DB, Taylor HR on behalf of the Vancouver Economic Burden of Vision Loss Group 2010, 'The Cost of Visual Impairment: Purposes, Perspectives and Guidance', *Investigative Ophthalmology and Visual Science*, accepted January 2010.

Gimbel H and Dardzhikova A 2011, 'Consequences of waiting for cataract surgery', *Current Opinion in Ophthalmology,* 22: 28-30.

Globe DR, Varma R, Torres M, Wu J, Klein R, Azen SP 2005, 'Self reported co-morbidities and visual function in a population-based study', *Archives of Ophthalmology*, 123: 815-820.

Gudmundsdottir E, Jonasson F, Jonsson V, Stefansson E, Sasaki H, Sasaki K & the Iceland-Japan Co-Working Study Groups 2000, '"With the rule" astigmatism is not the rule in the elderly', *Acta Ophthalmologica Scandinavica,* 78: 642-646.

Health Service Executive (HSE) and Irish College of Ophthalmologists 2008, *Framework for the development of a diabetic retinopathy screening programme for Ireland,* October.

Health Service Executive (HSE) 2008, *Primary Care Reimbursement Service (PCRS): Statistical analysis of claims and payments 2008,* http://www.hse.ie/eng/staff/PCRS/PCRS_Publications/FSA2008.pdf, accessed 20th November 2020.

Heijl A, Leske C, Bengtsson B, Hyman L, Bengtsson B, Hussein M for the Early Manifest Glaucoma Group 2002, 'Reduction of intraocular pressure and glaucoma progression', *Archives of Ophthalmology,* 120: 1268-1279.

Heitmueller A 2007, 'The chicken or the egg? Endogeneity in labour market participation of informal carers in England', *Journal of Health Economics*, 26:536-559.

Information Services Division Scotland (ISD) 2010, *NHS eye examination by type and NHS board*, http://www.isdscotland.org/isd/4715.html, accessed 20th November 2010.

Institute of Public Health Ireland 2006, *Making diabetes count. A systematic approach to estimating population prevalence on the island of Ireland in 2005.* First report of the Irish Diabetes Prevalence Working Group, Ireland and Northern Ireland's Population Health Observatory (INIsPHO).

Jackson AJ, O'Brien C, Gallagher B , Dardis E, Sugrue R, Codd M 2008, *Eyes on the future Ireland: a study into the prevalence of blindness and vision impairment in Ireland 2008,*Vision Impaired Service Providers Alliance (VISPA).

Kass MA, Heuer DK, Higginbotham EJ, Johnson CA, Keltner JL, Miller JP, Parrish RK II, Wilson MR, Gordon MO 2002, 'The Ocular Hypertension Treatment Study: a randomized trial determines that topical ocular hypertensive medication delays or prevents the onset of primary open-angle glaucoma', *Archives of Ophthalmology,* 120: 701-713.

Ke KM, Montgomery AM, Stevenson M, O'Neill C, Chakravarthy U 2007, 'Formal and informal care utilization amongst elderly people with partial sight and blindness', *British Journal of Ophthalmology*, 91: 1279-1281.

Kelliher C, Kenny D, O'Brien C 2006, 'Trends in blind registration in the adult population of the Republic of Ireland 1996-2003', *British Journal of Ophthalmology,* 90: 367-371.

Khan RI, O'Keefe M, Kenny D, Nolan L 2007, 'Changing pattern of childhood blindness', *Irish Medical Journal,* 100(5): 458-461

Klaver CCW, Wolfs RCW, Vingerling JR, Hofman A, de Jong PTVM 1998, 'Age-Specific Prevalence and Causes of Blindness and Partial sight and blindness in an Older Population: The Rotterdam Study', *Archives of Ophthalmology*, 116: 653-658.

Klein R, Klein BEK, Linton KLP, Moss SE 1995, 'Age-related eye disease and survival - The Beaver Dam Eye Study', *Archives of Ophthalmology*, 113: 333-339.

Kleven H and Kreiner C 2003, *The marginal cost of public funds in OECD countries: hours of work versus labour force participation,* CESIFO Working Paper no.935, Category 1: Public finance.

Knox FA, Barry M, McGowan B, O'Brien C 2006, 'The rising cost of glaucoma drugs in Ireland 1996-2003', *British Journal of Ophthalmology,* 90: 162-165.

Long VW and O'Brien CJ 2001, 'Trends in ophthalmic surgery in Ireland', *Irish Journal of Medical Science,* 174(2): 36-39.

Lopez AD, Mathers CD, Ezatti M, Jamison DT, Murray CJL 2006 *Global Burden of Disease and Risk Factors*, World Bank, Washington DC, last accessed 5 November 2010 at http://files.dcp2.org/pdf/GBD/GBD.pdf/

Mann A, Bressler S, Hawkins B, Holekamp N, Bressler N 2008, 'Comparison of methods to identify incident cataract in eyes of patients with neovascular maculopathy', Submacular Surgery Trials Report No.18, *Ophthalmology,* 115(1): 127-133.

