The Value of Vision

The case for investing in eye health – Methods Annex

A report by

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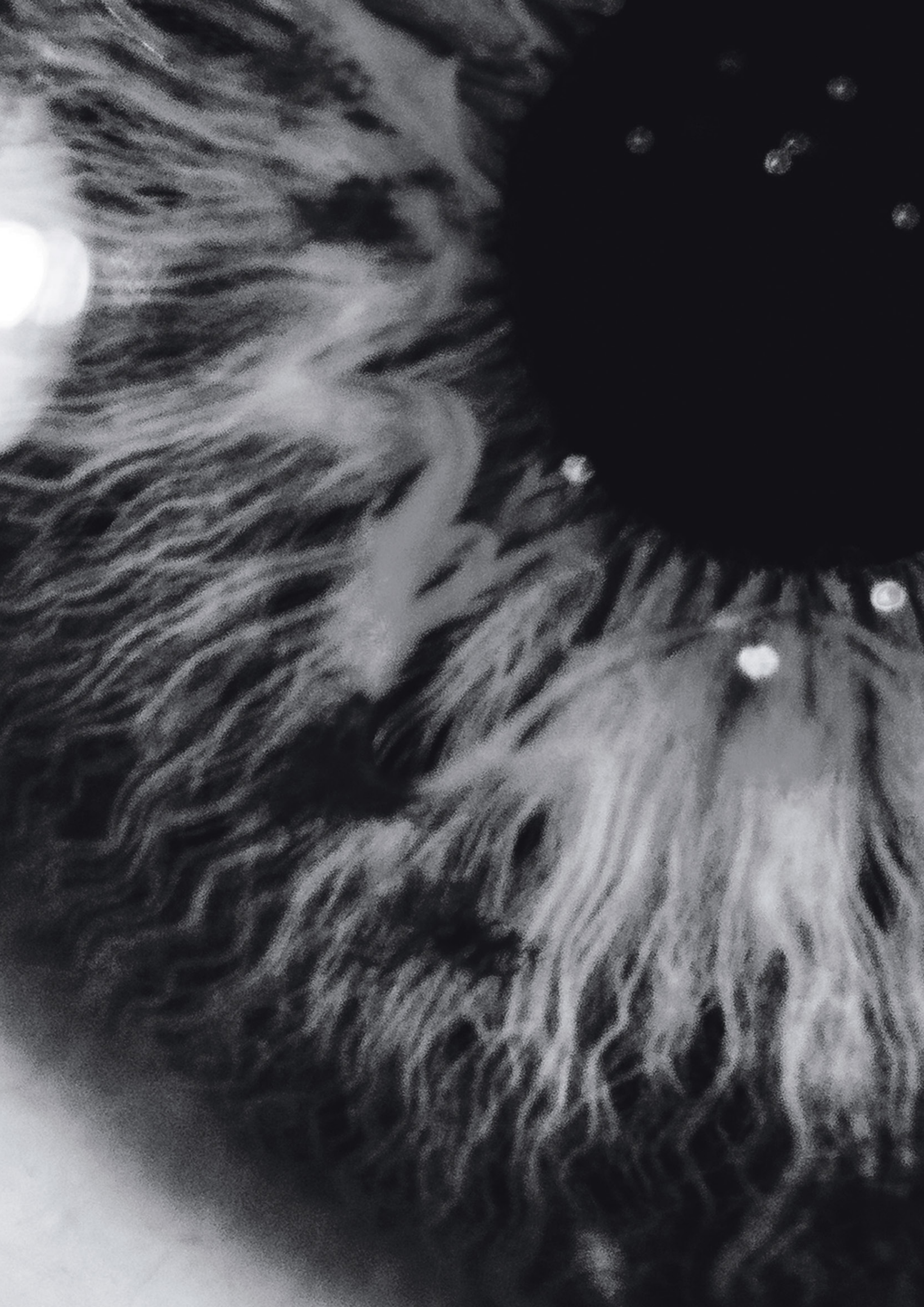

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The case for investing in eye health

Methods Annex

0.0 Introduction and General Parameters

This Methods Annex describes the quantitative modeling approach used to estimate the impacts, benefits, and costs associated with scaling up eye care interventions from 2026 to 2030, using 2025 as the pre-intervention baseline year. The analysis covers a five-year intervention window, but explicitly captures all benefits arising from interventions over the long term. For instance, if a child receives eyeglasses during the intervention period, the subsequent improvements in learning and future productivity are projected throughout their entire working life.

The investment case focuses exclusively on 111 low- and middle-income countries (LMICs), which together account for 98% of the global LMIC population. High-income countries (HICs) were excluded from the analysis primarily because they represent only 10% of the global burden of unaddressed visual impairment. Furthermore, eye care services in HICs typically rely heavily on privately funded delivery models, contrasting significantly with LMIC contexts where services depend largely on public provision or donor-supported programs. Additionally, the relatively smaller, underserved populations within HICs tend to have specialized or niche needs, which differ economically from the broad-based vision impairment prevalent in LMICs.

This investment case considers two conditions, refractive errors and cataracts, which together account for approximately 90% of all visual impairment worldwide. This decision does not imply that other eye diseases are unimportant; rather, for a first-of-its-kind global investment analysis, we chose to prioritize the two conditions contributing the largest share of avoidable visual impairment. Other eye conditions remain important areas for future research and investment cases.

All estimates and figures presented in the investment case are derived from an integrated Investment Case Model specifically developed for this analysis. The model comprises three interconnected modules:

1. **The Epidemiological Impact Module** - estimates the effects of scaling up various interventions on refractive error and cataract prevalence
2. **The Socio-Economic Benefits Module** - translates reductions in visual impairment prevalence into quantifiable benefits across seven socio-economic categories
3. **The Cost Module** - calculates detailed financial and economic costs of the interventions, using unit costs for 15 unique service-location combinations

The Epidemiological Impact Module serves as the starting point, generating prevalence estimates that are then used as inputs into the Socio-Economic Benefits and Cost Modules. Reductions in visual impairment drive benefit calculations, which vary according to several parameters including age, disease type, severity of visual impairment, country context, and in one instance, gender. For example, school-aged children with corrected vision experience learning benefits, whereas working adults with mild or near vision impairment benefit through increased occupational productivity.

Costs are driven by activities identified within the Epidemiological Impact Module, including the number of individuals screened, the number undergoing comprehensive eye exams, those receiving and using eyeglasses, and individuals undergoing cataract surgery. These activities are assigned unit costs, which vary by the service delivery location (e.g., community, school, health facility).

In the sections that follow, we provide comprehensive details on each module, including methods, data sources and assumptions.

1. Epidemiological Impact Module

1.1. Estimation of Current and Counterfactual Prevalence without the Investment Case

Data on the prevalence of visual impairment were sourced from the Vision Loss Expert Group (VLEG), which provides cause-specific and severity-specific prevalence estimates per 100,000 population, disaggregated by 5-year age groups, sex, and country (Bourne et al. 2021). These estimates cover both distance and near visual impairment and span four categories of visual acuity: mild, moderate, severe, and blindness for distance vision; plus an additional category for near vision impairment. For each country, sex, and age group, we extracted prevalence estimates for three major cause groupings: refractive error, cataract, and all other causes. As the VLEG does not disaggregate mild vision impairment by cause, we imputed this distribution by applying the cause-specific proportions observed in moderate visual impairment to the mild category within each demographic cell.

To estimate the absolute number of individuals with visual impairment, we applied the VLEG prevalence estimates to annual population projections from the United Nations World Population Prospects (medium variant) for the years 2025 to 2030. These population estimates are disaggregated by country, 5-year age group, and sex, allowing alignment with the structure of the VLEG data. This produced annual estimates of the number of people affected by refractive error, cataract, and other causes of visual impairment in each country over the analysis period. Our counterfactual scenario assumes a business-as-usual trajectory for eye care systems, in which current health system capacity grows only sufficiently to maintain constant age-standardized prevalence rates. As a result, total prevalence increases over time due to demographic drivers such as population growth and population aging rather than changes in disease risk or service coverage.

1.2. Eye Care Workforce and Productivity Estimates

The Epidemiological Impact Module relies on estimates of eyecare workforce and productivity. We used publicly available cross-country data to estimate the number of optometrists and their productivity, defined as glasses dispensed per unit time, and the number of surgeons and their productivity, defined as the number of surgeries conducted per unit time.

1.2.1. Estimates of the number of optometrists and their productivity

We sourced country-level estimates of effective refractive error coverage (eREC) (Bourne et al. 2025), the number of optometrists through the International Agency for the Prevention of Blindness (IAPB) Vision Atlas tool (Gammoh et al. 2024; Wang et al. 2024; Resnikoff et al. 2020) and the estimated burden of refractive error (from modeled VLEG prevalence). Using assumptions about the frequency of glasses replacement (once every three years) and the number of working days per year for a full-time optometrist (240 days).

Using these inputs, we first estimated the total need for glasses in each country by dividing the modeled burden of refractive error by one minus the eREC rate. This reflects the full pool of individuals in need of refractive services, including those currently unserved. We then calculated the number of people currently using glasses as the product of this total need and the eREC estimate. From there, we estimated the annual number of spectacle pairs dispensed by dividing the number of people with glasses by the assumed replacement period (once every three years). Optometrist productivity was calculated as the number of spectacle pairs dispensed annually divided by the number of optometrists in the country. Finally, productivity per working day (i.e., pairs dispensed per day) was derived by dividing annual productivity by 240 working days.

However, optometrist data were missing for 27 countries and appeared implausibly high (i.e. ≥20 spectacle pairs dispensed per day with the reported workforce) for an additional 24 countries. To impute missing or implausible values for optometrist productivity (defined as ≥20 spectacle pairs per day on average), we used data from countries with plausible dispensing rates (<20 pairs/day) to fit a linear regression model. This model predicted productivity as a function of log-transformed gross national income per capita, log-transformed population size, and geographic region.

The predicted dispensing rate from our model was then used to replace missing or implausible values. These updated values were used to calculate the optometrist productivity and, in turn, estimate the approximate capacity of the current and expanded workforce to meet refractive error needs over time.

