The **Fred Hollows** Foundation

TRANSFORMING LIVES: AN INVESTMENT CASE FOR EYE HEALTH

The Fred Hollows Foundation and the Victoria University Institute of Strategic Economic Studies

CONTENTS

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Citation: Hennessy, J and Sweeny, K 2023, *Transforming Lives: An Investment Case for Eye Health*, The Fred Hollows Foundation, Melbourne Australia

The Foundation would like to thank Dr Serge Resnikoff, Dr Hugh Taylor, Dr Matthew Burton Dr Stuart Keel, Dr Ana Patricia Marques, and Dr Rupert Bourne for their invaluable feedback while preparing this report.

EXECUTIVE SUMMARY

In its *World Report on Vision*, the World Health Organization (WHO, 2019) estimated that there are at least 2.2 billion people worldwide who are blind or vision impaired. Among these are at least 1 billion who have vision impairment (VI) that could have been prevented or has yet to be addressed.

The Fred Hollows Foundation (The Foundation) and Victoria University (VU) have developed an eye health model that provides the basis for the investment in programs that scale up interventions which reduce the burden of vision impairment. This model is the first of its kind developed for global eye health. However, similar methodologies have been used in other studies across a range of health interventions.

This report uses the model to estimate returns on investment (ROI) from programs to achieve the World Health Assembly (WHA) goals to reduce the burden of vision impairment across 19 countries where The Foundation works, and the unmet burden is high[1]. These countries are Afghanistan, Bangladesh, Burundi, Cambodia, China, Eritrea, Ethiopia, Indonesia, Kenya, Lao PDR, Myanmar, Nepal, Pakistan, Palestine, Papua New Guinea, Philippines, Rwanda, Timor-Leste, and Vietnam.

The model has been developed for the two leading causes of blindness and vision impairment, namely cataract and refractive error (in this case, myopia and presbyopia). The model estimates the benefits arising from treating these eye conditions in terms of improvements in both health outcomes and the subsequent economic benefits. It then compares these to the costs of achieving these benefits.

Much of the evidence used in developing this model, including the assumptions used in the modelling, has been derived from a detailed review of the Lancet Global Health Commission on Global Eye Health (the Lancet Commission, Burton et al 2020), its supplementary material and related publications.

The eye health model is designed to calculate the impact of an intervention program on the number of people treated for each cause of VI noted above. The target population for treatment in a particular year is defined as the prevalence of the condition while the effective coverage rate is the number of people treated (and receiving a good quality outcome) as a proportion of the target population (i.e. the proportion of the population in need of treatment).

The target coverage rates used in the model are taken from the goals for 2030 agreed at the 74th WHA in April 2021 (WHA 2021), namely:

A 30-percentage point increase in effective coverage of cataract surgery by 2030

- Countries with baseline effective coverage rates 70% or higher, should strive for universal coverage.

A 40-percentage point increase in effective coverage of refractive error by 2030

- Countries with baseline effective coverage rates 60% or higher, should strive for universal coverage.

For the ROI estimates in this report the time period for the scale up of interventions is 2022 to 2030, and the coverage rates are the same across age and sex groups.

[1] Note that the structure of the model allows for extension to other countries, timelines, and objectives, pending availability of suitable data.

Using data on prevalence of eye health conditions from the Vision Loss Expert Group (Bourne et al, 2022) and these coverage rates, the model estimates the numbers of people treated by age, sex and severity of condition. Using disability weights from the Global Burden of Disease (GBD) database it also calculates the number of life years saved - using disability-adjusted life years (DALYs) and years of sight saved (YSS).

These estimates were used to calculate the economic benefits associated with this improvement in eye health. These benefits arise from (i) improved labour force participation and productivity among working age patients, and (ii) improved educational participation and learning by school age patients. It is important to note that the additional benefits derived from savings to the health system, along with other intrinsic benefits (such as increased social participation) were beyond the scope of this model. As such, the benefit estimates provided in this report should be considered a conservative estimate of the total societal benefits to improving eye health.

The calculations use demographic projections from the United Nations (UN 2019), labour force participation rates from the International Labour Organization (ILO 2021), and Gross Domestic Product (GDP) and similar economic data from the World Bank (2022).

The costs of interventions to achieve the target eye health outcomes were calculated by taking the unit cost of treatment and multiplying by the numbers of persons treated, including a factor for the eye health screening program. The unit costs were estimates provided by The Foundation and were developed using an ingredients-based costing approach (see costs of interventions in Appendix).

As the economic benefits in this report are calculated more broadly than a typical ROI calculation (which calculates returns to the investment provider alone), the most appropriate way of comparing benefits to costs is the benefit cost ratio (BCR) in which discounted benefits are divided by discounted costs. The estimated benefits, costs and BCRs from a cataract treatment program over the period 2021 to 2030 for each country and region are given in

Table 10 in the main text. Table 11 and Table 12 provide the same estimates for myopia and presbyopia treatment programs, respectively. Below are the main results of the model.

Cataract

Meeting the WHA goals for 2030 across the 19 countries in this study will mean treating over 39.9 million people with cataracts equivalent to more than 117.9 million years of sight saved (YSS) at a total discounted cost of USD $28.4 billion.

The average ROI measured by the BCR is 20.5, with significant variation from country to country. This means that, on average, the cataract treatment program will return USD $20.50 for every dollar spent on the program.

The BCR is lowest in China at 7.7 and highest in Kenya at 52.1. Most countries fall in the range of 10 to 20.

Myopia

Meeting the WHA goals for 2030 across the 19 countries in this study will mean treating over 52.7 million people with myopia equivalent to more than 282.8 million YSS at a total discounted cost of USD $67.9 billion.

The average ROI measured by the BCR is 10.5 with significant variation from country to country. The BCR is lowest in Burundi at 2.7 and highest in Lao PDR at 33.2. Most countries fall in the range of 4 to 20. This means that, on average, the myopia treatment program will return USD $10.50 for every dollar spent on the program.

Presbyopia

Meeting the WHA goals for 2030 across the 19 countries in this study will mean treating over 232.9 million people with presbyopia equivalent to more than 223.2 million YSS at a total discounted cost of USD $240.8 billion.

The average ROI measured by the BCR is 8.0 with significant variation from country to country. The BCR is lowest in Burundi at 2.1 and highest in Lao PDR at 21.9. Most countries fall in the range of 3 to 11. This means that, on average, the presbyopia treatment program will return USD $8 for every dollar spent on the program.

Presbyopia is a condition that mainly affects older people, while myopia is more often treated in younger people. Therefore, we see a difference in the costs of providing glasses across their lifetimes (see Costs in main report). In addition, individuals with each condition will differ in the estimated length of time they are in the labour force generating economic benefits, resulting in the difference BCRs estimated above, despite both conditions requiring glasses.

Cataract, Presbyopia, and Myopia

Meeting the WHA goals for 2030 across the 19 countries in this study for both cataract and refractive error will mean treating over 325.5 million people equivalent to more than 623.8 million YSS at a total discounted cost of USD $337.2 billion.

The average ROI measured by the BCR is 9.4 with significant variation from country to country. The BCR is lowest in Burundi at 2.2 and highest in Lao PDR at 26.4. Most countries fall in the range of 3 to 10. This means that, on average, the cataract and refractive error treatment program will return USD $9.4 for every dollar spent on the program.

The key differences in outcomes for countries reflect the differences in incidence of eye health conditions by age and sex and the relative cost of treating these conditions, the average productivity within a country, and differing labour force participation rate by age and sex.

The BCRs arising from the ROI analysis are similar to those using a similar methodology in other studies across a range of health conditions and countries. In a study with WHO, for a range of interventions addressed at reproductive, maternal and child health for 75 low and middle income countries the BCR was estimated to be 8.7 (Stenberg et al 2014). For treating depression and anxiety the BCR was 4.0 (Chisholm et al 2016) while for cardiovascular disease it was 10.9 (Bertram et al 2018). For road safety programs across 75 countries the average BCR was 16.8 (Symons and Sweeny 2021). For a range of adolescent health and wellbeing programs the average BCR was 10.2 (Sheehan et al 2017).

The results provided in this study indicate that for most countries there are strong returns in the form of economic benefits from implementing programs that meet the WHA goals for cataract and refractive error. Indeed, the large average BCR estimated for cataract surgery alone (20.5) shows that this procedure provides among the highest returns on investment of disease interventions modelled through similar investment cases.

1. INTRODUCTION

In its *World Report on Vision*, the WHO (2019) estimated that there are at least 2.2 billion people worldwide with VI. Among these are at least 1 billion who have VI that could have been prevented or has yet to be addressed. The main unaddressed conditions include:

Unaddressed presbyopia	826 million
Unaddressed refractive error	124 million
Cataract	65 million
Glaucoma	7 million
Corneal opacities	4 million
Diabetic retinopathy	3 million
Trachoma	2 million

The Foundation and VU have developed an eye health model that provides the basis for the investment in programs that scale up interventions which reduce the burden of VI.

This report uses the model to estimate ROI from programs to achieve the WHA goals to reduce the burden of vision impairment across 19 countries where The Foundation works and the unmet burden is high.

The model has been developed initially for cataract and refractive error, namely myopia and presbyopia, and will complement the efforts of WHO to build an eye health module within the UN Interagency OneHealth Tool (OHT) (Avenir Health 2020).

1.1 DESCRIPTION OF EYE HEALTH CONDITIONS INCLUDED IN THE MODEL

A cataract is an opacification of the lens of the eye which leads to a decrease in vision. Cataracts often develop slowly and can affect one or both eyes. Symptoms may include faded colors, blurry or double vision, halos around light, trouble with bright lights, and trouble seeing at night. This may result in trouble driving, reading, or recognising faces. Poor vision caused by cataracts may also result in an increased risk of falling and depression. Cataracts cause half of all cases of blindness and 33% of VI worldwide (Liu et al 2017).

Refractive error is a problem with focusing light accurately on the retina due to the shape of the eye. The most common types of refractive error are near-sightedness or myopia, far-sightedness, astigmatism, and presbyopia. Near-sightedness results in faraway objects being blurry, far-sightedness and presbyopia results in close objects being blurry, and astigmatism causes objects to appear stretched out or blurry (Morgan, Ohno-Matsui and Saw 2012).

Near-sightedness is due to the length of the eyeball being too long, far-sightedness the eyeball too short, astigmatism the cornea being the wrong shape, and presbyopia ageing of the lens of the eye such that it cannot change shape sufficiently (Morgan, Ohno-Matsui and Saw 2012).

2. DESCRIPTION OF THE EYE HEALTH MODEL

The eye health model uses data on prevalence and other characteristics of VI for a set of 19 countries in which The Foundation works. These countries are listed in Table 1 along with their income status and GBD/IHME region (IHME 2021). Most of these countries have low or lower middle-income status according to the World Bank's classification (World Bank 2022).

Table 1: Countries included in the model.

	Income status	Region
Afghanistan	Low income	North Africa and Middle East
Bangladesh	Lower middle income	South Asia
Burundi	Low income	Sub-Saharan Africa
Cambodia	Lower middle income	Southeast Asia
China	Upper middle income	East Asia
Eritrea	Low income	Sub-Saharan Africa
Ethiopia	Low income	Sub-Saharan Africa
Indonesia	Lower middle income	Southeast Asia
Kenya	Lower middle income	Sub-Saharan Africa
Lao PDR	Lower middle income	Southeast Asia
Myanmar	Lower middle income	Southeast Asia
Nepal	Lower middle income	South Asia
Pakistan	Lower middle income	South Asia
Palestine	Lower middle income	North Africa and Middle East
Papua New Guinea	Lower middle income	Oceania
Philippines	Lower middle income	Southeast Asia
Rwanda	Low income	Sub-Saharan Africa
Timor-Leste	Lower middle income	Southeast Asia
Vietnam	Lower middle income	Southeast Asia

The model estimates the benefits arising from treatment of eye conditions in terms of improvements in health outcomes (i.e. DALYs and YSS) and in economic terms. It then compares this to the cost of achieving these benefits.

Much of the evidence used in developing this model, has been derived from a detailed review of the report of the Lancet Commission (Burton et al 2020), its supplementary material, and related publications (Ehrlich et al 2021, Assi et al 2021, Marques et al 2022)

2.1 TIME FRAME

In most instances, investment cases assess the impact of intervention programs scaled up over a period of time (Sweeny et al 2021, Rasmussen et al 2019, Sheehan et al 2017). Setting a specific timeframe for an investment case provides a tangible frame for calculating costs with a specific end-goal in mind.

For the ROI estimates in this report the time period for the scale up of interventions is 2022 to 2030, in line with the goals agreed at the WHA.

2.2 PREVALENCE RATES

The model includes the prevalence (i.e. the number of people at any one time with a condition) of VI for the following, by country:

- cataract,
- near vision loss, and
- refraction disorders

The data used by the model are prevalence rates provided at 10-yearly intervals from 1990 to 2020 by five-year age group and sex from the Vision Loss Expert Group (VLEG, Bourne et al 2021). This study is the first of its kind to utilise the disaggregated prevalence data provided through VLEG, which is considered more accurate than similar, publicly-available estimates such as those provided in GBD studies (Institute of Health Metrics and Evaluation (IHME) 2020).

Currently the VLEG estimates of the VI burden of disease only include data on prevalence, and GBD estimates include the years lived with disability (IHME 2020). They do not include incidence, deaths, or years of life lost. Analyses of this data on trends in prevalence of blindness and distance and near VI over 30 years have been published recently (Bourne et al 2021, Steinmetz et al 2020).

2.3 CATEGORIES OF VISION IMPAIRMENT

The classification of severity of VI within the International Classification of Diseases 11 (WHO 2020) is given in Table 22 in the Appendix. In that table, three alternative measures are given for each category, with the first listed being the metric version. For the purposes of modelling, we follow the Lancet Commission (Burton et al 2020) visual acuity categories defined on Snellen charts in metres, as follows:

- no vision impairment, (≥ 6/12)
- mild vision impairment (6/12 – 6/18)
- moderate vision impairment, (6/18 – 6/60)
- severe vision impairment, (3/60 – 6/60)
- blindness (< 3/60).