Mason H, Jones-Lee M, Donaldson C 2009, 'Modelling the monetary value of a QALY: A new approach based on UK data', *Health Economics*, 18: 933-950.

Mathers C, Vos T, Stevenson C 1999, *The burden of disease and injury in Australia*, Australian Institute of Health and Welfare (AIHW), Canberra.

McCarty CA, Nanjan MB, Taylor HR 2001, 'Vision impairment predicts 5 year mortality', *British Journal of Ophthalmology*, 85(3): 22-326.

Müller A, Keeffe JE, Taylor HR 2007, 'Changes in eye care utilization following an eye health promotion campaign', *Clinical and Experimental Ophthalmology*, 35(4): 305-309.

Munier A, Gunning T, Kenny D, O'Keefe M 1998, 'Causes of blindness in the adult population of the Republic of Ireland', *British Journal of Ophthalmology*, 82: 630-633.

Murray C, Lopez A 1996, *The Global Burden of Disease: a comprehensive assessment of mortality and disability from diseases, injuries and risk factors in 1990 and projected*

to 2020, Volume 1, Global Burden of Disease and Injury Series, Harvard: Harvard School of Public Health.

Murray C, Lopez A, Mathers C, Stein C 2001, *The Global Burden of Disease 2000 project: aims, methods and data sources.* World Health Organisation Discussion Policy Paper No. 36. World Health Organisation, Geneva.

National Council for the Blind of Ireland (NCBI) 2010, *Getting your eyes tested,* http://www.ncbi.ie/information-for/eye-health-and-eye-care/looking-after-your-sight/getting-your-eyes-tested, accessed 9th February 2011.

National Council on Ageing and Older People 2004, *Older people in Ireland: a profile of health status, lifestyle and socio-economic factors from SLAN,* Report no.82.

National Health and Medical Research Council (NHMRC) 2008, Guidelines for the *management of diabetic retinopathy*, prepared by the Australian Diabetes Society for the Department of Health and Ageing, Commonwealth of Australia.

National Treatment Purchase Fund (NTPF) 2010, *A report on the national treatment patient register April 2010.*

O'Donoghue L, McClelland JF, Logan NS, Rudnicka AR, Owen CG, Saunders KJ 2010, 'Refractive error and visual impairment in school children in Northern Ireland', *British Journal of Ophthalmology,* 94(9): 1155-1159.

Organisation for Economic Cooperation and Development (OECD) 2009, *Health at a glance 2009 OECD indicators,* http://www.oecd.org/health/healthataglance, accessed 20th November 2010.

Reidy A, Minassian DC, Vafidis G, Joseph J, Farrow S, Wu J, Desai P, Connolly A 1998, 'Prevalence of serious eye disease and partial sight and blindness in a north London population: population based, cross sectional study', *British Medical Journal*, 316: 1643-1646.

Reserve Bank of Australia (RBA) 2011, *Inflation calculator,* http://www.rba.gov.au/calculator/annualDecimal.html, last accessed 3 March 2011.

Resnikoff S, Pascolini D, Etya'ale D, Kocur I, Mariotti SP, Pokharel GP, Pararajasegaram R, Mariotti SP 2004, 'Global data on visual impairment in the year 2002', *Bulletin of the World Health Organisation*, 82(11): 844-851.

Robinson R, Deutsch J, Youngson-Reilly S, Hamlin D, Dhurjon L, Fielder A 1994, 'Unrecognised and unregistered visual impairment', *British Journal of Ophthalmology*, 78: 736-40.

Rosenfeld PJ, Brown DM, Heier JS, Boyer DS, Kaiser PK, Chung CY, Kim RY 2006, 'Ranibizumab for neovascular age-related macular degeneration', *New England Journal of Medicine*, 355(14): 1419-1431.

Rouhiainen H and Terasvirta M 1990, 'Kuopia Eye Survey', *Acta Ophthalmologica (Copenhagen),* 68: 554-558.

Royal National Institute for the Blind (RNIB) 2007, *Older people and eye tests,* http://www.rnib.org.uk/getinvolved/campaign/yoursight/Documents/public_oldereyesreportp.pdf, accessed February 9th 2011.

Schmier JK, Halpern MT, Covert D, Delgado J, Sharma S 2006, 'Impact of visual impairment on use of caregiving by individuals with age-related macular degeneration', *Retina*, 26(9): 1056-1062.

Smith SM, Holohan J, McAuliffe A, Firth RG 2003, 'Irish diabetes detection programme in general practice, *Diabetic Medicine,* 20: 717-722.

Stevenson MR, Hart PM, Montgomery AM, McCulloch DW, Chakravarthy U 2004, 'Reduced vision in older adults with age related macular degeneration interferes with ability to care for self and impairs role as carer', *British Journal of Ophthalmology*, 88: 1125-1130.

Stouthard M, Essink-Bot M, Bonsel G, Barendregt J, Kramers P 1997, *Disability weights for diseases in the Netherlands*, Department of Public Health, Erasmus University, Rotterdam.