1.2.2. Estimates of the number of surgeons and their productivity

For surgeons, we estimated service capacity using country-specific cataract surgical rates (CSRs), defined as the number of cataract surgeries performed annually per million population. CSR values were obtained directly from the IAPB Vision Atlas (Wang et al. 2016; Yan et al. 2019; Eurostat 2024) and were used without supplementation or imputation. We also used IAPB data on the number of ophthalmologists in each country, with the most recent year of data available ranging from 2010 to 2019. CSRs and population figures from UN Population were used to estimate the number of surgeries conducted per year in a given country. This was divided by the number of surgeons in a country to estimate the current productivity of surgeons across countries.

1.3. Decision Tree and Intervention Modelling

1.3.1. Decision Tree

The investment case model simulates service delivery and outcomes using a decision tree framework that tracks how individuals with different types of visual impairment move through the eye care pathway. The investment case considers two types of ways in which individuals first interact with eye care services - one approach where they are first screened in the community, and a second approach where they first walk-in to a facility for an eye exam. The decision trees are conceptually similar, but vary slightly based on the first point of contact with the eye care pathway with four key transitions modelled:

- **Community Screening:** Individuals first identified through proactive community-based vision screening.

- **Facility Walk-ins:** Individuals who independently present at an eye care facility seeking care.

Although both pathways share a broadly similar structure, they differ slightly based on the initial point of contact. Each pathway includes four key decision points, or "nodes," that influence whether an individual ultimately achieves improved vision:

1. **Initial Screening or Presentation:** Determines who enters the eye care pathway. This is based on the number and productivity of new workforce (community screeners, vision technicians and optometrists) who are present in the model in a given year for a given country.
2. **Comprehensive Eye Exam Following Screening:** Individuals identified with suspected vision impairment during community screening are referred for a full eye examination. Notably, individuals identified with near vision impairment (presbyopia) can receive ready-made eyeglasses immediately from community screeners, bypassing the comprehensive eye exam. For those self-presenting at a facility, the initial visit is assumed to include this comprehensive examination directly.
3. **Acceptance of Treatment After Diagnosis:** Following a confirmed diagnosis from the comprehensive eye exam, this node determines whether individuals accept the recommended treatment. Treatment acceptance rates include considerations of patient incentives where applicable
4. **Treatment quality**: This final node assesses whether the treatment provided successfully restores good functional vision (6/12 or better, or N8 at 40 cm).

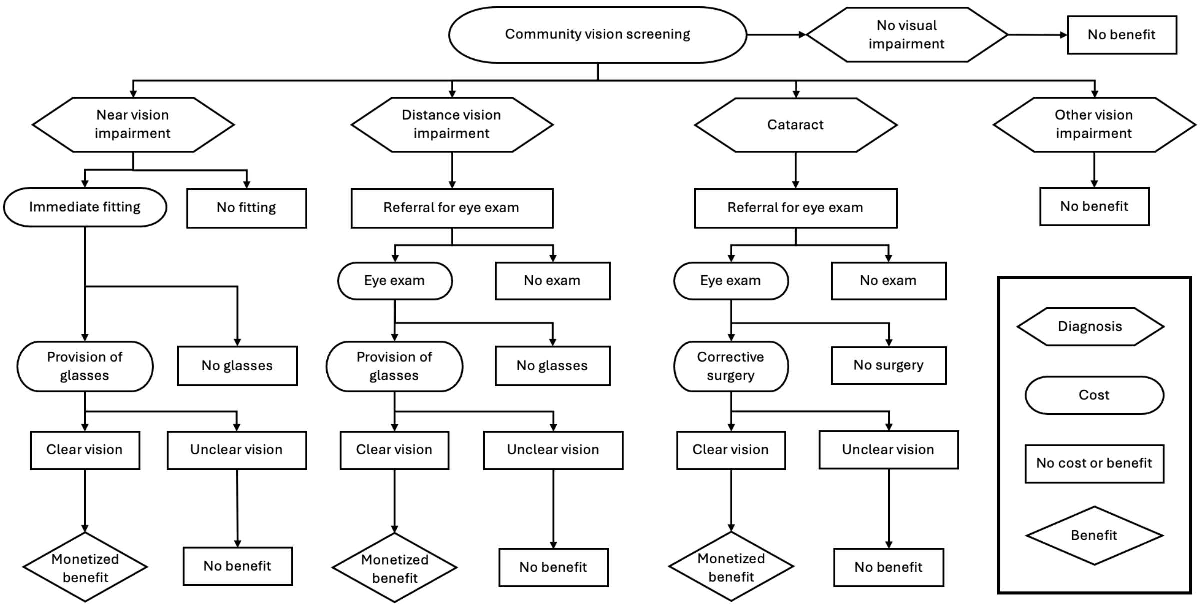

Figure 1: Decision tree with community screening as initial point of contact

For individuals who are first screened in the community (Figure 1), the subsequent nodes depend on the presumptive diagnosis from the screening. Individuals with near vision loss may be fitted immediately with ready-made glasses by community screeners, while those with presumptive distance refractive error, cataract, or other causes of impairment are referred for a comprehensive eye exam. Individuals with other causes are not modeled beyond this point, and no further benefits or costs are assigned. For those with refractive error and cataracts, individuals subsequently accept and receive treatment based on parameter assumptions conditional on disease type and whether incentives are included or not. The final node in the decision tree determines if the treatment provided is of sufficient quality to generate clear vision.

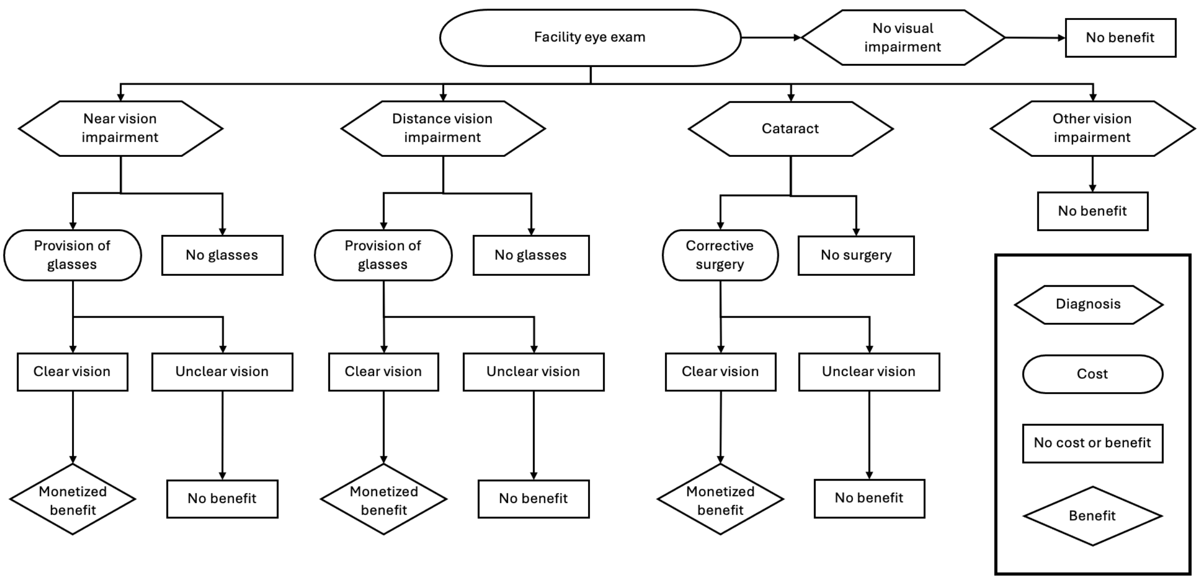

Figure 2: Decision tree with facility screening as initial point of contact

Individuals who initially self-present at facilities are assumed to proceed straight to an eye exam for diagnosis (Figure 2) with subsequent decision points mirroring the community screening pathway.

In both modes, whether community screening or facilities are the first point of contact, progression through the nodes depends on both demand (i.e patient progression) and supply (i.e. available workforce) factors. Demand determines the theoretical patient progression rates (assuming sufficient workforce) through the referral and uptake nodes of the tree. On the supply side, the total number of incremental vision exams that can be conducted in a given year is a function of the available optometrist / vision technician workforce, the difference between their current productivity and the theoretical ceiling, and the number of people estimated to have glasses in the country. The incremental vision exams available is given by:

Supply-constrained exam capacity

$$S_{i,y} = max\left\{0,\ \theta_i R_{i,y} - \frac{G_{i,y}}{L}\right\} \quad (1)$$

Where:
i = country index
y = year
θ_i = per-worker exam ceiling
$R_{i,y}$ = number of vision technicians / optometrists
$G_{i,y}$ = Number of existing people with glasses
L = Assumed life of glasses (3-years)

Realized incremental exams

$$\Delta X_{i,y} = min\left\{U_{i,y},\ S_{i,y}\right\} \quad (2)$$

Where:
$U_{i,y}$ = Unconstrained new vision exam demand from the pathway (referral x uptake)

Disaggregate by age and cause

$$\Delta X_{i,y,v,a} = U_{i,y,v,a} \times \frac{\Delta X_{i,y}}{U_{i,y}} \quad (3)$$

Where:
v = visual impairment cause
a = age band (5-year increments)

The implication of this equation is that optometrists and vision technicians service their existing clients (i.e. those who already have glasses and need them replaced periodically) before taking on new clients - a potentially conservative assumption. In each year, the number of individuals requiring a vision exam is compared to the incremental vision exams available given the existing workforce. If the number of available vision exams exceeds the number of individuals requiring an exam, then all individuals proceed to have a vision exam. If there are insufficient vision exams available then only a portion of the individuals proceed to have a vision exam up to the available limit. The flow-through rate is proportionally split across each age, cause and gender sub-group (by country), weighted by the share of that subgroup against the total individuals requiring a vision exam.

For cataract surgeries the number of available surgeries in a given country in a given year is defined as:

Achievable per-surgeon output

$$p_i = min\{\lambda_i b_i, M_i\} \quad (4)$$

Where:

λ_i = productivity multiplier

b_i = baseline per-surgeon output

M_i = Maximum per-surgeon capacity

Supply-constrained cataract surgical capacity

$$S^c_{i,y} = max\{O_i(p_i - b_i), 0\} + N_{i,y}p_i \quad (5)$$

Where:

i = country index, y = year

O_i = baseline number of ophthalmologists / surgeons

N_y = Newly trained ophthalmologists / surgeons

p_i = achievable per-surgeon output

b_i = baseline per-surgeon output

Realized incremental surgeries

$$\Delta Z_{i,y} = min\{U_{i,y}, S^c_{i,y}\} \quad (6)$$

Where $U_{i,y}$ is the unconstrained demand for cataract surgery

Disaggregate by age

$$\Delta Z_{i,y,a} = U_{i,y,a} \times \frac{\Delta Z_{i,y}}{U_{i,y}} \quad (7)$$

Where a indexes by 5-year age bands

As with eye exams, the number of surgeries performed in a given country in a given year is the lesser of the individuals passing through to the surgery node and the number of available surgeries.