This study obtained 2020 VLEG data including a classification of disease by severity of impairment by sex and five-year age group. This data is included within the eye health model. For cataract and refraction disorders there are three categories of vision loss: moderate, severe, and blindness. For near vision loss there is only one category: presbyopia. It should be noted that the threshold used for presbyopia corresponds to mild vision impairment (equivalent to 6/12), lower than the one used for myopia and cataract (6/18).

Separately, The Foundation used administrative (i.e. data obtained from in-country implementing partners) data to estimate the percentage of persons treated for cataract and refractive error by degree of visual acuity – mild, moderate, severe and blindness. These estimates were provided for each country where The Foundation works. In most countries, for cataract surgery, the percentage in the mild category is zero or very small. In the case of refractive error, a significant proportion for some countries is in the mild category. This reflects The Foundation’s priority to treat cataract conditions for individuals with moderate to severe VI.

2.4 PROJECTING PREVALENCE AND INCIDENCE

For time periods that extend into the future, it is necessary to project future prevalence rates and numbers, and use these to estimate the incidence (i.e. the number of people newly acquiring the condition) of VI in each year.

The model projects prevalence rates from the most recent year for which data is available (2020) to the end of the time period using the average rate of change in the prevalence rate over the period 2000 to 2020 by age and sex.

The projected prevalence rates are applied to the population projections by five-year age group and sex from the 2019 Revision of World Population Prospects produced by the Department of Economic and Social Affairs of the United Nations (UN 2019). This gives the projected numbers of people with each VI condition by age and sex for each year of the time period beyond 2020.

Applying the distribution of prevalence by categories of vision loss (discussed earlier) to these estimates enables the numbers of people in each category of severity to be calculated for each cause of VI by age, sex, and year.

As noted earlier, neither the VLEG or GBD include estimates of the incidence of eye health conditions. Prevalence measures the number of people with an eye health condition during the course of a particular year, while incidence measures the number of new cases in a particular year. Given the absence of direct incidence data, the model estimates the incidence for a particular year of the time period by calculating the difference between the prevalence in that year and the previous year.

Because the IHME data does not release data on deaths due to vison impairment, the model does not include this when estimating benefits arising from interventions. However, there is some evidence for a relationship between VI and deaths due to falls and other causes. This evidence is reviewed in the Appendix (see association between vision impairment and mortality).

2.5 TREATMENTS

CATARACT

The intervention program for cataract only considers cataract surgery and does not include prevention measures such as sunglasses or smoking reduction. There are three main types of cataract surgery (Liu et al 2017):

- ***Phacoemulsification (PHACO)*** is the most widely used cataract surgery in the developed world and uses ultrasonic energy to emulsify the cataract lens and replace it with an artificial intraocular lens (IOL).
- **Extracapsular cataract extraction (ECCE)** involves the removal of the natural lens while the elastic lens capsule (posterior capsule) is left intact to allow implantation of an intraocular lens. It involves manual expression of the lens through a large (usually 10–12 mm) incision made in the cornea or sclera.
- ***Manual small incision cataract surgery (SICS)*** is an evolution of ECCE where the entire lens is expressed out of the eye through a self-sealing scleral tunnel wound. An appropriately constructed scleral tunnel is watertight and does not require suturing. The "small" in the title refers to the wound being relatively smaller than an ECCE, although it is still markedly larger than a PHACO wound. Head-to-

head trials of SICS vs PHACO in dense cataracts have found no difference in outcomes, but shorter operating time and significantly lower costs with SICS.

In countries where The Foundation works, PHACO and SICS are the most common cataract procedures, with ECCE rarely performed, and costing estimates provided in this report were focused on PHACO and SICS. The cost of PHACO and SICS are different and vary from country to country.

The costs estimated in this report also account for three different cataract surgery delivery modes. The first is from centralised surgical units, the second is from surgical units of regional centres, and the third is from temporary surgical units in the field. Each mode differs in its cost and efficacy in terms of post-operative outcomes. For the purposes of this report, these proportions have been estimated by both review of the literature and programmatic data provided by The Foundation to produce a weighted average of a single unit cost per procedure.

REFRACTIVE ERROR

The model considers two types of refractive error: nearsightedness or myopia, and presbyopia.

Refractive errors are corrected with glasses, contact lenses, or surgery. Glasses are the easiest and safest method of correction. Contact lenses can provide a wider field of vision. However, they are associated with a risk of infection. Refractive surgery permanently changes the shape of the cornea.

The model considers screening for refractive error, clinical exam (refraction), and the provision of glasses in the calculation of costs and benefits. Similarly, the model allows for three different scenarios for treatment of myopia. In the first scenario, teachers or nurses with some experience in screening provide basic eye screening in schools. Children are then provided with a referral to a clinic for testing and provision of glasses. In the second scenario, testing is done in schools by eye care teams and standard glasses provided where appropriate. Where specialised glasses are required, these are manufactured off site and returned to the school setting for fitting. In the third scenario, screening and glasses are provided in clinics.

For presbyopia, there are two modes of screening and provision. The first occurs through clinics. The second is provided through outreach in workplaces.

As above, estimates for the proportion of screening and provision types have been taken from review of the literature and programmatic data provided by The Foundation to produce a weighted average of a single unit cost per pair of glasses provided.

2.6 COVERAGE OR TREATMENT RATES

The goals for 2030 agreed at the 74th WHA in April 2021 (WHA 2021) are:

A 30-percentage point increase in effective coverage of cataract surgery, by 2030

- Countries with baseline effective coverage rates 70% or higher, should strive for universal coverage.

A 40-percentage point increase in effective coverage of refractive error, by 2030

- Countries with baseline effective coverage rates 60% or higher, should strive for universal coverage.

According to the WHA, countries should aim to achieve an equal increase in effective coverage in all population sub-groups, independent of baseline estimates.

The eye health model is designed to calculate the impact of an intervention program on the number of people treated for each cause of VI. The target population for treatment in a particular year is defined as the prevalence of the condition while the coverage rate is the number of people treated as a proportion of the target population.

For the ROI estimates presented in this report, the time period for the scale up of interventions is 2022 to 2030 and the coverage rates are the same across age and sex groups.

The International Agency for the Prevention of Blindness (IAPB) has estimated both the Cataract Surgical Rate (CSR) which is the number of cataract operations performed per year, per million population, and the Cataract Surgical Coverage (CSC) which indicates the proportion of visually impaired individuals with bilateral cataract who were eligible for surgery and received it (IAPB 2020a).

The values for CSR and CSC and the year of reporting for each are given in Table 25 in the Appendix for the countries included in the modelling. CSR data is not available for Eritrea and Palestine and the latest year reported is usually 2014 or 2015. For CSC, at the time of writing, data was only available for nine countries and usually only for years prior to 2010.

Ramke et al (2017) have extended the concept of CSC to effective cataract surgical coverage (eCSC) defined as the number of people in a specific population with operated cataract and a good outcome (i.e. presenting vision 6/18 or better) as a proportion of those having operable plus operated cataract. They estimate CSC and eCSC for 20 countries of which seven are included in the model (Table 26 in the Appendix). McCormick et al (2022) have reported more comprehensive CSC and eCSC and the values for the countries included in the modelling in this study are given in Table 27 in the Appendix.

Similarly, McCormick et al (2020) have applied the same methodology to extend the refractive error coverage (REC) to an effective refractive error coverage rate (eREC) defined as the met need for refractive error divided by the sum of met need, undermet need and unmet need. In this case, VI of 6/12 is regarded as the threshold for met need. However, the authors only report eREC for three countries: South Africa (eREC 51.4% versus REC 54.3%), Pakistan (15.1% versus 22.7%) and Australia (93.5% versus 98.7% for non-Indigenous Australians, 82.2% versus 94.0% for Aboriginal and Torres Strait Islander people).

Bourne et al (2022) have reported distance effective refractive error coverage and near effective refractive error coverage by sex and age for a number of countries, including China and Nepal. The supplementary material to their article reports further estimates for the countries included in the model.

3. OUTCOMES FROM THE EYE HEALTH MODEL

3.1 NUMBER OF PERSONS TREATED

The economic analysis of the benefits and cost of the intervention program depends on the number of persons treated and the improvement in their visual acuity.

In order to model the impact of the meeting the WHA target coverage rates, we use the incremental effective coverage rates to estimate the number of people treated. The incremental effective coverage rates are estimated by assuming a low rate of effective coverage in the initial year and interpolating between this rate and the target rate in 2030, which is 30% for cataract and 40% for refractive error. As noted earlier, for this project we assume that these effective coverage rates are the same for each age and sex group, and for each degree of severity.

The number of persons treated depends on the coverage or treatment rates. To calculate this, the modelling starts with the prevalence in the year prior to the beginning of the intervention period – in this case the year 2021. The prevalence in the first year of the intervention period (2022) is calculated by adding the incidence in that year to the prevalence of the previous year, i.e. 2021. The number of persons treated in the first year is calculated by multiplying this estimate of the prevalence by the treatment rate in the first year. In the second year, the prevalence is equal to the prevalence in the first year minus the number of persons treated in the first year plus the incidence in the second year. The number of persons treated in the second year is calculated by multiplying this estimate of the prevalence by the treatment rate in the second year. The use of prevalence data to estimate incidence accounts for the estimated mortality of individuals that remain untreated in the previous year.

The estimates of prevalence calculated in this way replace the previous projections of prevalence described earlier.

This procedure is then applied to successive years until the end of the intervention period (year 2030). As the coverage rate increases during the intervention period, the number of persons treated first increases then begins to decrease significantly as the number of untreated persons is reduced, as well as older individuals reaching the end of their life.

The results of these calculations are estimates of the numbers of people treated by age and sex and severity of condition. The Foundation has provided estimates for each of the countries in the model by proportion of eye treatment outcomes that fall into three categories: good (a visual acuity of greater than 6/12), borderline (6/18-6/80), and poor (less than 6/60). Applying these proportions, the numbers of people treated that fall into these categories can be calculated. See Table , Table, and Table for the estimates of number of persons treated for cataract, myopia, and presbyopia, respectively.

3.2 YEARS OF SIGHT SAVED

These eye treatment outcomes can be expressed in in terms of YSS by considering the improvement in disability associated with each category of pre-treatment and post-treatment visual acuity during the intervention period.

Disability weights

The Lancet Commission noted that estimates of the disability weight for each category of visual acuity have varied considerably and argued that “further empirical research is urgently needed to understand societal valuations of VI and reach a broad, evidence-based consensus of weights that should be applied” (Burton et al 2021, p23).

The report identified nine studies estimating the disability weights associated with blindness and VI (Burton et al 2021, supplementary Appendix 1, p44). The disability weight for blindness varied from 0.173 to 0.6. The two main global estimates are those from global burden of disease studies by WHO (2013) and IHME (Salomon et al 2015) and these are shown in Table 2.

Table 2: Disability weights for vision impairment

	IHME	WHO
Blindness	0.187	0.338
Severe vision impairment	0.184	0.314
Moderate vision impairment	0.031	0.089
Mild vision impairment	0.003	0.005
Near vision impairment	0.011	0.047

The current GBD estimates use the IHME weights in calculating years lived with disability (YLD) and disability adjusted life years (DALY) (Vos et al 2020, supplementary Appendix 1, p1418). For the purposes of this report, we use the IHME weights below. The use of IHME weights are conservative estimates, and consistent with recent, high-profile studies assessing the burden of disease for VI (Bourne et al 2021; Yang et al 2021).

The Foundation has estimated disability improvement ratios for each category of pre and post-treatment visual acuity. These ratios and the assumed disability weights are used to calculate the improvement in disability weight. These are shown in Table 3. Note that for deterioration due to treatment the change in some disability weights is assumed to be zero.

Table 3: Improvement in disability weight, pre and post-treatment

				Post treatment				
Pre treatment			**Disability weight**	**Blindness**	**Severe vision impairment**	**Moderate vision impairment**	**Mild vision impairment**	**Full sight**
				< 3/60	3/60 – 6/60	6/18 – 6/60	6/12 - 6/18	>6/12
	Blindness	< 3/60	0.187	0%	2%	83%	98%	100%
	Severe vision impairment	3/60 – 6/60	0.184	0%	0%	82%	97%	98%
	Moderate vision impairment	6/18 – 6/60	0.031	0%	0%	0%	15%	17%
	Mild vision impairment	> 6/18	0.003	0%	0%	0%	0%	2%

Source: The Vision Loss Expert Group (VLEG), The Fred Hollows Foundation

The YSS saved are then estimated by applying these disability improvement measures to the estimated numbers of persons treated classified by improvement outcomes (i.e. those with poor (e.g. severe vision impairment to severe vision impairment), borderline (e.g. severe vision impairment to moderate vision impairment), and good post-intervention (e.g. severe vision impairment to mild vision impairment, or severe vision impairment to full sight) outcomes). To estimate the number of people treated by pre-treatment visual acuity and post-treatment outcome, the model uses data collected through The Foundation's implementing partners that identifies the proportion of each cohort by country. This data is included in Table 23 in the Appendix (see pre-treatment visual acuity and post-treatment outcome).

For each year of the intervention program, the model estimates the number of persons treated by age and sex and degree of improvement in sight. For each year, the number of persons in each age, sex and improvement category is multiplied by the degree of improvement and summed to give the amount of vision improvement associated with each age and sex category.

The number of persons with vision improvement from each year's cohort can be estimated for years following the treatment by applying projections of appropriate death rates to the number of persons in each age and sex category. Each year a person survives represents an extra year of vision improvement saved. Summing these years of sight improvement for each year the person survives gives the total amount of vision improvement associated with the treatment. The death rates are derived from the UN population projections (UN 2019) for the general population.