Tan J, Wang J, Flood V, Rochtchina E, Smith W, Mitchell P 2008, 'Dietary antioxidants and the long-term incidence of age-related macular degeneration: The Blue Mountains Eye Study', *Ophthalmology*, 115(2): 334-341.

Taylor HR, Vu HT, McCarty CA, and Keeffe JE 2004, 'The need for routine eye examinations', *International Ophthalmology Vision Science*, 45(8): 2539-2542.

Tomany S, Wang J, Van Leeuwen R, Klein R, Mitchell P, Vingerling JR, Klein BE, Smith W, De Jong PR 2004, 'Risk factors for incident age-related macular degeneration: pooled findings from 3 continents', *Ophthalmology*, 111(7): 1280-7.

Turner R, Holman R, Stratton I, Cull C, Frighi V, Manley S, Matthews D, Neil A, McElroy H, Kohner E, Fox C, Hadden D, Wright D 1998, 'Tight blood pressure control and risk of macrovascular and microvascular complications in type 2 diabetes: UK Prospective Diabetes Study Group', *British Medical Journal,* 317: 703-713.

UK Department for Transport 2007, *Highways economics Note No.1:2005*, Department for Transport, London.

UK National Statistics 2010, *Inflation,* http://www.statistics.gov.uk/cci/nugget.asp?id=19, accessed 15th November 2010.

Van den Berg B, Brouwer W, van Exel J, Koopmanschap M, van den Bos GAM, Rutten F 2006, 'Economic valuation of informal care: Lessons from the application of the opportunity cost and proxy good methods' *Social Science & Medicine*, 62: 835-845.

Van Veldhuisen PC, Ederer F, Gaasterland DE, Sullivan EK, Beck A, Prum BE Jr, Cyrlin MN, Weiss H 2000, 'The Advanced Glaucoma Intervention Study (AGIS): 7. The relationship between control of intraocular pressure and visual field deterioration', *American Journal of Ophthalmology,* 130: 429-440.

Wang JJ, Mitchell P, Smith W, Cumming RG, Attebo K 1999, 'Impact of visual impairment on use of community support services by elderly persons: the Blue Mountains Eye Study', *Investigative Ophthalmology and Visual Science*, 40(1): 12-19.

Wang JJ, Mitchell P, Simpson JM, Cumming RG, Smith W 2001, 'Partial sight and blindness, age related cataract, and mortality', *Archives of Ophthalmology*, 119(8): 1186-1190.

Wimo A, Jonsson L, Winblad B 2006, 'An estimate of the worldwide prevalence and direct costs of dementia in 2003', *Dementia and Geriatric Cognitive Disorders*, 21: 175–181.

World Bank 2010, *GDP per capita (current $US),* World Bank Data, http://data.worldbank.org/indicator/NY.GDP.PCAP.CD?cid=GPD_57, accessed 30th November 2010.

World Health Organisation (WHO) 2011, *Choosing interventions that are cost-effective (WHO-CHOICE), cost effectiveness thresholds,* http://www.who.int/choice/costs/CER_thresholds/en/index.html, accessed February 21, 2011.

Wormald RPL, Wright LA, Courtney P, Beaumont B, Haines AP 1992, 'Visual problems in the elderly population and implications for services', British Medical Journal, 304: 1226-

Limitation of our work

General use restriction

This report is prepared solely for the use of the NCBI (National Council for the Blind of Ireland). This report is not intended to and should not be used or relied upon by anyone else and we accept no duty of care to any other person or entity. The report has been prepared for the purpose of estimating the burden of vision impairment and blindness in the Republic of Ireland and estimating the cost effectiveness of several interventions to address this burden. You should not refer to or use our name or the advice for any other purpose.

Contact us

Deloitte Access Economics
ACN: 49 633 116

Level 1
9 Sydney Avenue
Barton ACT 2600
PO Box 6334
Kingston ACT 2604 Australia

Tel: +61 2 6175 2000
Fax: +61 2 6175 2001

www.deloitte.com/au/economics

Deloitte Access Economics is Australia's pre-eminent economics advisory practice and a member of Deloitte's global economics group. The Directors and staff of Access Economics joined Deloitte in early 2011.

About Deloitte

Deloitte provides audit, tax, consulting, and financial advisory services to public and private clients spanning multiple industries. With a globally connected network of member firms in more than 150 countries, Deloitte brings world-class capabilities and deep local expertise to help clients succeed wherever they operate. Deloitte's approximately 170,000 professionals are committed to becoming the standard of excellence.

About Deloitte Australia

In Australia, the member firm is the Australian partnership of Deloitte Touche Tohmatsu. As one of Australia's leading professional services firms. Deloitte Touche Tohmatsu and its affiliates provide audit, tax, consulting, and financial advisory services through approximately 5,400 people across the country. Focused on the creation of value and growth, and known as an employer of choice for innovative human resources programs, we are dedicated to helping our clients and our people excel. For more information, please visit our web site at www.deloitte.com.au.