The treatment quality indicator determines the percentage of individual receiving glasses or surgery who experience good vision post-treatment, as defined by the relevant clinical thresholds. For glasses this is assumed to be 90% (Bourne et al. 2025). For cataract surgeries, rates vary based on region, following estimates of proportions noted in McCormick et al. (2022).

Lastly, costs can be incurred at each node in the decision tree. However, benefits are allocated only to individuals who successfully complete all decision points and achieve good visual outcomes. To maintain simplicity and conservative estimates, the model assigns no benefit to individuals who do not fully complete the pathway, even if they experience partial improvement (e.g. from blindness to moderate visual impairment following cataract surgery).

Evidence Box - Evidence on Uptake With and Without Patient Incentives

Evidence on Referral and Treatment Uptake in Adults, without Patient Incentives

Despite increasing efforts to expand eye screening in LMICs, the uptake of follow-up eye care services remains suboptimal across many settings. In Kenya, a mobile health screening program using the Peek platform found that only 39.5% of people identified with potential eye diseases attended follow-up care at primary eye clinics (Rono et al. 2021). In Pakistan, the same Peek software noted important geographic disparities in referral rates: more than 90% of those living near referral centers attended, compared to 0–30% among those requiring transport (Khan et al. 2022). Similarly, in Iran, mobile digital screening or manual screening programs showed three-month adherence rates of just 32.7% to 35.6% in people identified with potential eye conditions (Katibeh et al. 2020). In China, only 33% of adults with uncorrected refractive error - mostly due to myopia - followed through with referrals for corrective services after visual screening in a health examination center-based model (Lin et al. 2021).

In Myanmar, the use of eye care services among elderly people with cataracts was 8.9%-16.1% at the baseline (Ko et al. 2021). Lastly, in Cambodia, only 49% of people who were told to attend eye care services after community outreach screening reported doing so (Ormsby et al. 2017). These findings collectively demonstrate that eye care service uptake after screening remains relatively low and inconsistent in LMICs.

Studies also examine patient transitions between initial screening and final uptake of treatment. In non-incentivized settings treatment uptake remains low to moderate. For instance, in Cambodia, while 68.9% of individuals diagnosed with eye conditions reported taking some form of treatment, only 7.4% attended the referral eye hospital for formal treatment. Most instead sought alternatives: 54% visited local pharmacies, 31.6% 'self-treated' at home, 10.7% consulted traditional healers, and 11% used practices like steaming with rice water (Ormsby et al. 2017).

In Kenya, among individuals diagnosed with eye disease through community mobile screening, only 22.3%–29.5% proceeded to eye care units for treatment (Rono et al. 2021). Similarly, in Pakistan, 22% of people diagnosed with RE and received prescriptions obtained their glasses through the program (Khan et al. 2022).

Overall these findings suggest that approximately only ~30% of individuals who are referred for an eye exam at a facility actually present for an eye examination, though exact results vary by context.

Results from Kenya and Pakistan note that the proportion of individuals who are diagnosed with RE and receive treatment ranged from 22-30% (Rono et al. 2021; Khan et al. 2022). For cataract, the range of treatment outcomes, conditional on diagnosis, has a lower bound with values ranging from 7% to 30% (Zhang et al. 2013; Ormsby et al. 2017; Rono et al. 2021).

For our model we assume that referral rates from presumptive diagnosis to eye exam are 30% for all distance vision refractive error and cataracts. Uptake rates for this sample of more motivated individuals (i.e. those that presented for eye exams), are assumed to be 80% for distance vision and 60% for cataract surgery. This leads to diagnosis-to-treatment uptake rates of 30%*80% = 24% for distance refractive error and 30%*60%=18% for cataracts, consistent with the range of evidence presented above.

For near vision impairment, we assume all individuals have a 100% 'referral' since the screening process reveals presbyopia. We assume only 24% of individuals with presbyopia take up the glasses - matching the figure for distance refractive error. This also reflects an interpretation of the findings from a recent study which assessed reading glasses purchase after varying the price, reporting 29%, 48% and 81% uptake rates when glasses were offered at 80%, 50% and 0% of the market price (Sabherwal et al. 2025).

Evidence on Referral and Treatment Uptake in Adults, with Patient Incentives

A handful of studies provide clear contrasts between incentivized and non-incentivized approaches. In rural China, providing only informational reminders for low-cost cataract surgery resulted in 14.4% uptake, while offering free surgery, free surgery plus transport reimbursement or free transport increased uptake to 27.8%-31.1% (Zhang et al. 2013). In a rural North Indian population, the uptake of near-vision glasses after a doorstep “experience” session was significantly higher when the glasses were free (81.4%), compared to $0.90 (48.3%) or $1.20 (29.2%) (Sabherwal et al. 2025). In the previously mentioned study in Myanmar (baseline rate of 8.9%-16.1%) a door-to-door three-month eye health education intervention increased the uptake to 85.7%, while a once-off education session saw a more modest rise to 35.7% (Ko et al. 2021).

Other studies reported data of how incentives can substantially boost adherence, even without comparisons to control groups. In Burkina Faso, 75.2% of adults were willing to purchase eyeglasses priced at USD 1.71 - about 80% of the production cost - suggesting that even minor subsidies may facilitate access (Grimm and Hartwig 2022). In the Cataract Impact Study, uptake of free cataract surgery reached 58.6% in Kenya, 53.9% in Bangladesh, and 47.1% in the Philippines, where affordability was a major barrier (Syed et al. 2013). Similarly, the GUSTO trial in China showed that cataract surgery uptake ranged between 35.1% - 40.1% when free surgeries are provided, regardless of the health education or counselling approach (Liu et al. 2012). Community outreach programs in Kenya, Zambia, and Uganda offering free cataract surgery achieved even higher uptake, with 62% to 73% adherence and a 66% average across countries (Bechange et al. 2022). A study of 2.3 million individuals seen at community screenings and vision centers in India noted a final uptake rate of glasses and cataract surgery following diagnosis between 65-70%, in which patient incentives such as subsidized or free treatment and transport plus counselling were provided (Wong, Singh, R. C. Khanna, et al. 2022).

The evidence suggests high uptake rates of glasses when incentives are offered ranging from approximately 50% to 80%. We adopt an uptake rate of 65%, the midpoint of the range and consistent with the findings of (Wong, Singh, R. C.

Khanna, et al. 2022). For cataracts the evidence indicates a range of approximately 25% to 75%. We take the midpoint of this range and assume 50% uptake in cataract surgery following eye exams when incentives are offered.

Evidence on Referral and Treatment Uptake in Children, without and with Patient Incentives

In many LMICs, a significant drop-off occurs between school vision screenings and eventual eye glasses usage, particularly when parents and children have to travel to facilities for eye exams and pay for glasses out-of-pocket. A scoping review of studies measuring glasses usage following school screening in LMICs noted endline usage rates of spectacles in control groups of visually impaired children of 15%-34%, when no incentives were provided (Anokye et al. 2025). This finding is broadly supported by some studies not included in the scoping review. In a randomized controlled study in China, only 14% of visually impaired children in a control group who received a glasses prescription but no other incentives (and who were not originally wearing glasses at baseline) were observed wearing glasses at endline (Ma et al. 2014). Similarly, a school screening program in India generated a 14% referral rate following screening (Agarwal et al. 2023).

Evidence indicates that a combination of incentives - provision of free glasses, direct delivery of glasses to schools and counselling including reminders - boosts uptake along the entire care pathway. The scoping review by Anokye et al. (2025) noted that groups that were provided free spectacles generally saw compliance rates around 50%. In Ma et al. (2014), the group that was provided a voucher for free glasses redeemable at a distant vision center had 26% uptake of glasses, while direct delivery of free spectacles generated a 30% uptake rate - both substantially higher than control usage at 14%.[1] Glewwe et al. (2016) noted a 70% uptake rate of free glasses in program schools in their RCT. Similarly in a study of six Indian providers the uptake rate of eyeglasses for school children averaged 40% across 330,000 children screened in a year (Wong, Singh, R. K. Khanna, et al. 2022).

For school screening, we assume uptake rates of 12% without incentives. For incentives we note a range in the literature of approximately 25% to 70%. We assume a 40% uptake of glasses in children when incentives are provided.

[1] These figures are derived from Table 5 of Ma et al. (2014) - observation of wear - and exclude in both the numerator and denominator the number of children wearing glasses at baseline. If those wearing glasses at baseline are included then the uptake rates are 26% (control), 37% (voucher) and 40% (direct delivery of free glasses).

1.3.2. Intervention Packages Modelled

Six separate interventions are modelled that impact the parameters in the decision-tree framework. These are:

1. **Early detection through screenings in the community** - an expansion of community screening effort to identify those with visual impairment
2. **Give out reading glasses on the spot** - fitting near vision glasses on-the-spot in community screening activities
3. **Increase capacity in the workforce for eye exams and dispensing glasses** - increase the system's capacity to provide eye exams through improving the productivity of the existing cadre, increasing the number of eye care workforce who can provide this service, and deploying these individuals to be co-located at community eye screening events.
4. **Boost surgical productivity and teams** - increase the system's capacity to provide cataract surgeries through improving the productivity of the existing cadre or increasing the number of eye care workforce who can provide this service.
5. **Remove barriers to access** - increase uptake of treatment by i) providing subsidized glasses, surgery and travel costs and/or ii) providing counselling and education.
6. **Make cataract surgery even better** - deploy interventions to improve the quality of surgery and/or include post-operative refraction and glasses

For the purposes of the investment case, **two packages of interventions are considered:**

- Given relatively lower fiscal resources, **low-income countries are assumed to implement interventions 1 and 2 only** (community screening plus on-the-spot dispensing of near vision glasses).
- **Lower-middle-income and upper-middle-income countries are assumed to implement all six interventions.**

Below we describe in detail how each intervention determines parameters in the decision tree model.