For example, suppose that the cataract surgery results in 10 women in age group 60-64 moving from blindness to full sight. This represents a change in disability weight (from 0.187 to 0) representing 100% of a gain of 1.0* 10 = 10 years of vision improvement in the first year. If 9 of these women survive to the next year an additional 1.0*9 = 9 years of vision improvement is gained. This continues for each year where there are survivors. This same process can be applied to the other women in age group 60-64 with other degrees of vision improvement. This is further generalised to the other age and sex and degree of vision improvement groups. This represents the outcomes in vison impairment for the first year of the intervention. Cohorts from subsequent years of the intervention are treated in the same way.

The results from each cohort are then summed to give a value for total amount of vision improvement due to the intervention program, and this figure taken as the YSS. In this respect, YSS calculates the lifetime benefits of interventions undertaken during the intervention period.

4. COSTS

The unit costs of treating cataract and refractive error are those prepared by The Foundation and are listed in Table 4 in 2022 US dollars. These unit costs combine the cost of labour, medical consumables, equipment, and other delivery costs associated with treating cataract and refractive error, and include a 15% markup to account for an estimate of health system costs. In this respect, the unit costs used in the model take the perspective of total costs to the health system, rather than those to an individual or service provider.

As discussed in previous sections, the unit cost for each country represents a weighted average of estimated costs for the different types of interventions within each category (e.g. school eye health programs and static facilities, PHACO and SICS), by country. These estimates were developed in consultation with The Foundation's implementing partners in each country included in this report.

There is significant variation in the estimates provided by country. For example in China the high unit cost of cataract surgery is driven by extremely high prices for IOLs, coupled with a larger proportion of PHACO surgeries. Similarly, high costs associated with refractive error (RE) can be due to different operating environments in each country. For example in Indonesia, high equipment and personnel costs associated with dispensing glasses lead to a higher unit cost estimate for RE.

The unit cost from Table 4 was increased in real terms by 3% per year over the modelling period 2021 to 2030. The total cost of treatment in a particular year was calculated by multiplying the unit cost in that year by the number of patients treated in that year. For myopia and presbyopia an additional cost was added to allow for a new refraction and a new pair of glasses every two years for each patient treated (i.e. removing the screening component for this recurrent cost). The two-yearly estimate for a new pair of glasses is in line with guidance from leading optometry institutions (Australian College of Optometry 2020) and Government programs (Queensland Department of Health 2022) and can be viewed as conservative for those in vulnerable settings (Victorian Department of Health 2022).

Table 4: Unit costs of treating cataract and refractive error, 2022 USD

	Cataract	Refractive error
Afghanistan	91	58
Bangladesh	158	190
Burundi	82	108
Cambodia	172	282
China	1058	189
Eritrea	103	114
Ethiopia	114	102
Indonesia	362	246
Kenya	166	113
Lao PDR	94	53
Myanmar	78	68
Nepal	89	106
Pakistan	249	46
Palestine	219	92
Papua New Guinea	199	147
Philippines	376	147
Rwanda	94	137
Timor-Leste	199	147
Vietnam	225	274

Source: The Fred Hollows Foundation estimates

As a form of sensitivity analysis, we include a review of the literature in the Appendix (see review of costs of treatment) based on those examined in the Lancet Commission and other sources including an internet search of providers in several countries included in this study.

Additional information on the costing method can be found in the costs of interventions section in the Appendix, where details of the unit costing approach are outlined.

5. ECONOMIC AND SOCIAL BENEFITS

5.1 BENEFIT PATHWAYS

The benefits generated from interventions to improve eye health are realised through several different mechanisms.

For cataracts there will be some direct gain in economic output from people who have surgery for moderate and severe visual loss in the last part of their working life and are now able to work.

For myopia, the direct economic benefit for persons of working age will be increased labour force participation and increased productivity at work. For younger ages, the benefits will come from higher school attendance rates and/or reduced dropout rates and from a reduction in learning gaps. This will improve the level of skills attained by school leavers and their productivity when they enter the labour force.

For presbyopia, the economic benefit will largely come from improving visual acuity enabling increased labour force participation and increased productivity at work.

In addition, the reduced need for carers for people with VI will deliver community and family benefits. If the carer is of working age, it enables that person to participate in the labour force to a greater degree than before. If the carer is under working age, it enables that person to participate in education to a greater degree than before. Finally, the person with restored visual acuity is now able to provide care to others, for instance young children in the immediate family. This would enable the parents, usually the mother, to participate in the labour force to a greater degree than before.

In summary, the different types of benefits are:

1. Improved labour force participation and productivity among working age patients
2. Improved educational participation and learning by school age patients
3. Increased labour force participation by working age carers
4. Increased educational participation by carers under working age
5. Provision of child care by patients over working age

It is critical to note that the benefits estimated in this report are only for the first and second benefits outlined above; improved labour force participation and productivity (among individuals of working age) and improved educational participation (among individuals of school age).

There is little information on the extent of caring activities in the countries included in the study. Therefore, it is not possible to include these benefits in the model at this stage. The Foundation and VU are currently working on a second phase of this project, which aims to gather information from women who have had cataract surgery to quantify the size of these extended benefits.

For completeness we include a discussion of the evidence for these benefits in the Appendix (see b*enefits from increased labour force participation by working age carers)*.

5.2 BENEFITS FROM IMPROVED LABOUR FORCE PARTICIPATION AND PRODUCTIVITY AMONG WORKING AGE PATIENTS

The direct economic benefit from improved vision can be calculated in two ways.

The first method is to assign an economic value to a year of vision improvement or YSS. This is analogous to the standard method of using the value of a (statistical) life year in cost effectiveness analysis. Jamison et al (2012) argue that the value for a statistical life year is in the range of 2 to 4 times per capita income.

The second method is to calculate the benefit directly for the different pathways of economic improvement discussed above. For cataract, presbyopia and myopia, there is a benefit associated with increased labour force participation and higher productivity at work for persons of working age. The calculations for this are similar to those outlined earlier for YSS.

For each year of the intervention program, the model estimates the number of persons treated by age and sex and degree of improvement in sight. For each year, the number of persons in each age, sex and improvement category can be multiplied by the improvement in productivity to calculate the total productivity increase for each age and sex group. The calculation of the productivity improvement is described in Section 6. As described above, we follow each cohort over time by applying appropriate death rates for each age, sex and year.

We use ILO (2021) projections of labour force participation rates by age and sex and year to calculate the numbers in the labour force for each age and sex group for each year. The ILO projections account for variation in typical working and retirement ages and are specific to each country (an age, sex, and year) included in the model.

For each cohort, the economic output associated with each age and sex category is obtained by multiplying the numbers of full sight equivalent people in the labour force in each category by an average productivity per person in the labour force modified by a productivity ratio dependent on age. The average productivity per person in the labour force is calculated by dividing the World Bank (2021) estimate of current GDP by the ILO estimate of the total labour force. This average productivity is allowed to increase over time in line with long-term trends in productivity. The productivity adjustment for age is based on Australian data for 2018 (ABS 2019). In summary, the economic contribution that a person with improved visual acuity makes depends on their labor force participation rate, the average productivity of a person at work, their age and the degree of their vision improvement.

This process is undertaken for each cohort within the intervention period.

5.3 IMPROVED EDUCATIONAL PARTICIPATION AND LEARNING BY SCHOOL AGE PATIENTS

For patients of school age, the principal benefit from improved VI is a greater level of participation in education. This will result in more years of schooling, greater skill levels and higher productivity on entering the labour force. Studies estimating the impact of VI on schooling have shown that poor vision can contribute to reductions in literacy and school performance across different age-groups of school-aged children (Bruce et al 2016, Jan et al 2019). Indeed, Hopkins et al (2020) notes the findings linking poor visual acuity and poor literacy performance are particularly relevant given that early literacy has been shown to be a key indicator of future reading and educational ability (Marchman and Fernald 2008).

Further, Gomes-Neto et al (1997) show that poor vision systematically leads to higher drop-out rates, to more grade repetition, and to lower achievement (i.e. literacy and numeracy grades) amongst primary school students. Specifically, the authors found that children with VI had a 10% higher probability of dropping out of school, an 18% higher probability of repeating a grade and scored from 0.2 to 0.3 standard deviations lower on literacy and numeracy tests than those without.

Hong and Press (2009) note that underlying VI can manifest as behavioural problems, including learning disabilities, dyslexia, and attention deficit disorder, which in turn have been associated with dramatically increased dropout rates (Ingrum 2006, Al-Lamki 2012, Mirza et al 2018).

The World Bank has regularly reported estimates of the ROI in education (Patrinos and Psacharopoulos 2010, Montenegro and Patrinos 2014, Psacharopoulos and Patrinos 2018).

The most recent estimates of the ROI for an additional year of schooling are shown in Table 5 where countries are grouped by income status. Table 32 in the Appendix shows returns from an additional year of schooling for the countries included in the model.

Table 5: Return on investment for an additional year of schooling, by country income status

Income status	%
Low	9.3
Middle	9.2
High	8.2
World	8.8

Source: Psacharopoulos and Patrinos 2018

6. ECONOMIC ANALYSES OF VISION IMPAIRMENT

The Lancet Commission undertook a systematic review of the economics of VI and eye health (Burton et al 2021, supplementary Appendix 1, section 4, Marques et al 2021, 2022). The authors identified 148 reports on 138 studies from 2000 to 2019. These studies varied in terms of degree of VI and condition covered, study perspective, epidemiological approach, type of study, and range of costs reported. The review notes that this literature has multiple limitations and great uncertainty.

Productivity loss estimates were limited in scope and generally made major, largely unsupported assumptions about the productivity and proportion of people with VI who work. These limitations mean that previous estimates might have substantially underestimated or overestimated the economic impact of VI, which limits the usefulness of cost-of-illness estimates and possibly led to flawed policy prioritisation decisions.

The review reported 37 studies on productivity loss due to VI and highlighted three global studies (Gordois et al 2012, Bastawrous and Suni 2019, and Frick and Foster 2003).

The Commission undertook its own estimates of the global and regional losses from unaddressed VI based on estimates from 11 peer-reviewed studies and five grey literature reports of the relative reduction in employment for people with VI and blindness compared to people without vision loss. Here the relative reduction is the difference between the ratio of employment to population of people with VI and blindness compared to the same ratio for people without vision loss. On average, the relative reduction was 30.23%. Marques et al

(2021) report alternative estimates based on Eurostat disability statistics data from 31 countries and arrive at an average of 19.55%.

The relative reduction in employment for various region are shown in Table 6. Using disability weights as a proxy for productivity losses, Marques et al estimated a reduction in employment of 33.8% for blindness, 31.4% for severe VI and 8.9% for moderate VI.

Combined with estimates of the numbers of people of working age with VI, employment rates and GDP, Marques et al estimated that in 2020 the global annual productivity loss was $410.7 billion. Potential productivity losses were estimated at $43.6 billion attributable to blindness and $367.1 billion attributable to MSVI. Productivity losses were highest in East Asia ($90.4 billion), while productivity losses as a proportion of GDP were highest in South Asia (0.6%).

However, as the authors discuss, the magnitude of productivity loss could have been underestimated because other productivity loss components were not included in their analysis due to data limitations. These components include absenteeism and presenteeism (reduced productivity in the working place), premature mortality, people older than 64 years, productivity losses of caregivers, and value of time lost from unpaid or informal labour activities. In addition, the use of the employment to population ratio does not differentiate between the reduction due to differences in labour force participation rate versus differences in unemployment rates.

Table 6: Relative reduction in employment; people with VI and blindness compared to people without vision loss

	Review	Eurostat
High Income	32.12	18.9
High-income Asia Pacific	26.70	-
Australasia	32.44	-
Western Europe	20.58	-
High-income North America	43.46	-
Central Europe, Eastern Europe and Central Asia	22.50	30.0
Central Europe	-	30.7
Eastern Europe	-	18.5
North Africa, Middle East	-	9.90
Western Sub-Saharan Africa	28.85	
Average	30.23	19.55

Source: Marques et al 2021

Harrabi et al (2014) examined the relationship between visual difficulty and employment status using data from World Health Surveys. Respondents were 219,048 adults aged 18 and older from 30 European countries, 18 African countries, seven North and South American, four Eastern Mediterranean, five Southeast Asian, and six Western Pacific countries in 2002–2003.[2] Table 7 shows the percentage of people working in each category of visual difficulty.

Table 7: Reduction in employment by severity of visual impairment

Visual difficulty	Working population, %
None	90.37
Mild	89.78
Moderate	84.56
Severe	79.11
Extreme	64.36

Source: Harrabi et al (2014)

Of people who wanted to work, they found that only 79% of people with severe visual difficulty and 64% of people with extreme visual difficulty were working (13% and 26% were not working due to ill health, respectively). People with visual difficulty were more likely to have lower status jobs such as in the agricultural and fisheries professions or as an elementary worker.

A number of other studies have examined various aspects of the economic impact of VI and these are discussed further in the Appendix (see e*conomic impacts of visual impairment-scoping the literature*).

7. RETURN ON INVESTMENT ANALYSIS

This section reports the results of using the eye health models to estimate the return on investment from interventions to meet the WHA goals outlined in Section 2.6.

Combining the assumptions on coverage rates and the efficacy of treatment (i.e. effective coverage), the model produces estimates of the number of persons treated by age and sex for each eye health condition classified by degree of visual improvement (good, borderline and poor).

Using the IHME disability weights these outcomes are also expressed as YSS.

The costs of achieving these outcomes are calculated by taking the unit cost of treatment and multiplying by the numbers of persons treated.

The economic benefits arising from the increased treatment rates are based on estimating the extra economic output resulting from improved vision, similar to the procedure used by Marques et al (2021). Here the relative improvement in the probability of employment is combined with an estimate of improved productivity when employed. For persons with improved vision these benefits accrue over the person's working life.

As noted earlier, the Lancet Commission undertook a systematic review of the economics of VI and eye health. In their review of productivity, Marques et al (2021) estimated the relative reduction in employment probability due to VI. On average, the relative reduction was 30.23%. Using disability weights as a proxy for productivity losses, they estimated a

[2] Far vision was assessed by asking ''In the last 30 days, how much difficulty did you have in seeing and recognizing a person you know across the road (i.e. from a distance of about 20 meters)?''. Possible responses included none, mild, moderate, severe, and extreme/unable.

reduction in employment of 33.8% for blindness, 31.4% for severe VI and 8.9% for moderate VI.

These estimates are used in the first column of Table 8 to show the employment effect at different levels of VI. The second column shows the relative reduction in productivity assuming the person is employed, using a conservative assumption on reductions in productivity common in investment case models (Sweeny et al 2019; Sheehan et al 2017; Rasmussen et al 2019; Rasmussen et al 2016). [3] The third column shows the combined effects of reduced employment probability and decreased levels of productivity.

Table 8: Employment, productivity and total effects by severity of vision impairment

Vision impairment	Employment effect	Productivity at work effect	Total effect
None	1	1	1
Mild	1	0.9	0.9
Moderate	0.911	0.8	0.729
Severe	0.686	0.7	0.480
Blindness	0.662	0.6	0.397

The values in Table 8 can be used to show the relative reduction/improvement in productivity in moving from one level of vision impairment to another (Table 9). For example, moving from blindness to good vision = 1-0.397 = 0.603.

Table 9: Improvement in total productivity, pre and post-treatment

			Post treatment		
			Poor	**Borderline**	**Good**
			< 6/60	6/18-6/60	> 6/12
Pre treatment	**Blindness**	< 3/60	0.083	0.332	0.603
	Severe vision impairment	3/60 – 6/60	0.000	0.249	0.520
	Moderate vision impairment	6/18 – 6/60	0.000	0.000	0.271
	Mild vision impairment	> 6/18	0.000	0.000	0.100

For myopia, a significant number of people treated will be of school age. We conservatively assume that the provision of glasses will enable children to stay at school for an extra year

[3] Note these assumptions are conservative compared to literature on employment and productivity for individuals with blindness or VI. For example, Reddy et al (2018) who noted a 21.7% productivity increase for individuals who improved from mild to moderate VI to good vision through the provision of glasses, and Brown et al (2014) who noted that individuals with severe vision loss had earnings (a proxy that can be used for estimates of productivity, Van Biesebroeck 2015) only 40.5% of an age-matched person with no disability. Similarly, these assumptions were conservative compared to studies that used disability weights as a proxy for productivity losses (Frick and Foster 2003, Bastawrous and Antti-Ville Suni 2020).

leading to improved skills when they enter the workforce. We use World Bank estimates by country of the percentage increase in income from an extra year of schooling (Table 32).

As is common with estimates of cost and benefits in the future, they are both discounted at the standard rate of 3% recommended by the World Bank. The discount rate applied represents the economic notion that a dollar in the future is worth less than a dollar today and is standard in this type of modelling (Broughel 2020).

In the context of this report, the simplest way of comparing benefits to costs is the BCR in which discounted benefits are divided by discounted costs. The estimated benefits, costs and BCRs from a cataract treatment program over the period 2021 to 2030 for each country and region are given in Table 10.

The region BCRs are given in unweighted and weighted terms. The unweighted results give equal importance to each country in a region (no matter the size (i.e. population) of the countries) when calculating the regional average. The weighted results are calculated by summing the benefits and cost of the countries in the region and dividing total benefits by total costs. In this case, larger countries such as China can skew the average. Arguments can be made for weighted and unweighted averages. However, it is the author's opinion that unweighted averages are most appropriate in the context of this report.

Table 11 and Table 12 report the same metrics for myopia and presbyopia treatment programs respectively, while Table gives the results from combining the results from cataract, myopia and presbyopia.

Table and Table show the number of persons treated for cataracts and the resulting years of sight saved. Table and Table show the same for myopia and Table and Table 13 for presbyopia.

CATARACT

Meeting the WHA goals for 2030 across the 19 countries in this study will mean treating over 39.9 million people with cataracts equivalent to more than 117.9 million years of sight saved (YSS) at a total discounted cost of USD $28.4 billion.

The average ROI measured by the BCR is 20.5, with significant variation from country to country. This means that, on average, the cataract treatment program will return USD $20.50 for every dollar spent on the program.

The BCR is lowest in China at 7.7 and highest in Kenya at 52.1. Most countries fall in the range of 10 to 20.

MYOPIA

Meeting the WHA goals for 2030 across the 19 countries in this study will mean treating over 52.7 million people with myopia equivalent to more than 282.8 million YSS at a total discounted cost of USD $67.9 billion.

The average ROI measured by the BCR is 10.5 with significant variation from country to country. The BCR is lowest in Burundi at 2.7 and highest in Lao PDR at 33.2. Most countries fall in the range of 4 to 20.

PRESBYOPIA

Meeting the WHA goals for 2030 across the 19 countries in this study will mean treating over 232.9 million people with presbyopia equivalent to more than 223.2 million YSS at a total discounted cost of USD $240.8 billion.

The average ROI measured by the BCR is 8.0 with significant variation from country to country. The BCR is lowest in Burundi at 2.1 and highest in Lao PDR at 21.9. Most countries fall in the range of 3 to 11.

Presbyopia is a condition mainly of older people, while myopia is more often treated in younger people. Therefore, we see a difference in the costs of providing glasses across their lifetimes (see costs in main report). In addition, individuals with each condition will differ in the estimated length of time they are in the labour force generating economic benefits, resulting in the difference BCRs estimated above, despite both conditions requiring glasses.

The key differences in outcomes for countries reflect the differences in incidence of eye health conditions by age and sex and the relative cost of treating these conditions, the average productivity within a country, and differing labour force participation rate by age and sex.

COMPARISON ACROSS SIMILAR STUDIES

The BCRs arising from the ROI analysis are similar to those using a similar methodology in other studies across a range of health conditions and countries. In a study with WHO, for a range of interventions addressed at reproductive, maternal and child health for 75 low and middle income countries the BCR was estimated to be 8.7 (Stenberg et al 2014). For treating depression and anxiety the BCR was 4.0 (Chisholm et al 2016) while for cardiovascular disease it was 10.9 (Bertram et al 2018). For road safety programs across 75 countries the average BCR was 16.8 (Symons and Sweeny 2021). For a range of adolescent health and wellbeing programs the average BCR was 10.2 (Sheehan et al 2017).

The results provided in this study indicate that for most countries there are strong returns in the form of economic benefits from implementing programs that meet the WHA goals for cataract and refractive error. Indeed, the large average BCR estimated for cataract surgery alone (20.5) shows that this procedure provides among the highest ROI of any disease interventions modelled through investment cases.

Table 10: Cataract: benefits, costs, benefit cost ratios, 3% discount rate, US dollars (millions)

	Benefits	Costs	Benefit cost ratios	Benefit cost ratios
Afghanistan	409	37	11.1	-
Bangladesh	10,299	531	19.4	-
Burundi	16	1	14.9	-
Cambodia	1,326	59	22.6	-
China	173,774	22,444	7.7	-
Eritrea	28	2	13.1	-
Ethiopia	2,857	155	18.4	-
Indonesia	79,141	2,997	26.4	-
Kenya	3,820	73	52.1	-
Lao PDR	134	3	42.1	-
Myanmar	1,715	103	16.6	-
Nepal	854	35	24.7	-
Pakistan	10,130	1,000	10.1	-
Palestine	142	11	13.5	-
Papua New Guinea	733	25	29.5	-
Philippines	9,008	605	14.9	-
Rwanda	43	2	18.6	-
Timor-Leste	37	2	19.2	-
Vietnam	5,373	356	15.1	-
			Weighted	Unweighted
East Asia	173,774	22,444	7.7	7.7
North Africa and Middle East	551	48	11.5	12.3
Oceania	733	25	29.3	29.5
South Asia	21,283	1,566	13.6	18.1
Southeast Asia	96,734	4,125	23.5	22.4
Sub-Saharan Africa	6,764	233	29.0	23.4
All countries	299,839	28,440	10.5	20.5

Table 11: Myopia: benefits, costs, benefit cost ratios, 3% discount rate, US dollars (millions)

	Benefits	Costs	Benefit cost ratios	Benefit cost ratios
Afghanistan	4,013	485	8.3	-
Bangladesh	45,849	6,833	6.7	-
Burundi	166	62	2.7	-
Cambodia	4,764	1,056	4.5	-
China	829,011	37,587	22.1	-
Eritrea	135	35	3.8	-
Ethiopia	3,421	1,107	3.1	-
Indonesia	80,997	9,565	8.5	-
Kenya	6,902	452	15.3	-
Lao PDR	1,649	50	33.2	-
Myanmar	4,417	653	6.8	-
Nepal	4,179	574	7.3	-
Pakistan	33,433	2,135	15.7	-
Palestine	1,721	93	18.6	-
Papua New Guinea	2,699	227	11.9	-
Philippines	44,896	2,852	15.7	-
Rwanda	310	120	2.6	-
Timor-Leste	288	42	6.8	-
Vietnam	28,109	4,014	7.0	-
			Weighted	Unweighted
East Asia	829,011	37,587	22.1	22.1
North Africa and Middle East	5,734	578	9.9	13.5
Oceania	2,699	227	11.9	11.9
South Asia	83,461	9,542	8.7	9.9
Southeast Asia	165,120	18,232	9.1	11.8
Sub-Saharan Africa	10,934	1,776	6.2	5.5
All countries	1,096,959	67,943	16.1	10.5

Table 12: Presbyopia: benefits, costs, benefit cost ratios, 3% discount rate, US dollars (millions)

	Benefits	Costs	Benefit cost ratios	Benefit cost ratios
Afghanistan	961	216	4.4	-
Bangladesh	87,977	19,188	4.6	-
Burundi	754	357	2.1	-
Cambodia	3,701	1,251	3.0	-
China	2,520,858	181,512	13.9	-
Eritrea	466	133	3.5	-
Ethiopia	11,815	2,385	5.0	-
Indonesia	88,296	13,487	6.5	-
Kenya	17,129	1,307	13.1	-
Lao PDR	1,867	85	21.9	-
Myanmar	6,410	1,005	6.4	-
Nepal	24,047	3,818	6.3	-
Pakistan	51,360	3,457	14.9	-
Palestine	574	50	11.4	-
Papua New Guinea	2,585	270	9.6	-
Philippines	29,744	2,785	10.7	-
Rwanda	2,917	624	4.7	-
Timor-Leste	251	37	6.7	-
Vietnam	31,191	8,847	3.5	-
			Weighted	Unweighted
East Asia	2,520,858	181,512	13.9	13.9
North Africa and Middle East	1,535	266	5.8	7.9
Oceania	2,585	270	9.6	9.6
South Asia	163,384	26,463	6.2	8.6
Southeast Asia	161,460	27,497	5.9	8.4
Sub-Saharan Africa	33,081	4,806	6.9	5.7
All countries	2,882,903	240,814	12.0	8.0

Table 13: Cataract, myopia and presbyopia: benefits, costs, benefit cost ratios, 3% discount rate, US dollars (millions)

	Benefits	Costs	Benefit cost ratios	Benefit cost ratios
Afghanistan	5,383	738	7.3	-
Bangladesh	144,125	26,552	5.4	-
Burundi	936	420	2.2	-
Cambodia	9,791	2,366	4.1	-
China	3,523,643	241,543	14.6	-
Eritrea	629	170	3.7	-
Ethiopia	18,093	3,647	5.0	-
Indonesia	248,434	26,049	9.5	-
Kenya	27,851	1,832	15.2	-
Lao PDR	3,650	138	26.4	-
Myanmar	12,542	1,761	7.1	-
Nepal	29,080	4,427	6.6	-
Pakistan	94,923	6,592	14.4	-
Palestine	2,437	154	15.8	-
Papua New Guinea	6,017	522	11.5	-
Philippines	83,648	6,242	13.4	-
Rwanda	3,270	746	4.4	-
Timor-Leste	576	81	7.1	-
Vietnam	64,673	13,217	4.9	-
			Weighted	Unweighted
East Asia	3,523,643	241,543	14.6	14.6
North Africa and Middle East	7,820	892	8.8	11.6
Oceania	6,017	522	11.5	11.5
South Asia	268,128	37,571	7.1	8.8
Southeast Asia	423,314	49,854	8.5	10.4
Sub-Saharan Africa	50,779	6,815	7.5	6.1
All countries	4,279,701	337,197	12.7	9.4

Table 14: Cataract: patients treated, 2021 to 2030

	Female			Male			Persons		
	15-49	50 and over	Total	15-49	50 and over	Total	15-49	50 and over	Total
Afghanistan	22,110	193,757	215,868	14,727	131,300	146,027	36,837	325,057	361,895
Bangladesh	83,910	1,682,584	1,766,495	57,625	1,183,397	1,241,022	141,535	2,865,982	3,007,517
Burundi	1,201	5,616	6,818	878	3,802	4,680	2,080	9,418	11,498
Cambodia	17,135	174,233	191,368	13,483	100,520	114,003	30,618	274,752	305,370
China	316,679	11,392,970	11,709,649	300,123	6,990,508	7,290,631	616,802	18,383,478	19,000,280
Eritrea	1,183	9,977	11,160	828	6,423	7,251	2,010	16,400	18,410
Ethiopia	138,248	607,311	745,559	92,470	382,263	474,733	230,718	989,574	1,220,291
Indonesia	397,232	4,006,268	4,403,500	317,891	2,693,416	3,011,307	715,124	6,699,683	7,414,807
Kenya	39,096	193,453	232,549	30,123	132,886	163,009	69,219	326,339	395,558
Lao PDR	1,404	17,219	18,623	1,159	10,581	11,739	2,562	27,800	30,362
Myanmar	56,841	693,593	750,434	44,978	388,089	433,067	101,819	1,081,682	1,183,501
Nepal	12,254	212,724	224,978	5,555	117,333	122,888	17,809	330,056	347,866
Pakistan	158,074	1,843,759	2,001,833	142,999	1,450,390	1,593,390	301,073	3,294,149	3,595,223
Palestine	1,988	22,801	24,789	1,628	16,589	18,217	3,616	39,390	43,006
Papua New Guinea	5,688	54,838	60,526	5,553	45,828	51,381	11,241	100,666	111,907
Philippines	44,206	857,756	901,963	40,391	499,069	539,460	84,597	1,356,825	1,441,422
Rwanda	1,620	11,955	13,575	1,181	7,524	8,706	2,801	19,480	22,281
Timor-Leste	355	4,863	5,218	300	3,121	3,421	655	7,984	8,639
Vietnam	47,609	871,067	918,676	40,745	458,092	498,837	88,354	1,329,159	1,417,513
All countries	1,346,833	22,856,744	24,203,581	1,112,637	14,621,131	15,733,769	2,459,470	37,477,874	39,937,346