1.3.2.1. Early detection through screenings in the community

Relevant Model Parameters Affected:

- The number of community screeners entering the model determines the number of additional people who undergo a screening.
- Assumptions around the target beneficiary group determine the make up of those who receive a community screening.

This intervention is modeled as a scale-up in the number of community-based screeners delivering basic vision screenings from 2026 to 2030. We assume that by 2030, each country reaches a target of 1 full-time equivalent (FTE) community screener per 10,000 adults aged 40 and older, with effort increasing linearly over five years to meet this target. While we appreciate that screeners will serve others besides those aged 40 and above, tying the workforce scale up to the size of this group reflects the fact that half of their time will be spent on adults aged 40+, and the magnitude of effort should be proportional to the size of this group.

Community screeners are assumed to spend their time screening different population groups using the following time-shares: 30% to children aged 5–14 (school screening), 20% to individuals aged 15-40, and 50% to adults aged 40 and over. We further assume that 1 FTE community screener is able to screen 6,000 individuals per year, based on data reported by providers in the costing survey (see Section 3). Over a 240-day working year with 8 hours of work time per day, this averages out to be just over 3 screenings per hour, a potentially conservative assumption. These assumptions affect both the number and distribution of screenings across age groups. Screening reveals a number of presumptively diagnosed individuals with visual impairment that reflect age and country specific prevalence from VLEG.

1.3.2.2. Give out reading glasses on the spot

Relevant Model Parameters Affected:

- Referral structure for adults who are assessed as having presbyopia

This intervention enables community screeners to dispense ready-made near vision glasses to adults with near vision loss at the time of screening. In the model, this modifies the treatment cascade for those identified with near vision loss at community screenings by removing the need for a comprehensive eye exam and referral. Instead, screening conditional upon a finding of near vision impairment leads directly to treatment with uptake rates varying by whether patient incentives are provided or not. We assume a baseline uptake rate of 24% of near vision glasses following diagnosis. This reflects the findings from a recent study which assessed glasses purchase after varying the price of glasses, reporting 29%, 48% and 81%

uptake rates when glasses were offered at 80%, 50% and 0% of the market price (Sabherwal et al. 2025).

Note, that for school children, we assume that they still require a comprehensive eye exam to confirm hyperopia and cannot be provided with on-the-spot near vision glasses.

1.3.2.3. Increase capacity in the workforce for eye exams and dispensing glasses

Relevant Model Parameters Affected:

- The number of optometrists and vision technicians entering the model determines the number of additional people who are able to receive a vision exam.
- The number of optometrists and vision technicians who are assumed to be mobile, changes the referral structure and referral uptake rates for adults assessed as having distance refraction or cataracts, if they are screened in the community
- The number of optometrists and vision technicians who are assumed to work in facilities determines how many people enter the eye care pathway via a facility and the number of vision exam referrals that are possible
- Optometrist productivity ceiling is assumed to increase by 20% from 4000 vision exams per year to 4800

This intervention impacts a number of parameters in the decision tree model. One key variable is the number of new vision technicians and optometrists entering the model. We assume that optometrist and vision technician workforce increases by 10% of baseline workforce every year, where workforce expansion is assumed to begin in 2027 following a one-year training period.

New optometrists are split evenly between two deployment types: mobile vision technicians who accompany community screeners and fixed vision center staff who conduct eye exams. With mobile vision technicians the referral uptake rate increases from a baseline rate of 30% to 100% since refraction or eye exam can occur on the spot. We assume that one mobile vision technician is required for every four community screeners and if there are insufficient mobile vision technicians relative to screeners then the remaining individuals screened default to 30% referral rate.

The number of optometrists and vision technicians who are assumed to be in a facility determines the number of individuals entering the eye care pathway through self-presentation. Every new fixed optometrist / vision technician is assumed to see 4000 (low-income) or 4800 (middle-income) people for consultation per year, with the clientele weighted such that prevalence of vision impairment is twice the population prevalence (Wong, Singh, R. C. Khanna, et al. 2022; Yip et al. 2018).

Lastly, when this intervention is activated, the total number of vision exams / dispensing productivity ceiling is assumed to rise from 4,000 to 4,800 per year for existing optometrists, reflecting productivity improvements possible with tele-ophthalmology. As discussed above, this affects the system's delivery capacity, allowing for more of those with distance refractive error and cataracts to be seen for an eye exam in facilities.

1.3.2.4. Boost surgical productivity and teams

Relevant Model Parameters Affected:

- The number of surgeons entering the model determines the number of additional people who are able to receive a cataract surgery.
- The productivity ceiling of every surgeon - new and existing - increases.

This intervention models two distinct enhancements to cataract surgical capacity: a phased scale-up in the number of trained ophthalmologists beginning in 2029, and an increase in the productivity ceiling of the existing ophthalmologist workforce.

Surgeon scale-up is modeled only for middle-income countries, beginning in 2029. A 5% annual increase in the ophthalmologist workforce is applied in 2029 and 2030, equivalent to training new surgeons over a four-year horizon beginning in 2025. The number of additional surgeries from new ophthalmologists reflects the productivity ceiling of the same surgeons in their country.

Due to the increased screening effort from Intervention 1 (early detection from community screenings) more individuals present for cataract surgery. To reflect existing health system constraints, we assume that surgical productivity, due to increased case finding, in low-income countries only increases by a maximum of 20% per year, or to 600 surgeries per year, whichever is lower. In middle-income countries which initiate the productivity enhancing intervention, surgical capacity is assumed to increase by 50% per year or to 800 surgeries per year, whichever is lower. As noted above, these productivity ceilings are not necessarily hit if there is insufficient patient demand.

1.3.2.5. Remove barriers to access

Relevant Model Parameters Affected:

- Increase in the effective uptake rate of glasses and cataract surgery

This intervention models an increase in the uptake of treatment - glasses and cataract surgery - by addressing key demand-side barriers including financial costs, distance to services, and stigma. Specifically, these are addressed via subsidized treatment, subsidized transport and community-based eye care, and counselling services. The model operationalizes these changes through direct modification of treatment uptake parameters across intervention scenarios.

Due to the packaged nature of the interventions, this parameter is conjoined with the referral uptake parameter, the product of which determines the percentage of people presumptively diagnosed that receive treatment (subject to workforce constraints). In many cases, the literature only reports this conjoined outcome, not the individual steps separately.

In low-income countries where there is no on-the-spot refraction in community outreach, and no patient incentives modelled, the effective uptake rates (i.e. those who are diagnosed and subsequently receive an eye exam and accept treatment) are 24% for glasses, 18% for cataracts in adults; and 12% for children (See Evidence Box for further details).

In middle-income countries where both on-the-spot refraction and patient incentives are modelled, the effective uptake rate rises to 65% for glasses and 50% for cataract surgeries - noting that the referral rates for eye exams are 100% due to their co-located, concurrent nature. In children, glasses uptake increases to 40% (See Evidence Box for further details).

1.3.4.6. Make cataract surgery even better

Relevant Model Parameters Affected:

- Increases the percentage of individuals who meet clinical thresholds after cataract surgery from baseline rates to 80%

This intervention simulates improvements in the effectiveness of cataract surgery by increasing the probability that surgery results in functional vision restoration (defined as visual acuity of 6/12 or better, or N8 at 40 cm). In the model, this is implemented by adjusting the treatment success probability applied to individuals who receive cataract surgery.

Baseline treatment success rates for cataract surgery are assigned by region, reflecting observed differences in quality across geographies as reported in a recent systematic review (McCormick et al. 2022). For instance, countries in sub-Saharan Africa are assigned lower baseline quality factors, while countries in regions such as Latin America or East Asia begin with higher surgical outcome probabilities. These regional baseline values capture both intraoperative and postoperative limitations.

Under the investment case scenario, the probability that surgery results in full functional vision is increased to 80% across all middle-income settings, representing the potential gains from a comprehensive set of quality improvement strategies. These include: surgeon retraining (e.g., simulation and wet lab sessions), use of intraocular lens biometry, postoperative follow-up including provision of glasses to address residual refractive error. The combined impact is captured through the uplift in the treatment success parameter.

A summary of parameters used are presented in Tables 1, 2 and 3.

Table 1: Assumptions Related to Countries Implementing Intervention 1 and 2 only - Community Screening Pathway

Step in node	**Near**	**Distance**	**Cataract**
Community Screening	50% of time allocated to adults 40+ 30% of time allocated to children in schools 20% of time allocated to adults under 40		
Referral	100% referral success rate for adults since fitting readers happens on the spot 12% referral and uptake success rate for hyperopic children.	24% referral and uptake success rate 12% referral and uptake success rate for myopic children.	18% referral and uptake success rate
Uptake	24%	Incorporated into 24% figure above	Incorporated into 18% figure above
Treatment Quality	90% successful	90% successful	Varies by region 56.2% in Sub-Saharan Africa to 72.4% in South East Asia

Table 2: Assumptions Related to Countries Implementing all Six Interventions - Community Screening Pathway

Step in node	Near	Distance	Cataract
Community Screening	50% of time allocated to adults 40+ 30% of time allocated to children in schools 20% of time allocated to adults under 40		
Referral	With sufficient optometrist/vision technician capacity: 100% referral success rate since it happens on the spot in the community With insufficient capacity: default referral and uptake rates		
Uptake	65% uptake 40% uptake for children	65% uptake 40% uptake for children	50% uptake
Treatment Quality	90% successful	90% successful	80% across all regions

Table 3: Assumptions Related to Countries Implementing all Six Interventions - Facility Pathway

Step in node	Near	Distance	Cataract
Initial Vision Exam	Weighted such that prevalence of VI in clientele is twice the population prevalence (Wong, Singh, R. C. Khanna, et al. 2022; Yip et al. 2018) 75% of time allocated to adults 40+ 5% of time allocated to children in schools 10% of time allocated to adults under 40		
Uptake	70% uptake for adults 40% uptake for children	70% uptake for adults 40% uptake for children	30% uptake without incentives 65% uptake with patient incentives
Treatment Quality	90% successful	90% successful	80% across all regions

2. Socio-Economic Benefits Module

2.1. General Parameters

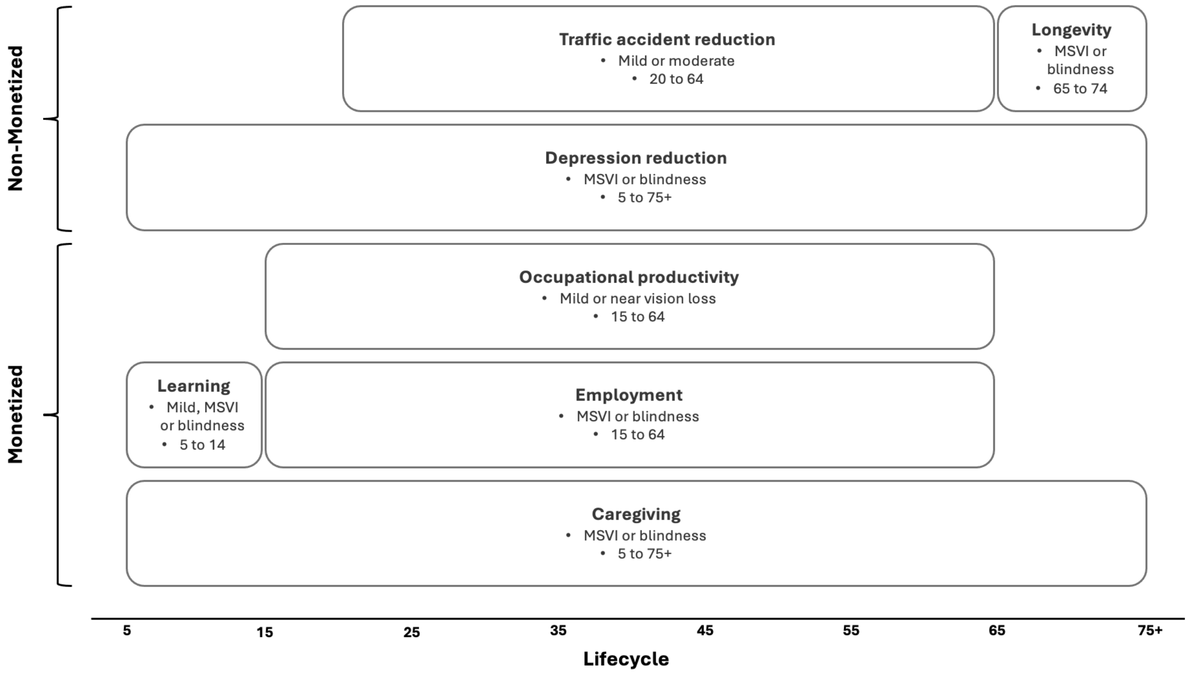

Figure 3: Investment case benefits mapped across lifecycle and severity

All monetary values in this analysis are expressed in constant 2025 U.S. dollars using market exchange rates. Country-specific discount rates were applied to future costs and benefits based on the methodology recommended by Haacker et al. (2020), which accounts for variation in national income levels. These rates reflect the time value of money and are aligned with standard practices for investment cases in health and development economics.

Projections of gross national income per capita (GNIpc) from 2025 to 2030 were sourced from the International Institute for Applied Systems Analysis (IIASA) Shared Socioeconomic Pathways (SSPs), using the SSP2 "Middle of the Road" scenario (Riahi et al. 2017). These projections enable forward-looking estimates of individual income, labor productivity, and value of life years across countries.

To estimate the present value of employment and occupational productivity gains, we applied net present value (NPV) multipliers to income flows. For individuals receiving treatment with glasses (for either distance or near visual impairment), we assumed a benefit duration of three years per pair. For cataract surgery, benefits were assumed to continue until age 65, consistent with working-age constraints. Age-specific midpoints from 5-year age bands were used to determine years of benefit remaining, and the NPV of each income stream was calculated accordingly, adjusting for the year in which treatment occurred. Caregiver productivity gains were treated separately. Benefits following cataract surgery were assumed to accrue over the full remaining life expectancy of the treated individual, and the corresponding NPV multipliers were calculated using the same discount rate.

The NPV multiplier is calculated as:

$$\Phi^{k}_{y} = \frac{1-(1+r)^{-t_k}}{r} \times \frac{1}{(1+r)^{y-b}} \qquad (8)$$

Where:

$k = benefit\ component\ (employment,\ occupational\ productivity,\ caregiving)$
$y = year\ of\ treatment$
$r = annual\ discount\ rate$
$t = duration\ of\ benefit\ (years)$
$b = base\ year\ (2025)$

A second treatment cycle was applied for individuals with refractive error and near vision loss initially treated in 2026 or 2027 to reflect the replacement of spectacles at the end of their expected life span. For these individuals, a second benefit stream was initiated in 2029 or 2030, respectively, with recalculated GNI per capita and corresponding NPV multipliers.

For both refractive error and cataract, visual acuity was modeled ex-post by applying initial country-, age-, and sex-specific distributions of severity (mild, moderate, severe, and blindness) drawn from the disaggregated VLEG dataset. These severity shares were used to disaggregate baseline prevalence and were then applied uniformly to all modeled prevalence and treatment flows throughout the analytic period.

2.2. Employment Benefits

To estimate the gains in productivity from restored employment following treatment of visual impairment, we applied the approach used by Marques and colleagues (2021), who found a 30.2% reduction in employment among individuals with moderate or severe visual impairment or blindness. This effect was applied to successfully treated individuals aged 15–64 with MSVI or blindness due to either refractive error or cataract.

Expected income for each country was approximated as the product of gross national income per capita ($GNIpc_{i,y}$) and the employment-to-population ratio (EtP_i), reflecting country-specific labor productivity. Gains in employment were then calculated as:

$$Employment\ Gain_{i,v,a,y} = N^{t}_{i,v,a,y} \times GNIpc_{i,y} \times EtP_{i} \times \delta^{emp} \times \Phi_{y}^{emp} \quad (9)$$

Where:

$i = country\ index$
$v = visual\ impairment\ severity\ (specifically\ MSVI\ or\ blindness)$
$a = age\ cohort\ (specifically\ 15–64)$
$y = year\ of\ treatment$
$N^{t}_{i,v,a,y} = number\ of\ individuals\ successfully\ treated\ for\ MSVI\ or\ blindness$
$GNIpc_{i,y} = gross\ national\ income\ per\ capita\ for\ country\ i\ in\ year\ y$
$EtP_{i} = employment - to - population\ ratio\ for\ country\ i$
$\delta^{emp} = percentage\ employment\ penalty\ (30.2\%)$
$\Phi_{y}^{emp} = present\ value\ multiplier\ for\ future\ income\ gains$

The present value multiplier (Φ_{y}) captures the discounted value of income gains over the duration of benefit (three years for glasses; age-dependent for cataract surgery), with the base year set to 2025. For individuals treated in 2026 or 2027 with refractive correction, a second episode of treatment was modeled in 2029 or 2030, respectively, with updated GNIpc values and corresponding multipliers. Employment benefits were only applied to individuals in working-age cohorts (15–64 years) and limited to those treated for MSVI or blindness. Individuals with mild VI or near vision loss were excluded from this component.

2.3. Occupational Productivity Benefits

To estimate occupational productivity gains from correcting mild and near visual impairment, we applied a 10.0% productivity boost to successfully treated individuals of working age (15 to 64 years) with these severity levels. This estimate is based on a conservative adjustment of a random-effects meta-analysis of six LMIC-based studies (see Figure 2), which yielded an average productivity increase of 12.4% (95% CI 4.5% to 20.2%) following refractive error correction. While some studies reported larger gains in specific populations or settings, the 10.0% value is adopted here to ensure applicability across settings and reduce the risk of overstatement.

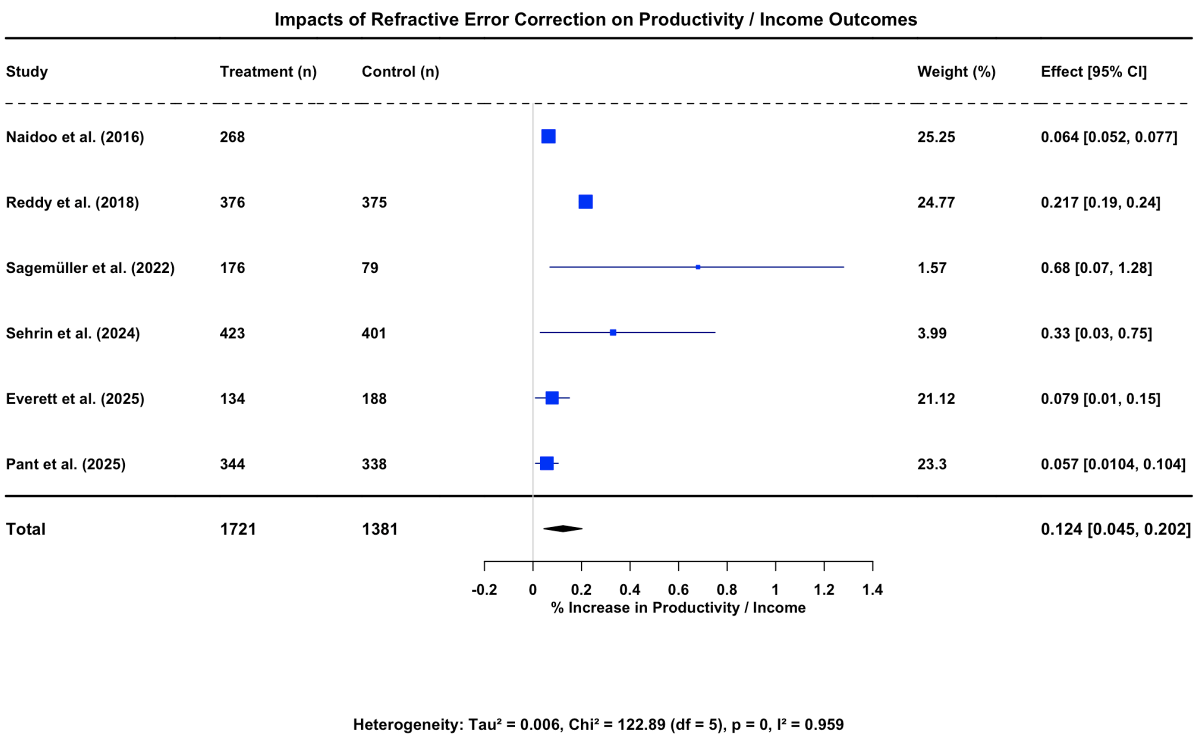

Figure 4: Random-effects meta-analysis derived from systematic review of studies that measure productivity or income losses following visual impairment correction

Occupational productivity benefits were calculated as the product of the GNI per capita ($GNIpc_{i,y}$) and employment-to-population ratio (EtP_i) for each country-year, multiplied by the number of individuals successfully treated and adjusted by a net present value multiplier (Φ_y) assuming a three-year effective benefit duration.