Table 15: Cataract: years of sight saved, 2021 to 2030

	Female			Male			Persons		
	15-49	50 and over	Total	15-49	50 and over	Total	15-49	50 and over	Total
Afghanistan	198,352	561,665	760,017	98,635	278,590	377,225	296,987	840,255	1,137,242
Bangladesh	737,757	6,525,475	7,263,233	440,684	3,642,388	4,083,072	1,178,441	10,167,863	11,346,305
Burundi	10,641	17,322	27,963	6,488	9,174	15,663	17,129	26,496	43,626
Cambodia	144,496	487,935	632,431	87,410	237,008	324,418	231,906	724,943	956,849
China	3,097,851	29,583,017	32,680,868	2,621,507	15,861,712	18,483,219	5,719,358	45,444,729	51,164,087
Eritrea	8,091	21,387	29,477	4,678	10,851	15,529	12,768	32,237	45,006
Ethiopia	800,313	1,303,619	2,103,932	330,186	515,580	845,767	1,130,499	1,819,200	2,949,699
Indonesia	3,718,052	13,808,517	17,526,568	2,271,261	7,364,850	9,636,111	5,989,313	21,173,367	27,162,679
Kenya	280,066	553,828	833,893	189,998	322,777	512,775	470,063	876,605	1,346,668
Lao PDR	8,498	34,208	42,706	5,019	18,020	23,039	13,517	52,228	65,745
Myanmar	319,108	1,278,041	1,597,149	138,663	448,760	587,423	457,771	1,726,801	2,184,572
Nepal	67,430	514,181	581,611	28,573	236,794	265,367	96,003	750,975	846,978
Pakistan	1,184,608	4,926,777	6,111,385	983,737	3,583,734	4,567,471	2,168,345	8,510,511	10,678,855
Palestine	12,249	49,028	61,277	8,004	26,596	34,601	20,253	75,624	95,877
Papua New Guinea	43,505	110,142	153,647	30,893	81,516	112,409	74,398	191,658	266,056
Philippines	343,907	2,141,336	2,485,244	230,420	975,725	1,206,145	574,328	3,117,061	3,691,389
Rwanda	7,105	17,255	24,360	3,550	7,673	11,223	10,655	24,928	35,583
Timor-Leste	3,292	11,977	15,268	2,128	6,944	9,072	5,420	18,921	24,340
Vietnam	320,353	2,226,701	2,547,054	220,542	1,061,664	1,282,206	540,895	3,288,365	3,829,261
All countries	11,305,674	64,172,411	75,478,083	7,702,376	34,690,356	42,392,735	19,008,049	98,862,767	117,870,817

Table 16: Myopia: patients treated, 2021 to 2030

	Female				Male				Persons			
	<15	15-49	50 and over	Total	<15	15-49	50 and over	Total	<15	15-49	50 and over	Total
Afghanistan	102,180	200,452	85,522	388,154	113,952	220,465	95,956	430,372	216,132	420,917	181,478	818,526
Bangladesh	176,038	801,851	1,428,328	2,406,217	165,771	667,347	1,446,843	2,279,960	341,809	1,469,198	2,875,171	4,686,177
Burundi	6,903	13,614	10,150	30,667	7,684	14,595	10,630	32,909	14,587	28,209	20,780	63,576
Cambodia	40,582	93,250	81,764	215,596	38,219	87,995	68,130	194,345	78,801	181,245	149,894	409,941
China	979,356	3,233,446	11,942,552	16,155,354	921,789	2,779,645	9,040,645	12,742,080	1,901,145	6,013,091	20,983,197	28,897,434
Eritrea	2,831	7,460	7,941	18,232	2,985	7,681	8,084	18,750	5,816	15,141	16,025	36,982
Ethiopia	154,435	282,156	130,006	566,598	131,809	246,520	117,882	496,210	286,244	528,676	247,888	1,062,808
Indonesia	350,832	862,926	937,787	2,151,545	341,973	892,488	991,944	2,226,405	692,805	1,755,414	1,929,731	4,377,950
Kenya	41,808	105,252	66,205	213,265	41,128	101,656	63,818	206,601	82,936	206,908	130,023	419,866
Lao PDR	9,938	22,931	22,786	55,655	8,982	20,857	20,052	49,890	18,920	43,788	42,838	105,545
Myanmar	102,185	227,632	282,436	612,253	88,182	199,422	221,513	509,117	190,367	427,054	503,949	1,121,370
Nepal	30,365	147,125	225,400	402,890	24,804	91,931	181,622	298,356	55,169	239,056	407,022	701,246
Pakistan	406,913	1,189,494	1,550,570	3,146,976	336,238	926,134	1,232,897	2,495,269	743,151	2,115,628	2,783,467	5,642,245
Palestine	11,645	24,410	13,946	50,001	11,758	23,543	11,697	46,997	23,403	47,953	25,643	96,998
Papua New Guinea	15,137	33,921	44,092	93,150	16,178	35,353	41,692	93,222	31,315	69,274	85,784	186,372
Philippines	191,808	423,998	589,098	1,204,904	179,639	406,614	493,176	1,079,429	371,447	830,612	1,082,274	2,284,333
Rwanda	8,349	22,189	24,728	55,265	7,530	18,506	20,068	46,105	15,879	40,695	44,796	101,370
Timor-Leste	3,804	6,060	6,814	16,679	3,393	5,670	6,456	15,519	7,197	11,730	13,270	32,198
Vietnam	138,572	343,011	407,304	888,887	134,002	326,095	321,079	781,176	272,574	669,106	728,383	1,670,063
All countries	2,773,681	8,041,178	17,857,429	28,672,288	2,576,016	7,072,517	14,394,184	24,042,712	5,349,697	15,113,695	32,251,613	52,715,000

Table 17: Myopia, years of sight saved, 2021 to 2030

	Female				Male				Persons			
	<15	15-49	50 and over	Total	<15	15-49	50 and over	Total	<15	15-49	50 and over	Total
Afghanistan	955,365	1,467,012	258,250	2,680,627	970,365	1,439,991	271,597	2,681,952	1,925,730	2,907,003	529,847	5,362,579
Bangladesh	2,056,216	7,113,629	6,137,492	15,307,337	1,870,536	5,541,064	5,038,797	12,450,397	3,926,752	12,654,693	11,176,289	27,757,734
Burundi	60,761	92,332	29,451	182,544	62,766	89,566	28,031	180,363	123,527	181,898	57,482	362,907
Cambodia	401,642	715,552	289,080	1,406,275	353,069	616,297	216,314	1,185,680	754,711	1,331,849	505,394	2,591,955
China	11,043,564	31,116,828	51,369,184	93,529,576	10,351,816	25,724,444	33,628,510	69,704,770	21,395,380	56,841,272	84,997,694	163,234,346
Eritrea	22,739	50,395	22,806	95,940	22,783	48,774	21,346	92,903	45,522	99,169	44,152	188,843
Ethiopia	640,753	916,052	184,284	1,741,089	474,594	696,146	150,132	1,320,871	1,115,347	1,612,198	334,416	3,061,960
Indonesia	2,816,340	5,399,026	2,578,966	10,794,332	2,623,680	5,119,468	2,397,863	10,141,011	5,440,020	10,518,494	4,976,829	20,935,343
Kenya	409,049	870,313	263,593	1,542,955	346,594	672,923	201,392	1,220,910	755,643	1,543,236	464,985	2,763,865
Lao PDR	88,440	158,064	63,843	310,347	75,737	127,022	50,844	253,603	164,177	285,086	114,687	563,950
Myanmar	539,893	1,064,621	603,199	2,207,712	403,134	711,478	359,959	1,474,571	943,027	1,776,099	963,158	3,682,283
Nepal	311,737	1,148,140	832,985	2,292,863	243,163	679,323	541,504	1,463,990	554,900	1,827,463	1,374,489	3,756,853
Pakistan	3,268,535	6,882,222	3,812,774	13,963,530	2,471,329	4,908,385	2,684,766	10,064,480	5,739,864	11,790,607	6,497,540	24,028,010
Palestine	85,423	145,710	34,674	265,806	80,286	124,795	23,519	228,600	165,709	270,505	58,193	494,406
Papua New Guinea	109,579	163,314	71,970	344,864	108,555	154,667	65,201	328,423	218,134	317,981	137,171	673,287
Philippines	1,589,286	2,837,035	1,678,170	6,104,492	1,376,130	2,296,655	1,150,852	4,823,637	2,965,416	5,133,690	2,829,022	10,928,129
Rwanda	36,272	81,406	39,262	156,939	29,308	58,607	27,668	115,582	65,580	140,013	66,930	272,521
Timor-Leste	28,752	36,150	15,269	80,170	24,431	30,912	13,336	68,678	53,183	67,062	28,605	148,848
Vietnam	1,494,243	3,183,845	1,884,933	6,563,021	1,365,151	2,703,444	1,369,748	5,438,343	2,859,394	5,887,289	3,254,681	12,001,364
All countries	25,958,589	63,441,646	70,170,185	159,570,419	23,253,427	51,743,961	48,241,379	123,238,764	49,212,016	115,185,607	118,411,564	282,809,183

Table 18: Presbyopia, patients treated, 2021 to 2030

	Female				Male				Persons			
	<15	15-49	50 and over	Total	<15	15-49	50 and over	Total	<15	15-49	50 and over	Total
Afghanistan	1,020	64,021	288,941	353,982	1,801	63,263	252,287	317,350	2,821	127,284	541,228	671,332
Bangladesh	7,550	2,016,498	6,016,097	8,040,146	13,374	1,768,785	5,418,112	7,200,271	20,924	3,785,283	11,434,209	15,240,417
Burundi	796	78,708	216,474	295,979	1,261	70,392	170,702	242,354	2,057	149,100	387,176	538,333
Cambodia	428	80,715	387,777	468,920	742	68,106	244,894	313,742	1,170	148,821	632,671	782,662
China	25,323	10,264,062	81,796,019	92,085,405	48,337	9,494,256	65,646,494	75,189,087	73,660	19,758,318	147,442,513	167,274,492
Eritrea	194	24,976	80,992	106,162	341	23,015	65,592	88,948	535	47,991	146,584	195,110
Ethiopia	4,437	385,531	1,877,020	2,266,987	7,341	354,763	1,542,100	1,904,204	11,778	740,294	3,419,120	4,171,191
Indonesia	4,313	589,197	5,394,565	5,988,076	7,587	526,730	4,106,505	4,640,822	11,900	1,115,927	9,501,070	10,628,898
Kenya	1,942	211,015	876,117	1,089,073	3,234	185,327	664,118	852,679	5,176	396,342	1,540,235	1,941,752
Lao PDR	183	24,979	132,617	157,779	325	22,647	106,317	129,290	508	47,626	238,934	287,069
Myanmar	1,127	195,173	1,493,883	1,690,184	1,953	157,384	949,222	1,108,560	3,080	352,557	2,443,105	2,798,744
Nepal	2,100	947,149	1,968,944	2,918,194	3,765	635,008	1,512,700	2,151,473	5,865	1,582,157	3,481,644	5,069,667
Pakistan	10,812	1,521,468	4,890,090	6,422,370	17,416	1,412,585	4,379,033	5,809,034	28,228	2,934,053	9,269,123	12,231,404
Palestine	123	8,229	42,752	51,104	202	7,864	36,011	44,077	325	16,093	78,763	95,181
Papua New Guinea	270	30,364	151,874	182,508	463	28,284	126,155	154,902	733	58,648	278,029	337,410
Philippines	2,048	218,239	1,989,170	2,209,457	3,625	200,180	1,343,358	1,547,163	5,673	418,419	3,332,528	3,756,620
Rwanda	712	91,149	310,138	401,999	1,138	76,277	248,308	325,723	1,850	167,426	558,446	727,722
Timor-Leste	42	3,690	21,886	25,618	69	3,375	17,848	21,292	111	7,065	39,734	46,910
Vietnam	1,758	359,680	3,237,008	3,598,446	3,165	318,593	2,182,329	2,504,087	4,923	678,273	5,419,337	6,102,533
All countries	65,178	17,114,843	111,172,364	128,352,389	116,139	15,416,834	89,012,085	104,545,058	181,317	32,531,677	200,184,449	232,897,447

Table 19: Presbyopia, years of sight saved, 2021 to 2030

	Female				Male				Persons			
	<15	15-49	50 and over	Total	<15	15-49	50 and over	Total	<15	15-49	50 and over	Total
Afghanistan	3,151	107,014	186,233	296,399	3,052	95,616	151,840	250,508	6,203	202,630	338,073	546,907
Bangladesh	24,521	3,821,355	5,685,248	9,531,124	23,435	3,100,836	4,530,630	7,654,901	47,956	6,922,191	10,215,878	17,186,025
Burundi	2,386	126,135	151,184	279,706	2,171	103,505	110,339	216,015	4,557	229,640	261,523	495,721
Cambodia	1,358	140,162	271,839	413,359	1,286	107,596	162,787	271,669	2,644	247,758	434,626	685,028
China	84,168	19,779,312	71,691,427	91,554,907	88,850	17,127,848	52,300,058	69,516,756	173,018	36,907,160	123,991,485	161,071,663
Eritrea	607	41,828	59,454	101,888	579	34,266	43,510	78,355	1,186	76,094	102,964	180,243
Ethiopia	13,914	681,450	1,337,179	2,032,544	13,100	576,685	1,028,020	1,617,805	27,014	1,258,135	2,365,199	3,650,349
Indonesia	13,892	1,069,329	3,883,326	4,966,547	13,254	860,530	2,651,664	3,525,448	27,146	1,929,859	6,534,990	8,491,995
Kenya	6,058	357,104	649,006	1,012,168	5,427	276,768	442,221	724,417	11,485	633,872	1,091,227	1,736,585
Lao PDR	582	43,074	92,528	136,183	563	34,671	67,117	102,351	1,145	77,745	159,645	238,534
Myanmar	3,514	320,121	989,118	1,312,752	3,055	224,566	566,321	793,942	6,569	544,687	1,555,439	2,106,694
Nepal	6,783	1,683,699	1,822,306	3,512,788	6,346	1,029,678	1,215,453	2,251,476	13,129	2,713,377	3,037,759	5,764,264
Pakistan	33,340	2,488,946	3,499,745	6,022,031	30,667	2,157,789	3,032,635	5,221,091	64,007	4,646,735	6,532,380	11,243,122
Palestine	401	15,831	33,094	49,326	379	13,812	24,852	39,042	780	29,643	57,946	88,368
Papua New Guinea	809	45,420	90,180	136,409	757	39,114	73,290	113,161	1,566	84,534	163,470	249,570
Philippines	6,535	404,340	1,478,792	1,889,667	6,141	310,944	839,343	1,156,428	12,676	715,284	2,318,135	3,046,095
Rwanda	2,275	164,478	247,927	414,681	2,090	124,348	178,688	305,125	4,365	288,826	426,615	719,806
Timor-Leste	133	6,457	14,880	21,470	123	5,337	11,192	16,652	256	11,794	26,072	38,122
Vietnam	5,766	709,512	2,696,973	3,412,250	5,716	552,428	1,674,131	2,232,275	11,482	1,261,940	4,371,104	5,644,525
All countries	210,193	32,005,567	94,880,439	127,096,199	206,991	26,776,337	69,104,091	96,087,417	417,184	58,781,904	163,984,530	223,183,616

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APPENDIX

COSTS OF INTERVENTIONS

Cost per cataract surgery and pair of glasses provided were calculated using country specific costs of each input required to deliver (i.e. intervention costs) and manage (i.e. program costs) these services using an ingredients-based approach[4]. These costs included:

- **Staff time** - valued at country specific total wage rates from most recent official government documentation available in most countries. Where this data was not available the WHO-CHOICE method of ratios of GDP per capita was used (Serje et al 2018)
- **Allowances for staff (travel and meetings)** - obtained from each country using official government travel and subsistence allowance rates or provided and verified by The Foundation's implementing partners in each country.
- **Equipment and supplies** – with standard requirements per 1000 interventions taken from IAPB essential lists and prices taken from essential lists of relevant countries, The Foundation's implementing partners in relevant country and/or global review.
- **Other inpatient/outpatient costs** – from country-specific cost analysis where available or WHO-CHOICE costs inflated to 2021 dollars applied to days/visits obtained from literature review, FHF-specific studies, program documents, or The Foundation's implementing partners and medical advisers.

Table 13: Cost by intervention type (2021 USD)

Intervention	Type	Delivery platform	Median cost	Range
Eye screening	Basic	Static health centre	$ 1.20	$ 0.60 – $4
		Outreach	$3.00	$1 - $43
Eye exam	Comprehensive	1st level vision centre & 2nd level eye unit	$8	$3 – $20
Cataract surgery	SICS	Static –2nd level hosp	$135	$68 – $463
		Outreach to 1st level hosp	$165	$75 – $615
	Phaco	Static – 2nd & tertiary level hosp	$178	$81 – $825
Refractive error (per glasses distributed)	Distance	Static – vision centre (1st level)	$46	$13 – $162
	Distance	School Eye Health	$110	$49 – $314

[4] An ingredients-based (or bottom-up) method identifies and values each resource used for a particular intervention (see WHO guidance on ingredients-based costing (https://www.who.int/teams/health-systems-governance-and-financing/economic-analysis/costing-and-technical-efficiency/quantities-and-unit-prices-(cost-inputs)/programme-costs-in-the-economic-evaluation-of-health-interventions))

Costs of identifying and diagnosing those requiring intervention were included based on the average ratio of screenings and comprehensive eye exams conducted per cataract surgery and per pair of glasses distributed (by country) taken from FHF programmatic data.

Program management activities were taken from national or global guidelines and FHF programming documentation with input costs as above. These costs were divided by the average country specific number of interventions delivered per facility per year to obtain a per intervention cost. Resulting costs per intervention are provided in Table 14.

This shows in general, as may be expected, higher costs in East and Southeast Asia, followed by South Asia and then Africa. Refractive error costs in Africa tend to be higher than other regions due to lower prevalence and therefore greater numbers of screenings per individual identified, as well as higher commodity prices faced of lenses and frames compared with South Asia.

Table 14: Cost per intervention delivered by region (2021 USD)

Fred Hollows Foundation Region	Per cataract surgery	Per glasses provided
East and Southeast Asia (including China)	$338	$180
Southeast Asia (excluding China)	$218	$178
South Asia / Middle East	$161	$80
Africa	$113	$130
Across regions (including China)	$219	$131
Across regions (excluding China)	$167	$128

Costs of cataract surgery are driven by type and cost of IOL provided, days in hospital after surgery (each incurring a per inpatient day cost) and, to a lesser degree, the cost of other surgical consumables. Costs of refractive error correction with glasses tend to be driven by low utilisation, particularly of public sector static facilities but with high fixed costs (e.g. equipment), both for refraction and dispensing. Scale up investments in human resources and equipping of new units was estimated calculated at 10 – 20% of intervention cost, depending on the size of the gap between facilities and human resource current levels and targets. In addition, a markup of 15% was added to the unit costs to account for a total health system unit cost estimate.

REVIEW OF COSTS OF TREATMENT

The Lancet Commission identified 148 health economic studies of vision impairment of which 96 were for high income countries (Bourne et al 2021, Supplementary Table 15). Many of these studies estimate the cost of VI in terms of lost productivity and health care costs. The Commission reviewed 10 cost effectiveness studies for cataract surgery, two for refractive error and one study for both.

These studies form the base for finding the costs of cataract surgery and refractive error and were supplemented by a literature search using Google Scholar, Google and PubMed using the terms "cost", "cost effectiveness" and "cost benefit" in combination with "vision impairment", "cataract", "refractive error", "myopia" and "presbyopia" globally and in combination with names of the 21 countries in which The Fred Hollows Foundation has a presence.

A number of these studies report results for multiple countries, mostly for high income countries.

Cataract surgery

Baltussen et al (2004) calculated the cost effectiveness of ICCE and ECCE for 14 WHO regions in terms of cost per DALY averted but not the unit cost of cataract surgery.

Lansingh, Carter and Martens (2007) undertook a meta-analysis of studies to determine the cost-effectiveness of cataract surgery worldwide. The search was restricted to the years 1995 through 2006. Cataract surgery costs were converted to 2004 United States dollars (US$). They reported the cost of cataract surgery for 13 mainly high income countries. The results for low and middle income countries are shown in Table 15.

Table 15: Cost of cataract surgery by country, year, and method

Country	Year	PHACO	SICS	ECCE	Reference
Brazil	2000	264			Filho et al
India	2000	27.2	18.5	17.7	Muralikrishnan et al
India	2004		15.5	15.7	Gogate et al
Malaysia	2000	1252		1007	Loo et al
Malaysia	2001	565		475	Rizal et al
Nepal	1992			28.9	Marseille
Nepal	1997			23.2	Ruit et al
Tanzania	2004			13.8	Lewallen et al

Source: Lansingh, Carter and Martens (2007)

Lansingh and Carter (2009) reviewed 36 studies to determine the cost utility of cataract surgery worldwide. The results in 2004 US dollars for low and middle income countries for the year 2000 and later are in Table 16.

Griffiths et al (2014) estimated the cost effectiveness of cataract surgery and refractive error/presbyopia correction in Zambia based on data from three eye care centres. The mean costs per patient of cataract surgery in 2010 US$ were 111, 49, and 76 for an average of 79. For refractive error the costs were 70, 21, and 66 for an average of 52.

Table 16: Cost of cataract surgery by country, year, and method

		PHACO	SICS	ECCE	Unspecified	Reference
Brazil	2000	264				Saad Filho et al 2005
China	2001				Rural: 533-666b	He et al 2007
China	2006				Rural: 187-281; PR: 356-469; city: 590-937	Tan 2006
China	2006				292-936	Lin 2007
Ethiopia	2004				GOV: 23.5; city: 353; rural: 60	Melese et al 2004

India	2000	27.7	18.5	17.7		Muralikrishnan et al 2004
India	2004		15.5	15.7		Gogate et al 2003
India	2004	47.5	20.8			Gogate et al 2007
Kenya	2006				94	Lewallen et al 2006
Malaysia	2000	1252		1007		Loo et al 2004
Malaysia	2001	565		475		Rizal et al 2003
Uganda	2006				94	Lewallen et al 2006
Zimbabwe	2006				94	Lewallen et al 2006

Source: Lansingh and Carter (2009)

In a follow up study, Griffiths et al (2015) compared the mean costs of cataract surgery and refractive error correction at Lusaka Eye Hospital with cost in other countries. The mean cost per patient, in 2010 US$ for low and middle income countries is shown in Table 17

Table 17: Cost of cataract surgery by country, year, and method

		PHACO	SICS	ECCE
China	2009	536, 1293*		
India	2002		25	25
India	2001	43	29	
Thailand	2006	351	304	

* County, provincial hospital
Source: Griffiths et al (2015)

Khan et al (2015) calculated the cost of cataract surgery in Aligarh, Uttar Pradesh, India in 2012–2013. The costs of PHACO and SICS were 7825 and 4994 Indian rupees or 142.6 and 91.0 US dollars at an exchange rate of 54.88 rupees per dollar.

Wulandari et al (2020) and Rochmah et al (2020) estimated the average direct costs of cataract surgery at Rumah Sakit Mata Undaan Eye Hospital, Surabaya, Indonesia in 2019 for PHACO and SICS as 9,479,319 and 9,332,000 Indonesian rupiah or 659 and 649 US dollars at an exchange rate of 14,383 rupiah per dollar.

Saad et al (2020) calculated the cost of PHACO at Universidade de São Paulo, Brazil performed by third year residents in 2011 and compared this with the cost of ECCE performed in 1997. The mean cost of PHACO was US$ 416 ± 112 (US$ 178- 879) and the estimated ECCE value was US$ 284. They also comment that similar studies conducted at Escola Paulista de Medicina (EPM), Universidade Federal de São Paulo (UNIFESP) and University of São Paulo Hospital (HCFM-USP) reported lower costs for PHACO and for ECCE: At EPM the mean intraoperative cost of ambulatory cataract surgery for PHACO was US$ 231, which was 36.5% higher than the cost for ECCE (US$ 169)(13). While at University of São Paulo Hospital (HCFM-USP), the difference in cost between surgeries was 70%, being US$ 231 for PHACOs and US$ 136 for ECCEs.

Deshpande, Deshpande and Amale (2017) examined the records of 600 patients at a private hospital in Nagpur, India and calculated the costs of PHACO and SICS as 30670 and 20720 Indian rupees or 413 and 279 US dollars at an exchange rate of 74.34 rupees per dollar

Le et al (2016) estimated the costs of cataract surgery at Aravind Eye Hospital–Madurai, India in July 2013 as USD 62.72 and 95.37 (2016 $US) for surgery based on the most common IOL cost and mean IOL cost respectively.

Jongsareejit et al (2012) compared the costs and effectiveness of PE and SICS of cataract patients at Phrapoklao Hospital, Chuntaburee province, Thailand in 2005 and 2006. The average costs of PHACO and MSCIS were 11,454.15 and 9,940.07 Thai baht or 348 and 302 US dollars at 32.96 Thai Baht per dollar.

Habtamu, Eshete and Burton (2013) calculated the costs of cataract surgery in the Southern Nations Nationalities and Peoples' Region (SNNPR) in Ethiopia in 2011. They found that the average provider cost of cataract surgery in 2010 was US$141.6 (Range: US$37.6–312.6).

Niyonzima et al (2015) reported that cost in of PHACO and SICS in Burundi in public and private hospitals in 2013 to 2016 in US$ as follows

Table 18: Costs of cataract surgery in Burundi by method and provider type

	Public	Private
SICS	45.5	162.3
PHACO	162.3	260

Source: Niyonzima et al (2015)

Islam et al (2019) estimated the costs of cataract surgery in eye care facilities in Dhaka, Bangladesh. For SICS using PMMA intraocular lens manufactured in India the cost was 5000 to 6500 Bangladeshi taka or 62 to 80 USD, while for Phacoemulsification surgery using PMMA intraocular lens manufactured in India the costs were 10000 to 16500 Bangladeshi taka or 123 to 203 USD.

Dieu (2016) quotes the cost in Angiang province in the south west of Vietnam of ECCE with posterior intraocular lens as USD30 to USD50 and of PHACO as USD 50 to USD 100.

The Nayan Eye Centre (2021) in Kolkata, India states that the cost for a Topical Phaco Foldable IOL surgery ranges from 12,500 123,000 India rupees or 168.1 to 1,654.6 USD at 74.34 India rupees per US dollar.