Specifically, the total gain in occupational productivity was calculated using the following formula:

$$Occ.\ Productivity\ Gain_{i,v,a,y} = N^{t}_{i,v,a,y} \times GNIpc_{i,y} \times EtP_{i} \times \delta^{occ} \times \Phi^{occ}_{y} \qquad (10)$$

Where:

$i = country\ index$
$v = visual\ impairment\ severity\ (specifically\ Mild\ or\ Near\ VI)$
$a = age\ cohort\ (specifically\ 15–64)$
$y = year\ of\ treatment$
$N^{t}_{i,v,a,y} = number\ of\ individuals\ successfully\ treated\ for\ Mild\ or\ Near\ VI$
$GNIpc_{i,y} = gross\ national\ income\ per\ capita\ for\ country\ i\ in\ year\ y$
$EtP_{i} = employment - to - population\ ratio\ for\ country\ i$
$\delta^{occ} = percentage\ productivity\ improvement\ (10.0\%)$
$\Phi_{y}^{occ} = present\ value\ multiplier\ for\ future\ income\ gains$

Gains were summed across country, year, age, and sex strata to estimate total productivity benefits associated with improved occupational performance following treatment.

2.4. Caregiver Productivity Benefits

Caregiver productivity benefits are calculated for individuals with moderate or severe visual impairment (MSVI) and blindness, using separate percentage productivity loss parameters and discounting future gains via an NPV multiplier.

Following Naidoo et al. (2019) and (Wong, Singh, R. K. Khanna, et al. 2022), we assume a 5% productivity loss for caregivers of individuals with MSVI and a 10% loss for caregivers of individuals with blindness. These parameters are applied only to age-severity groups expected to require caregiver support, conditional on successful treatment of the individual with VI.

The caregiver productivity gain is defined as:

$$Caregiver\ Gain_{i,v,a,y} = N^{t}_{i,v,a,y} \times GNIpc_{i,y} \times EtP_{i} \times \delta_{v}^{care} \times \Phi_{y}^{care} \quad (11)$$

Where:

$i = country\ index$
$v = visual\ impairment\ severity\ (specifically\ MSVI\ or\ blindness)$

$a = age\ cohort\ (all\ ages)$

$y = year\ of\ treatment$

$N^{t}_{i,v,a,y} = number\ of\ individuals\ successfully\ treated\ for\ MSVI\ or\ blindness$

$GNIpc_{i,y} = gross\ national\ income\ per\ capita\ for\ country\ i\ in\ year\ y$

$EtP_{i} = employment - to - population\ ratio\ for\ country\ i$

$\delta_{v}^{care} = caregiver\ productivity\ increase\ (5.0\%\ for\ MSVI;\ 10.0\%\ for\ blindness)$

$\Phi_{y}^{care} = present\ value\ multiplier\ for\ future\ income\ gains\ specific\ to\ caregivers$

Caregiver productivity gains are calculated separately for MSVI and blindness and summed to yield total annual gains at the country level.

2.5. Learning Benefits for School Children

We estimate the economic value of improved educational outcomes resulting from refractive error correction among children aged 5–14. Learning benefits are modeled only for children who are successfully treated for distance refractive error, near vision loss or cataract (i.e., receive and comply with treatment leading to corrected visual acuity), though the prevalence of cataract and near vision loss among children is extremely low. Each intervention scenario produces annual estimates of the number of children successfully treated from 2025 to 2030, stratified by country, sex, and single-year age.

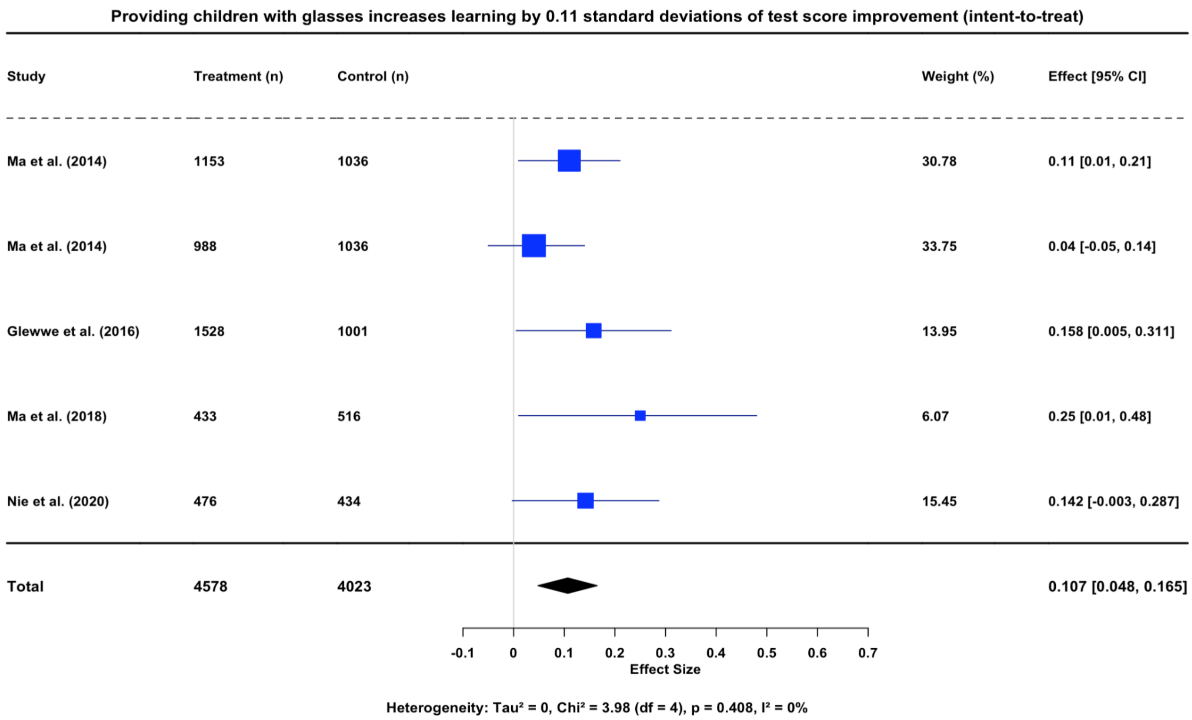

Figure 5: Random-effects meta-analysis of studies measuring learning outcomes following visual impairment correction in randomized controlled trials

For each treated child, we assign an additional 0.445 years of schooling per year of treatment, or the expected years of schooling loss (EYOS), following the methodology of the Better Education in Sight study (Dhakhwa et al. 2024). The EYOS is calculated by dividing the average treatment effect on the treated (ATT) by what a typical child without visual impairment is expected to learn in a single year. The ATT estimate is derived from the estimated intent-to-treat (ITT) effect estimated in a meta-analysis of existing related literature (see Figure 1). The steps to convert the ITT estimate to the ATT estimate (measured in standard deviation test score improvement) are detailed below.

To estimate the ATT effect for those who complied with treatment:

$$ATT_{compliers} = ITT \,/\, compliance\ rate \quad (12)$$

Where:

$ITT = Intent - to - treat\ effect\ from\ the\ meta\ analysis$

$compliance\ rate = percentage\ of\ compliant\ treated\ individuals\ across\ all\ studies$

To estimate the ATT effect for those who did not comply with treatment:

$$ATT_{non-compliers} = ATT_{compliers} * [VI_{non-compliers} / VI_{compliers}] \quad (13)$$

Where:

$VI_{non-compliers} = average\ visual\ impairment\ for\ non-compliers,\ measured\ in\ diopters\ for$

$VI_{compliers} = average\ visual\ impairment\ for\ compliers,\ measured\ in\ diopters$

To estimate the overall ATT effect:

$$ATT = \%share_{compliers} * ATT_{compliers} + \%share_{non-compliers} * ATT_{non-compliers} \quad (14)$$

Where:

$\%share_{compliers} = share\ of\ individuals\ who\ complied\ with\ treatment\ across\ included\ studies$

$\%share_{non-compliers} = share\ of\ individuals\ who\ did\ not\ comply\ across\ included\ studies$

Glewwe et al. (2016) report an average test score gain of 0.44 standard deviations among Chinese students with good vision. Based on this, the estimated ATT of 0.197 standard deviations corresponds to approximately 45% of a year of schooling lost (0.197 ÷ 0.44 = 0.45), with a 95% confidence interval ranging from 20% to 69% of a school year.

This effect is translated into increased lifetime earnings using country-specific returns to schooling and discounted projections of gross national income per capita (GNIpc) from the IIASA SSP database (Riahi et al. 2017). Annual income gains are estimated from ages 15 to 64, with earnings adjusted for country-specific employment-to-population ratios (EPR) and discounted at a country-specific social discount rate equal to the short term (five-year) average of GDP per capita growth rate x 1.4 and adding 1 percent (Haacker et al. 2020).

The total benefit for each age is divided evenly across the remaining years of school exposure (i.e. a child treated at age 7 accrues 8 years of benefit). Enrollment rates from the most recent available year are applied to weight benefits based on the likelihood of attending school: country-specific primary enrollment rates are used for ages 5 to 11, and secondary enrollment rates for ages 12 to 14. Missing enrollment data are filled using regional averages. Interpolation is used to estimate the number of treated children by single year of age based on model outputs provided in 5-year age bands.

The final learning benefit is the product of this per-child value and the interpolated number of successfully treated children, adjusted for enrollment. Results are aggregated by country and year and benefits are distributed across years in proportion to modeled reductions in prevalence between 2025–2030. Benefits are reported in constant 2025 USD using market exchange rates and represent gains over the baseline scenario, which assumes no new treatment occurs.

2.6. Road Safety Benefits

We estimated averted road traffic injuries and fatalities resulting from treatment of visual impairment among adults with mild or moderate refractive error or cataract. The analysis distinguishes between two subpopulations: (1) all adults of driving age (20–74 years), and (2) occupational drivers (males aged 20–54). For both subpopulations, we calculated population attributable fractions (PAFs) under the baseline and investment case scenarios using modeled prevalence values. The difference in attributable mortality and injury between the two scenarios represents the expected benefit of vision correction.