The Renuka Eye Institute (2021) in Kolkata, India states that the cost of PHACO ranges from 6,800 to 70,000 Indian rupees or 92 to 492 USD.

According to Seedi Eye Care Centre (2021), the cost of cataract eye surgery in Bangalore usually varies between 20,000 - 65,000 INR for each eye.

Eye Health Nepal (2021) states that in a non-governmental organization run hospital in Nepal phacoemulsification cataract surgery generally starts from NRs 10-12,000 includes surgery cost and regular foldable IOLs and in private clinics, it may cost higher. This is equivalent to 84 to 101 USD at 119 Nepalese rupees per US dollar.

The Aga Khan University Hospital (2021) in Hyderabad in Pakistan quotes cataract surgery prices from 22,000 to 53,000 Pakistani rupees or 133 to 231 US dollars at 165 Pakistani rupees per US dollar.

Table 19 summarises the results from these studies.

Table 19: Cost of cataract surgery, summary of studies (US dollars)

Country	Status	Year	PHACO	SICS	ECCE	Unspecified	Reference
Bangladesh	Lower	2015	123-203	62-80			Islam et al (2019)
Brazil	Upper	2000	264				Lansingh, Carter and Martens (2007)
Brazil	Upper	2011	416	284			Saad et al (2020)
Brazil	Upper	2011	231	169			Saad et al (2020)
Brazil	Upper	2011	231	136			Saad et al (2020)
Burundi	Low	2016	162	45			Niyonzima et al (2015)

Burundi	Low	2016	260	162			Niyonzima et al (2015)
China	Upper	2001				Rural: 533-666b	Lansingh and Carter (2009)
China	Upper	2006				Rural: 187-281; PR: 356-469; city: 590-937	Lansingh and Carter (2009)
China	Upper	2006				292-936	Lansingh and Carter (2009)
China	Upper	2009	536, 1293*				Griffiths et al (2015)
Ethiopia	Low	2004				GOV: 23.5; city: 353; rural: 60	Lansingh and Carter (2009)
Ethiopia	Low	2010	142				Habtamu, Eshete and Burton (2013)
India	Lower	2000	28	19	18		Lansingh and Carter (2009)
India	Lower	2004		16	16		Lansingh and Carter (2009)
India	Lower	2004	48	21			Lansingh and Carter (2009)
India	Lower	2002		25	25		Griffiths et al (2015)
India	Lower	2001	43	29			Griffiths et al (2015)
India	Lower	2012	143	91			Khan 2015
India	Lower	2017	413	279			Deshpande, Deshpande and Amale (2017)
India	Lower	2013	63				Le et al (2016)
India	Lower	2013	95				Le et al (2016)
India	Lower	2021	168-1655				Nayan Eye Centre (2021)
India	Lower	2021	92-492				Renuka Eye Institute (2021
India	Lower	2021	269-874				Seedi Eye Care Centre (2021)
Indonesia	Upper	2019	659	649			Wulandari et al (2020)
Kenya	Lower	2006				94	Lansingh and Carter (2009)
Malaysia	Upper	2000	1252		1007		Lansingh and Carter (2009)
Malaysia	Upper	2001	565		475		Lansingh and Carter (2009)
Nepal	Lower	2021	84-101				Eye Health Nepal (2021)
Pakistan	Lower	2021	133-231				Aga Khan University Hospital (2021)
Tanzania	Lower	2004			14		Lansingh, Carter and Martens (2007)
Thailand	Upper	2006	351	304			Griffiths et al (2015)
Thailand	Upper	2006	348	302			Jongsareejit et al (2012)
Uganda	Low	2006				94	Lansingh and Carter (2009)
Viet Nam	Lower	2016	50-100		30-50		Dieu (2016)
Zimbabwe	Lower	2006				94	Lansingh and Carter (2009)

The average cost of cataract surgery based on the values in Table 19 are shown in Table 20 and Table 21. Here the averages are based on country income status. The first two columns are based on those countries in Table 19 in which The Fred Hollows Foundation has a presence and are included in the modelling. The second two columns are based on all countries in Table 19.

Table 20: Average cost of cataract surgery (PHACO) by income status (US dollars)

	FHF lower	FHF upper	All lower	All upper
Low income	188	188	188	188
Lower middle	97.5	158.75	125.15	320.65
Upper middle	597.5	976	485.3	561

Table 21: Average cost of cataract surgery (SICS) by income status (US dollars)

	FHF lower	FHF upper	All lower	All upper
Low income	103.5	103.5	207	207
Lower middle	62	80	67.75	70
Upper middle	976	597.5	307	307

ECONOMIC IMPACTS OF VISUAL IMPAIRMENT- CCOPING THE LITERATURE

A study by Access Economics for AMD Alliance International (Access Economics 2010, Gordois et al 2012) estimated the direct health care costs of VI to be $2.3 trillion in 2010, with an expected dead-weight loss (DWL) of $238 billion, productivity loss of $168 billion and an estimated informal care burden of $246 billion. In total, the global cost of was estimated as $3.0 trillion. This study also incorporated the cost of mortality associated with VI.

Smith et al (2009) estimated the potential global economic productivity loss associated with the burden of VI from uncorrected refractive error (URE). Based on 158.1 million cases of VI resulting from uncorrected or undercorrected refractive error in 2007; they estimated the global economic productivity loss in international dollars (I$) associated with this burden at I$ 427.7 billion before, and I$ 268.8 billion after, adjustment for country-specific labour force participation and employment rates. With the same adjustment, but assuming no economic productivity for individuals aged 50 years and over they estimated the potential productivity loss at I$ 121.4 billion.

In calculating productivity loss, Smith et al (2009) first estimate the prevalence of VI from uncorrected refractive error, by degree of VI. They multiply this by PPP-adjusted GDP per capita and use a disability weight to adjust for reduced productivity, which is further adjusted for labour force participation rate and employment rates. In addition, the authors assume that each person with VI requires care from an adult and that this person had their productivity reduced by 10% in the case of blindness and 5% for MS VI. The authors recognise that the study has a number of limitations, importantly that the assumed disability weight is an accurate measure of reduced productivity.

Fricke et al (2012) used the same estimates of the burden of VI to estimate that the cost of educating the additional personnel and of establishing, maintaining and operating the refractive care facilities needed to address this burden was estimated to be around US$20 billion and the upper-limit cost was US$28 billion. The authors argue this cost is small compared to the productivity losses calculated by Smith et al (2009). Using a similar approach, Naidoo et al (2019) estimate the potential lost productivity from VI as 2015 US$244 billion from uncorrected myopia, and US$6 billion from myopic macular degeneration. They argue that even under conservative assumptions, the potential productivity loss associated with VI and blindness resulting from uncorrected myopia is substantially greater than the cost of correcting myopia.

In a similar study, Frick et al (2015) estimate that the potential productivity loos from uncorrected presbyopia in 2011 was US$11.0 billion for people aged <50 years, and US$25.4 billion for people aged <65 years.

Armstrong et al (2012) estimated the cost of eliminating avoidable blindness over the period 2011 to 2020 at $632 billion per year at 2009 prices, or an additional $40 billion per year compared to actual expenditure of $592 billion.

Bastawrous and Suni (2019) estimated the global, regional and country-level productivity gains up to 2030, 2040 and 2050 from known effective interventions for treating VI, primarily cataract surgery and treated uncorrected refractive errors. For the period 2018 to 2050, they estimated that the total global productivity gains from treating avoidable blindness, moderate and severe VI (MSVI) and presbyopia is around US$19 trillion over a period of 2018–2050. Productivity gains from MSVI, averted blindness and averted uncorrected presbyopia were US$17 trillion, US$984 billion and between US$907 billion and US$1.05 trillion, respectively. The authors argue that the estimated benefits far outweigh the costs reported by Armstrong et al (2012) and Fricke et al (2012).

In 2012, PWC undertook a study for The Fred Hollows Foundation and others (PWC 2013) on the costs and benefits of VISION 2020 - the global initiative for the elimination of avoidable blindness and VI. They estimated the value of productivity gains for those of working age (15-65), deadweight loss, and health systems savings from fewer co-morbidities (such as falls), to be at least US$843.5 billion over the 10 years from 2011 to 2020 compared to costs of US$394.2 billion, or a benefit cost ratio of 2.1. In developing countries, they estimated the total benefits to be at least $517.1 billion (2009 USD) with cost of $128.2 billion (2009 USD), a benefit cost ratio of 4.0.

PRESENTING DISTANCE VISUAL ACUITY CLASSIFICATIONS

Table 22: International Classification of Diseases 11, 9D90 vision impairment including blindness

Category	Presenting distance visual acuity	
	Worse than:	**Equal to or better than:**
0 No vision impairment		6/12 5/10 (0.5) 20/40
1 Mild vision impairment	6/12 5/10 (0.5) 20/40	6/18 3/10 (0.3) 20/70
2 Moderate vision impairment	6/18 3/10 (0.3) 20/70	6/60 1/10 (0.1) 20/200
3 Severe vision impairment	6/60 1/10 (0.1) 20/200	3/60 1/20 (0.05) 20/400
4 Blindness	3/60 1/20 (0.05)	1/60* 1/50 (0.02)

		5/300 (20/1200) or counts fingers (CF) at 1 metre
5 Blindness	1/60* 1/50 (0.02) 5/300 (20/1200)	Light perception
6 Blindness	20/400 No light perception	
9	Undetermined or unspecified	
Near visual acuity	N6 or M 0.8 with existing correction	

Source WHO 2020

PRE-TREATMENT VISUAL ACUITY AND POST-TREATMENT OUTCOME

Data collected through The Foundation's implementing Partners was used to estimate the number of individuals treated by pre-visual acuity, as well as the treatment outcomes included in the eye health model.

Where multiple Partners provided data, an average was taken to estimate the proportions of individuals in each cohort. Where specific data was not available (e.g. through lack of record keeping or established health information management systems collecting clinical data) the best estimates of key stakeholders from Partners were provided, in consultation with representatives of The Foundation's medical team.

The number of implementing partners in some countries included in the model is very small. Hence, data below is provided at the regional level to protect commercially private data. Table 23 shows the average and ranges for pre-visual acuity and post-treatment outcome for cataract surgery, by region, for the 19 countries included in the eye health model.

Table 23: Average and ranges for pre-visual acuity and post-treatment outcome for cataract surgery, by region

Region	Variable	Pre-VA				Post-treatment outcome		
		<3/60	<6/60	6/60-6/18	>=6/18	Good	Border	Poor
East Asia	**Median value**	29%	59%	11%	1%	80%	17%	2%
	Range	-	-	-	-	-	-	-
North Africa and Middle East	**Median value**	74%	19%	6%	0	62%	20%	18%
	Range	73 - 75%	14 - 25%	2 - 11%	0	54 - 70%	16 - 23%	14 - 22%
Oceania	**Median value**	44.0%	30.0%	14.0%	12.0%	62%	23%	15%
	Range	-	-	-	-	-	-	-
South Asia	**Median value**	53%	20%	27%	0	76%	15%	8%

	Range	35 - 53%	20 - 47%	18 - 27%	0	61 - 89%	9 - 16%	2 - 24.3%
Southeast Asia	**Median value**	50%	26%	14%	2%	67%	15%	15%
	Range	40 - 76%	14 - 50%	7 - 24%	0 - 12%	39 - 83%	13 - 44%	3 - 22%
Sub-Saharan Africa	**Median value**	65%	19%	11%	0	54%	19%	28%
	Range	41 - 75%	14 - 32%	3 - 40%	0	27 - 68%	16 - 44%	13 - 44%

Source: FHF implementing partner data

ASSOCIATION BETWEEN VISION IMPAIRMENT AND MORTALITY

As part of the Lancet Commission, Ehrlich et al (2021) examined the association between VI and mortality through a systematic review and meta-analysis. They identified 28 studies for the systematic review and included 17 studies in their meta-analysis.

The results of the meta-analysis are summarized in Table 24, which shows how the hazard ratio varies depending in the levels of visual acuity being compared. As visual acuity declines the hazard of mortality increases, with those less than 6/12 having a 29% higher hazard than those with 6/12 or better.

Table 24: Association between vision impairment and mortality

Level of visual acuity	Comparison	Hazard ratio	Number
Maximally adjusted			
<6/12	>=6/12	1.29	15
<6/18	>=6/18	1.43	2
<6/60	>=6/18	1.89	1
<6/60	>=6/60	1.02	2
Minimally adjusted			
<6.12	>=6/12	1.41	15

Source: Ehrlich et al 2021

An earlier meta-analysis by Zhang et al (2016) included 29 prospective studies to summarise the evidence about the association between VI and the risk of mortality. They found that compared to no VI, the highest VI level was significantly associated with an increased risk of mortality (RR: 1.36, 95% CI 1.25 to 1.46). The association remained significant in participants older than 65 years (RR: 1.28, 95% CI 1.18 to 1.39), and a significant association was also observed in men (RR: 1.29, 95% CI 1.07 to 1.54) and women (RR: 1.39, 95% CI 1.14 to 1.70), respectively. For dose–response analysis, a linear relation was found between visual acuity (VA) and the risk of mortality. For every 0.1 Logarithm of the Minimum Angle of Resolution (LogMAR) increment, the risk of mortality increased by 4% (RR: 1.04, 95% CI 1.01 to 1.06).

In her commentary on this article, Bruce (2016) reflected on the heterogeneity of results from a number of different studies.

A number of other studies not included in these reviews also reported on the association between VI and mortality.

The Melbourne Visual Impairment Project (VIP) found among a sample of Melbourne residents aged 40 years and older after five year follow up in 1997, that even mild vision impairment increased the risk of death more than twofold (McCarty 2001).