For the general adult population, we computed PAFs using modeled prevalence of mild and moderate visual impairment from 2026 to 2030, applied separately to baseline (counterfactual) and intervention scenarios. A risk ratio (RR) of 1.46 for road traffic crashes among visually impaired drivers (Piyasena et al. 2021) was applied to calculate annual PAFs. These were then multiplied by country-level road traffic mortality estimates from the Global Burden of Disease cause-of-death dataset (i.e., deaths coded under road injury causes) less mortality associated with occupational risk. Averted deaths were calculated as the difference in attributable mortality between baseline and intervention scenarios.

Occupational drivers were modeled separately due to their elevated exposure to crash risk and higher assumed prevalence of visual impairment (Piyasena et al. 2021). For this subgroup, the same RR of 1.46 was used to calculate PAFs, but applied to occupational road traffic mortality estimates derived from risk factor data (rather than cause-level death counts). To avoid double-counting, occupational mortality was subtracted from total road injury deaths before estimating general driver impacts. Additionally, baseline prevalence was set to 13.2%, the mean prevalence of central visual acuity across studies included in a systematic review assessing occupational drivers with visual impairment (Piyasena et al. 2021).

We used the standard PAF formula:

$$PAF = \frac{Pe \times (RR - 1)}{Pe \times (RR - 1) + 1} \quad (15)$$

Where *Pe* is the population with visual impairment under either the baseline or investment case scenario, and *RR* is the estimated risk ratio.

Averted injuries were estimated using the same approach as deaths, except that PAFs were applied to the incidence of transport related injuries from GBD (IHME 2024), rather than mortality.

2.7. Mental Health Benefits

To quantify the mental health benefits associated with improvements in visual impairment, we first estimated the baseline prevalence of depression among visually impaired populations. Drawing from existing literature, we adopted a prevalence estimate of 25% for individuals experiencing moderate-to-severe visual impairment (MSVI) or blindness, based on findings from the systematic reviews by Parravano et al. (2021). For individuals with mild or near vision impairment, we conservatively assumed no increased risk of depression, even though the systematic review included some cases of depression among those with mild visual impairment.

To determine the impact of vision improvement interventions on depression, we relied on results from a recent meta-analysis by Pellegrini et al. (2020), which analyzed depression outcomes following cataract surgery. This study found a standardized mean difference of -0.16 in depression scores - assessed using validated tools including the Geriatric Depression Scale (GDS), Center for Epidemiologic Studies Depression Scale (CES-D), and Depression Anxiety Stress Scale (DASS) - for patients undergoing cataract surgery compared to controls. Assuming a normal distribution of depression scores, this effect size corresponds to a 5-percentage-point absolute reduction (or a relative reduction of approximately 20%) in the prevalence of depression among operated individuals.

Finally, we estimated the total number of depression cases averted by multiplying the projected reduction in the number of individuals with MSVI and blindness (as derived from our epidemiological impact model) by the baseline depression prevalence (25%), and further multiplying this figure by the estimated relative reduction in depression prevalence (20%).

2.9. Improved Longevity in Old Age

We estimated the reduction in all-cause mortality attributable to the correction of moderate and severe visual impairment among older adults ages 65 to 74 (IHME 2024). The model calculates averted mortality resulting from treatment of refractive error and cataract in these age groups and converts them into years of life gained.

2.9.1. Relative Risk Estimation by Severity

To account for differential mortality risk by severity of visual impairment, we derived separate relative risk (RR) estimates for mild, moderate, and severe impairment using a constrained system of simultaneous equations (Wong, Singh, R. K. Khanna, et al. 2022). These equations were calibrated to replicate three observed mortality risk ratios from a systematic review and meta-analysis (Ehrlich et al. 2021) and reflect 10-year mortality risks, based on comparisons across aggregated severity categories:

$$1.29 \times RR_{no} = \frac{\omega_{mild} \times RR_{mild} + \omega_{mod} \times RR_{mod} + \omega_{sev} \times RR_{sev}}{\omega_{mild} + \omega_{mod} + \omega_{sev}} \quad (16)$$

$$1.43 \times \frac{(\omega_{no} \times RR_{no} + \omega_{mild} \times RR_{mild})}{\omega_{no} + \omega_{mild}} = \frac{\omega_{mod} \times RR_{mod} + \omega_{sev} \times RR_{sev}}{\omega_{mod} + \omega_{sev}} \quad (17)$$

$$1.89 \times \frac{(\omega_{no} \times RR_{no} + \omega_{mild} \times RR_{mild})}{\omega_{no} + \omega_{mild}} = RR_{sev} \quad (18)$$

Where ω_k and RR_k represent the population weights and relative risks for visual impairment states, k = no, mild, moderate or severe. Population weights for each state of visual impairment are drawn from our baseline scenario, while RR_{no} = 1, by definition.

To solve for severity-specific RRs we used each country- and sex-specific distribution of mild, moderate, and severe VI among 65–74-year-olds in 2025. These weights were used to solve the system such that the derived severity-specific risks minimized squared residual error relative to the observed composite RRs. A lower-bound constrained and exact solution were both implemented for robustness. These derived RRs were then applied to model PAFs by country, sex, and year.

2.9.2. Attributable Mortality and Years of Life Gained

We used the standard PAF formula:

$$PAF = \frac{Pe \times (RR - 1)}{Pe \times (RR - 1) + 1} \quad (19)$$

Where *Pe* is the age- and severity-specific prevalence of visual impairment under either the baseline or investment case scenario, and *RR* is the estimated severity-specific risk ratio.

Estimated PAFs were applied to country-specific all-cause mortality estimates for ages 65–74. These were projected forward from 2025 using UN population growth projections to obtain projected mortality totals from 2026 to 2030. The difference in attributable deaths between baseline and investment case scenarios represents the number of deaths averted by vision correction.

Years of life gained were calculated by multiplying averted deaths by residual life expectancy at age 60, with midpoint adjustments for the 65–69 and 70–74 age brackets. Country- and sex-specific life expectancy estimates were used. Final results are aggregated by year, country, sex, and age bracket and reported as total averted deaths and total life years gained. Because the derived severity-specific relative risks represent 10-year mortality risks, the final results are divided by 10 to yield annual estimates.

3. Cost Module

3.1. General Principles

There is a paucity of publicly available studies that specifically estimate the costs of cataract surgical and refractive error service provision (Foo et al. 2021; Ginel et al. 2023). The studies that do exist suffer from several limitations that preclude their use in our investment case model. First, the literature is dated, with global inflationary pressures and conflict disrupting supply chains and service delivery leading to disproportionately rising health service delivery costs (Poongavanam et al. 2023). Second, most studies focus on a small number of countries, and data is particularly rare in LMICs (Jolley et al. 2022). Third, costs estimated in the literature are almost exclusively focused on delivery of services in one specific setting (*e.g.* hospital-based provision of glasses) when in many LMICs, outreach and primary care services play an increasingly important role in service delivery (Lee et al. 2023; Chen et al. 2025). Finally, for the purposes of our model and the interventions to be costed, we required specific costs of each component or *intervention* required as part of the whole continuum of care (*i.e.* from screening to treatment).

To address these issues, we developed a primary data collection protocol using a purpose-designed *costing tool* to collect data on the costs associated with cataract and refractive error service delivery. The costing tool collected data on costs of equipment, medicines, consumables, workforce (clinical and non-clinical), transportation, accommodation, and overheads as well as service volumes associated with delivery of 15 individual interventions, as follows:

Table 4: Interventions costed as part of the cost module

Location	Service
Community-based (outreach)	Vision screening
	Vision exam
	Provision of readymade glasses
	Provision of custom-made glasses
	Cataract surgery
School-based (outreach)	Vision screening
	Vision exam

	Provision of custom-made glasses
Facility-based (primary)	Vision exam
	Provision of readymade glasses
	Provision of custom-made glasses
Facility-based (secondary/tertiary)	Vision exam
	Provision of readymade glasses
	Provision of custom-made glasses
	Cataract surgery

By collecting disaggregated cost data from individual service providers for each of these 15 interventions, we developed a consistent approach to estimating the costs (and cost types) contributing to cataract and refractive error service delivery in LMICs. By accounting for different levels and types of service delivery, we allow for different costs and quantities of equipment, medicines, consumables, and workforce to vary across settings. This was critical to provide cost data that could be accurately modelled through the decision tree framework (see section 1.3. Decision Tree and Intervention Modelling). A consistent, and conservative approach was used to move from primary data collected from service providers to the unit cost estimates used in this report. This section details our approach from primary data collection to the calculation of country-specific unit costs and cost drivers.

3.2. Data Collection Process

Development of costing tool

We developed a purpose-built costing tool to collect data from refractive error and cataract service providers. The cost tool was spreadsheet-based, to allow for providers with limited technical capabilities to submit data, and to allow for providers to 'pass' the spreadsheet via email to different individuals who may require input (*e.g.* accounting departments, service delivery managers, clinicians). The cost tool consisted of five individual worksheets with detailed instructions embedded, to collect the following data:

1. **Services and Volume:** collects data on provider type (eye-health specific provider or general service provider), number and type of facilities providing cataract and refractive error services, interventions provided and annual (last 12 months) patient volume, and overheads (*e.g.* rent, utilities).
2. **Equipment, Medicines, and Consumables – Refractive Error:** collects data on the cost (in local currency) per unit of equipment, medicines, and

consumables associated with refractive error service delivery (by intervention). The tool allowed providers to specify if costs varied by location, and input any notes that providers deemed important (*e.g.* unusual 'per unit' quantities).

3. **Equipment, Medicines, and Consumables – Cataract:** collects data on the cost (in local currency) per unit of equipment, medicines, and consumables associated with cataract surgical service delivery (by intervention). The tool allowed providers to specify if costs varied by location, and input any notes that providers deemed important (*e.g.* unusual 'per unit' quantities).
4. **Workforce:** collects data on the average salary of one FTE of clinical and non-clinical workforce types used in service delivery, and the total number and location of FTE across each intervention. For clinical workforce type, the time taken to deliver each specific intervention (in minutes) was collected.
5. **Transport and Accommodation:** collects data on total transport costs for staff (for community-based interventions and school eye health programs) and patients (for facility-based cataract surgery), staff per diems, staff accommodation costs, and the number of overnight stays required to deliver each community-based and school eye health program annually.