Brunes et al (2017) examined the associations of self-reported vision impairment and physical activity (PA) with all-cause mortality among 65,236 Norwegians aged ⩾20 years who had participated in the Nord-Trøndelag Health Study (HUNT2, 1995−1997). They found that after a mean follow up of 14.5 years, 13,549 deaths were identified. Compared with adults with self-reported no VI, the multivariable hazard ratios among adults with self-reported VI were 2.47 (95% CI 1.94–3.13) in those aged <60 years, 1.22 (95% CI 1.13–1.33) in those aged 60–84 years and 1.05 (95% CI 0.96–1.15) in those aged ⩾85 years. The strength of the associations remained similar or stronger after additionally controlling for physical activity.

Liu et al (2017) explored the association of vision with mortality in 1,257 Indigenous Australians over the age of 40 years who were patients from The Central Australian Ocular Health Study and followed up during a 10-year period. They found that reduced visual acuity was associated with increased mortality rate (5% increased mortality per one line of reduced visual acuity; $t = 4.74$; $P < 0.0001$) after adjustment for age, sex, diabetes and hypertension.

Sun, Li and Sun (2020) examined how sensory impairment is associated with the risk of all-cause mortality among 37,076 elderly adults in the Chinese Longitudinal Healthy Longevity Survey. Compared with participants without sensory impairment, those with VI (HR=1.20, 95% CI: 1.15-1.24), had a significantly higher risk of all-cause mortality after adjusting for potential confounders.

Similarly, Wang et al (2020) explored associations between VI and mortality in adult participants in the Liwan Eye Study, a population-based prevalence survey conducted in Guangzhou, Southern China in 2003. At 10-year follow up of visually impaired participants had a significantly increased 10-year mortality compared with those without VI (40.0% vs. 17.2%, $P < 0.05$). After adjusting for age, gender, income, educational attainment, BMI, history of diabetes and hypertension, both VI (HR, 1.55; 95% CI, 1.14–2.11) and non-correctable VI (HR, 2.72; 95% CI, 1.86–3.98) were significantly associated with poorer survival, while correctable VI (HR, 0.99; 95% CI, 0.66–1.49) was not an independent risk factor for 10-year mortality.

Table 25: Cataract surgical rate and cataract surgical coverage, by year last reported

	CSR	Year Last Reported	CSC % at level 3/60	CSC % at level 6/18	Year Last Reported
Afghanistan	717	2014			
Australia	7,202	2014			
Bangladesh	1,193	2014			
Burundi	247	2014			
Cambodia	1,844	2015	54	24	2007
China	1,402	2015			
Eritrea			60	40	2008
Ethiopia	434	2010			
Indonesia	1,411	2014			
Kenya	494	2014			
Lao PDR	888	2014	55	22	2007
Myanmar	1,978	2015			
Nepal	4,364	2015	85	55	2009
Pakistan	2,819	2014	77	44	2006
Palestine			83	54	2008
Papua New Guinea	196	2014			
Philippines	1,485	2014			
Rwanda	483	2015	68	44	2015
Timor-Leste	784	2014	46	21	2016
Viet Nam	2,435	2014	67	39	2007

Source: IAPB 2020a.

Table 26: Effective cataract surgical coverage estimates, by country, year of study, number of participants, and gender

			CSC persons <6/60 %			eCSC persons <6/60 %		
Country	Year of study	Participants	Women	Men	Total	Women	Men	Total
Bangladesh	2005	4,868	51.0	48.9	50.2	33.8	37.2	35.1
Cambodia	2011/12	4,471	42.7	46.2	43.6	33.6	37.4	34.6
Eritrea	2008	3,163	53.4	58.5	55.7	27.9	29.3	28.5
Kenya	2011	3,124	57.7	78.7	66.1	42.3	60.0	49.5
Pakistan	2013	3,084	88.2	88.6	88.4	67.6	74.6	71.3
Philippines	2006	3,177	46.5	48.1	46.9	33.7	48.1	37.2
Vietnam	2007	1,787	33.8	46.9	38.0	25.0	31.3	27.0

Source: Ramke et al 2017 al 2022

Table 27: Nominal and effective cataract surgical coverage (adjusted <6/18 (%)) by country and year

	Year	CSC	CSC	CSC	eCSC	eCSC	eCSC
			Male	Female		Male	Female
Bangladesh	2005	30·8	31.5	30.2	21·4	22.6	20.3
Burundi	2010	9·3	8.0	9.9	7·6	8.0	7.4
Cambodia	2012	21·5	21.4	21.6	15·6	16.1	15.4
China	2015-2017	55·2	55.8	54.2	34·8	37.5	33.3
Ethiopia	2021	33·3	39.6	29.5	18·5	21.8	16.5
Indonesia	2013-2016	26·2	31.0	22.9	19·0	22.5	13.4
Kenya	2011	40·0	48.2	33.7	26·7	31.0	23.5
Nepal	2018-2021	69·2	71.6	70.7	57·6	58.2	56.5
Pakistan	2015-2016	55·4	61.9	57.6	34·9	38.4	32.1
Palestine	2008	57·6	60.9	55.3	32·9	40.2	27.5
Papua New Guinea	2017	27·4	33.9	21.0	17·0	23.3	11.0
Philippines	2005-2006	25·7	26.9	25.3	18·8	20.2	18.1
Rwanda	2015	45·2	46.8	44.4	33·9	35.6	33.2
Timor-Leste	2016	23·3	33.1	15.2	15·3	19.9	11.5
Vietnam	2015	37·4	36.5	38.0	24·8	29.5	24.8

Source: McCormick et al (2022)

BENEFITS FROM INCREASED LABOUR FORCE PARTICIPATION BY WORKING AGE CARERS

Caring arrangements

There is very little evidence on the extent and nature of paid or unpaid caring arrangements in the community generally and especially for patients with VI.

The United Nations has developed the International Classification of Activities for Time Use Statistics (ICATUS) as a classification of all the activities a person may spend time on during the 24 hours in a day (UN Statistics Division 2019). Its purpose is to serve as a standard framework for time-use statistics based on activities grouped in a meaningful way. It has been developed based on internationally agreed concepts, definitions and principles in order to improve the consistency and international comparability of time use and other social and economic statistics. Reliable time use statistics have been critical for (a) the measurement and analysis of quality of life or general well-being; (b) a more comprehensive measurement of all forms of work, including unpaid work and non-market production and the development of household production accounts; and (c) producing data for gender analysis for public policies. Additionally, ICATUS serves as an important input for monitoring progress made towards the achievement of the Sustainable Development Goals (SDGs) and targets, including target 5.4 which aims at “recogniz[ing] and valu[ing] unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate” and the related SDG indicator 5.4.1 on the proportion of time spent on unpaid domestic and care work, by sex, age and location.

Division 4 of ICATUS concerns unpaid caregiving services for household and family members. Section 42 covers care for dependent adults while sections 44 and 49 are also relevant (Table 28).

Table 28: International Classification of Activities for Time Use Statistics, Division 4

			Description
4			Unpaid caregiving services for household and family members
	42		Care for dependent adults
		421	Assisting dependent adults with tasks of daily living
		422	Assisting dependent adults with medical care
		423	Assisting dependent adults with forms, administration and accounts
		424	Affective/emotional support for dependent adults
		425	Passive care of dependent adult
		426	Meetings and arrangements with adult care service providers
		429	Other activities related to care for dependent adults
	44		Travelling and accompanying goods or persons related to unpaid caregiving services for household and family members
		441	Travelling related to caregiving services for household and family members
		442	Accompanying own children
		443	Accompanying dependent adults
		444	Accompanying non-dependent adult household and family members
	49		Other activities related to unpaid caregiving services for household and family members

	490	Other activities related to unpaid caregiving services for household and family members

Source: UN Statistics Division 2019

Although ICATUS and its variants provide a framework for gathering data on caring activity related to VI there appear to be relatively few time-use surveys that have asked questions that will produce information relevant to caring for persons with VI.

The OECD Time Use Database (OECD 2020) reports the results of time use surveys in OECD countries and for China, India and South Africa. However for results for their category 2.3.2 - adult care are only reported for 14 OECD countries and for South Africa (for the year 2010).

The ESRC Centre for Time Use Research is based at the UCL Institute of Education in University College London (UCL). The centre is home to the Multinational Time Use Study (MTUS 2020) which brings together more than a million and a half diary days from over 90 randomly sampled national-scale surveys, into a single standardised format. MTUS allows researchers to analyse time spent by different sorts of people in various sorts of work and leisure activities, over the past 55 years and across 30 countries.

The UN Statistics Division (2018) provides a web portal giving data and detailed metadata for time-use statistics provided by 180 countries. It shows the average time spent on paid and unpaid work in a 24-hour period, by sex for each country with available data as of August 2018. However the data reported is highly aggregated.

The International Labour Organization and United Nations Development Programme have undertaken a review of time-use surveys and statistics in Asia and the Pacific (ILO and UNDP 2018). This review includes 37 countries although seven had yet to undertake a time use survey. Table 29 shows the most recent survey for 10 of the countries included in this project.

The review concluded that

> *None of the background schedules helped in understanding the care economy in their respective country because none collected data on the need for care in the household (presence of someone disabled, chronically sick person, older person needing care and children by age group), and how it was organized at the household level, such as who provides care: household women, other household members, elder child, government support, the market or NGO groups. Hence, it was difficult to understand the total care needed at the household and macro levels and how it was shared at the household level and at the macro level by different agencies*. (p 30).

Table 29: Time-use surveys by country and year

Country	Year
Australia	2009-10
Bangladesh	2012
Cambodia	2003–04
China	2008
Indonesia	1976
Nepal	2010
Pakistan	2007
Philippines	2000
Timor-Leste	2007

Viet Nam	2004

Source: ILO and UNDP 2018

Over the course of 2019, the National Statistical Office in India conducted a detailed time-use survey across 138,799 households collecting information on time-use from 447,250 persons of age six years and above. (NSO 2020)

They reported that the percentage of a day spent on care for dependent adults (Section 42) was as shown in Table 30. For children 6-14 years the time spent was small and only significant for females. The age group with the highest time spent on care for dependent adults was 60 years and above. For all age groups females spent more time than males.

Table 30: Unpaid caregiving services for household members, percentage of time in day on activity, time-use in India, Section 4

	6-14 years	15-29 years	15-59 years	60 years and above	all (6 years and above)
42 Care for dependent adults					
Rural males	0.0	0.2	0.2	0.3	0.2
Rural females	0.1	0.4	0.5	0.9	0.5
Rural males	0.0	0.2	0.2	0.6	0.2
Rural females	0.1	0.3	0.6	1.2	0.6
41 Childcare and instruction					
Rural males	6.3	12.4	16.2	10.0	13.8
Rural females	7.8	41.5	32.7	15.6	27.2
Rural males	4.9	7.6	13.7	10.9	12.3
Rural females	6.0	32.8	29.6	15.5	25.2
4 Unpaid caregiving services for household members					
Rural males	6.5	13.0	16.9	10.7	14.4
Rural females	8.2	42.3	33.7	17.1	28.2
Rural males	5.2	8.3	14.7	12.1	13.2
Rural females	6.6	33.7	30.7	17.2	26.3

Source: NOS 2019

For those that did provide care for dependent adults, the amount of time per day spent on this activity is as shown in Table 31.

Table 31: Unpaid caregiving services for household members, time in day on activity, minutes

	6-14 years	15-29 years	15-59 years	60 years and above	all (6 years and above)
42 Care for dependent adults					
Rural males	41	85	96	106	96
Rural females	64	65	82	101	85
Rural males	139	130	119	118	119
Rural females	103	67	91	116	97
41 Childcare and instruction					
Rural males	100	74	72	86	75

Rural females	98	151	135	119	132
Rural males	81	70	69	85	71
Rural females	85	161	140	115	137
4 Unpaid caregiving services for household members					
Rural males	99	76	74	89	77
Rural females	98	151	135	119	132
Rural males	82	73	72	91	75
Rural females	86	162	142	117	138

Source: NOS 2019

Feeny et al (2018) report on interviews with 82 cataract patients and 83 caregivers randomly recruited from a Ho-Chi-Minh City Hospital in 2016. After surgery 58% of patients were at work compared to 48% pre-surgery. There was no statistically significant difference in work status for caregivers. There were large increases in health and mental health for patients and caregivers. The Cataract Impact Study was a longitudinal intervention study conducted in Kenya (Nakuru district), Bangladesh (Satkhira district) and the Philippines (Negros Island and Antique district). At baseline cases with VI from cataract and controls without VIwere identified and interviewed about time-use, health related quality of life and poverty. All cases were offered free or subsidised surgery. Approximately one year later, cases and controls were retraced, re-examined and reinterviewed.

Activity groups analysed were productive activities, leisure outside household, leisure inside household and assistance with any activity. In Kenya, the percentage reporting assistance with any activity reduced from 25% to 12%. In Bangladesh the reduction was 43% to 19% while in the Philippines it was 23% to 1% (Polack et al 2010). Danquah et al (2014) reported the results of a six-year follow up in Bangladesh and the Philippines. In the Philippines, the reduction was from 29% at baseline to 5% at 1 year and 12% at 6 years. For Bangladesh, the percentages were 39%, 14% and 11%.

Table 32: Return on investment from an additional year of schooling by country and year of study (%)

Country	Year	%
Afghanistan	2007	1.6
Bangladesh	2006	10.0
Burundi	2006	18.0
Cambodia	2007	8.5
China	2009	10.3
Eritrea	2002	10.9
Ethiopia	2011	12.5
Indonesia	2007	10.7
Kenya	1995	13.2
Lao PDR	2008	5.1
Myanmar	2007	8.5
Nepal	2008	7.9
Pakistan	2009	6.2
Palestine	2011	5.1
Papua New Guinea	1987	19.4
Philippines	2000	12.6
Rwanda	2005	45.0
Timor-Leste	2007	3.9
Vietnam	2014	5.7

Source: Psacharopoulos and Patrinos 2018, Annex 2, Montenegro and Patrinos 2014

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