Data for equipment, medicines, and consumables was pre-filled based on the WHO Package of Primary Eye Care Interventions (PECI) (*Package of Eye Care Interventions* 2022) and was designed to provide insight into the specific model of care used by providers to deliver the interventions. Workforce data was based on typical bottom-up costing data used in similar global costing studies (Cunnama et al. 2020; Bertram et al. 2021; Raza et al. 2024; Boonstoppel et al. 2024). Clinical workforce types (cadres) were pre-filled based on the WHO Eye Care Competency Framework (*Eye Care Competency Framework* 2022) and the WHO PECI list.

Collection of data from providers

A convenience sample of providers was used to collect cost data for inclusion in the cost module. Providers were approached through networks of the core research team, as well as through engagement with membership of IAPB provider organisations. Care was given to ensure an appropriate geographic spread within the confines of the project timelines, as well as to ensure that a range of provider types (*e.g.* comprehensive eye care providers, general hospitals, primary health services, refractive-error only specialist providers) of different volumes and locations (*e.g.* urban vs rural) were included.

Members of the research team were trained to formally engage providers to ensure collection of consistent data across multiple contexts around the globe. Data collectors first approached known providers with an invite letter and a formal explanation of the project, its aims, its intended impacts, and other standard items such as data anonymity and storage rules. After obtaining consent, the data collectors shared the costing tool with service providers noting that various sections may need input from multiple individuals within the organisation. For this reason, a spreadsheet-version of the tool was used to allow for sharing amongst individuals within the same organisation.

Data collectors worked with providers to answer any questions about the cost tool and ensure that all instructions were clear. Written instructions were embedded in the spreadsheets of the final tool and providers were given the option to work with data collectors to complete the tool together (via videoconference or phone call) or to collect the data themselves.

Once data was received from providers, data collectors checked the spreadsheets for completeness and screened for obvious errors (large outliers, text in numeric cells, missing data, providers filling in data for services they don't provide). Data collectors followed up with providers to obtain any missing or inaccurate data where possible.

Data were collected from 64 service providers in 29 LMICs; after quality checks, 55 providers from 25 countries were retained. Of these, 48% were based in Africa, 24% in Latin America, 12% in South-East Asia, 12% in the Western Pacific, and 4% in the Eastern Mediterranean; 52% were from lower-middle-income, 28% from low-income, and 20% from upper-middle-income countries. In total, 49% of reported data were usable for unit cost analysis, primarily for vision examinations at secondary/tertiary facilities, facility-based cataract surgery, and community-based vision screening.

3.3. Approach to Estimate Unit Costs

The cost tool was deliberately designed to account for different uses of equipment, medicines, consumables, and workforce types delivering services. Amongst the 64 providers that provided costing data, there was enormous variation in the mix of equipment, medicines, consumables and workforce types used in delivery of these services. For the purposes of modelling these costs, we aimed to define a consistent, methodological approach to converting provider data into unit cost data for incorporation into the broader model. This section presents the six steps that the research team conducted with each provider spreadsheet to ensure consistency in unit cost reporting.

Step 1: Estimating Service Type and Volume

The '1. Services and Volume' tab of the cost tool was first used to identify which of the 15 interventions unit costs must be estimated for, by provider. Due to the calculations used to estimate unit cost figures, any interventions missing provider-based volume data were excluded from subsequent analysis – even if costs had been given for items associated with these interventions.

For providers that delivered multiple interventions (*e.g.* community-based refractive error and facility-based cataract surgery), as was the case with many comprehensive eye health providers, up to 69 total unit cost inputs were estimated per provider (15 equipment costs, 15 medicines and consumables costs, 15 non-clinical workforce costs, 15 clinical workforce costs, 9 transport and accommodation costs). Therefore, it was essential that the service provider type and volume were captured as a first step.

Step 2: Establishing a 'Typical' Model of Care

There was large variation in the equipment, consumables, medicines, and workforce types used to deliver services across providers. For the purposes of this investment case, we wanted to ensure that the costs included in the scale-up scenarios were representative of a 'typical' case of care provided by service providers in each country.

In this step, we used the provider data, along with expert consultation to adapt the WHO PECI equipment, medicines and consumables list to a set that reflected the 'typical' inclusions across each intervention. Table 5 below represents the list of equipment, consumables, and medicines that were incorporated into a 'typical' case for each refractive error intervention. Note that the PECI list included equipment and consumables considered substitutes (*i.e.* only one of the substitutes was needed in a typical intervention). These have been identified in Table 5 below.

Table 5: Refractive error equipment, medicines, and consumables included in the unit cost calculation, by intervention

Service	Equipment, medicines, consumables	Community-based (outreach)	School-based (outreach)	Facility-based (primary)	Facility-based (secondary/tertiary)
Vision screening	Torch	Yes	Yes	Yes	Yes
	Snellen visual acuity charts	Yes	Yes	Yes	Yes
	Measuring tape/rope	Yes	Yes	Yes	Yes
	Occluder	Yes	Yes	Yes	Yes
	Pin hole	Yes	Yes	Yes	Yes
	LogMAR charts	No	No	No	Yes
	LEA Symbols	No	Substitute A	No	No
	Sloan letters	No	No	Yes	Yes
	HOTV charts	No	Substitute A	No	No
	Kay's pictures	No	Substitute A	No	No
	Toys with detail for fixation (illuminated and non-illuminated)	No	No	No	No
	Teller acuity cards	No	Substitute B	No	No
	Cardiff acuity test	No	Substitute B	No	No
	LEA Gratings	No	Substitute B	No	No
Vision exam	Slit Lamp Biomicroscope	No	No	No	Yes
	Lens 60D, 78D or 90D	No	No	No	Yes
	Manually adjustable slit lamp table	No	No	No	Yes

Service	Equipment, medicines, consumables	Community-based (outreach)	School-based (outreach)	Facility-based (primary)	Facility-based (secondary/tertiary)
	Manually adjustable chair	No	No	No	Yes
	Autorefractor	No	No	No	Yes
	Photoscreener	No	No	No	No
	Universal trial frame	Yes	Yes	Yes	Yes
	Trial lens set (full diameter with minimum number of trial lenses)	Yes	Yes	Yes	Yes
	Lens bars	Yes	Yes	Yes	Yes
	Cross cylinder	Yes	Yes	Yes	Yes
	Light box	Yes	Yes	Yes	Yes
	Full aperture trial lens set	No	No	No	Yes
	Pediatric trial frame	No	Yes	No	No
	Retinoscope	No	Yes	No	Yes
	Retinoscopy lens rack	No	Yes	No	Yes
	Standard automated perimeter with progression software	No	No	No	Yes
	Amsler grid chart	No	No	No	Yes
	Pelli-robson chart	No	No	No	Yes
	Bailey Lovie chart	No	No	No	Yes
	Ishihara plates	No	No	No	Yes

Service	Equipment, medicines, consumables	Community-based (outreach)	School-based (outreach)	Facility-based (primary)	Facility-based (secondary/tertiary)
	HRR plates	No	No	No	Yes
	Applanation tonometer	No	No	No	Yes
	Non-contact tonometer	No	No	No	Yes
	Fluorescein strips	Duplicate	Duplicate	Duplicate	Duplicate
	Keratometer	No	No	No	Yes
	Hand held keratometer	No	No	No	Yes
	Optical and/or ultrasound biometer	No	No	No	Yes
	Direct Ophthalmoscope	No	No	No	Yes
	Indirect ophthalmoscope	No	No	No	Yes
	20D and 28D lens	No	No	No	Yes
	Pan retinal lens.	No	No	No	Yes
	Direct gonioscopy lenses	No	No	No	Yes
	Coupling agent	No	No	No	Yes
	Indirect gonioscopy lenses (adult and child sizes).	No	No	No	Yes
	Ultrasound scanner Mode A and B	No	No	No	Yes
	Ultrasound/optical pachymeter	No	No	No	Yes
	Computer and monitor	No	No	No	Yes

Service	Equipment, medicines, consumables	Community-based (outreach)	School-based (outreach)	Facility-based (primary)	Facility-based (secondary/tertiary)
	Pachymetry software	No	No	No	Yes
	Non-Mydriatic fundus camera	No	No	Yes	Yes
	Cards for diagnosis of fundus	No	No	Yes	Yes
	Fundus charts	No	No	Yes	Yes
	Random dot and Lateral disparity	No	No	No	Yes
	Stereo Smile design for young children	No	No	No	No
	TNO test	No	No	No	No
	Titmus fly test	No	No	No	No
	Worth 4 dot test equipment with red- green glasses or bagolini glasses	No	No	No	Yes
	Prism bar (horizontal and vertical)	No	No	No	Yes
	Loose prisms	No	No	No	Yes
	Duochrome test chart	No	No	No	Yes
	Schirmer's strips	No	No	No	Yes
	Sodium fluorescein dye	No	No	No	Yes

Service	Equipment, medicines, consumables	Community-based (outreach)	School-based (outreach)	Facility-based (primary)	Facility-based (secondary/tertiary)
	Fluorescein strips	Duplicate	Duplicate	Duplicate	Duplicate
	Corneal topography machine	No	No	No	Yes
	Antiseptic handwash solution (500 ml)	No	No	No	Yes
	Atropine sulphate eye drops, 0.5–1%	No	No	No	Yes
	Cyclopentolate hydrochloride, 0.5–1% eye drops	No	No	No	Yes
	Tropicamide, 0.5–1% eye drops	No	No	No	Yes
	Homatropine, 2% eye drops, 5 ml	No	No	No	Yes
	Epinephrine (adrenaline), 2% eye drops	No	No	No	Yes
Provision of readymade glasses	Readymade reading spectacles (+1.50, +2.00, +2.50, +3.00) - Please provide the cost for one unit of the most commonly used type	Yes	Yes	Yes	Yes

Service	Equipment, medicines, consumables	Community-based (outreach)	School-based (outreach)	Facility-based (primary)	Facility-based (secondary/tertiary)
Provision of custom made glasses	Frames for adults (single vision) - Please provide the cost for one unit of the most commonly used type	Yes	Yes	Yes	Yes
	Frames for adults (bifocal) - Please provide the cost for one unit of the most commonly used type	No	No	No	No
	Frames for children - Please provide the cost for one unit of the most commonly used type	No	Yes	No	No
	Single vision lenses - Please provide the cost for one unit of the most commonly used type	Yes	No	Yes	Yes
	Bifocal lenses - Please provide the cost for one unit of the most commonly used type	No	No	No	No
	Auto-edger	No	No	No	Yes

Service	Equipment, medicines, consumables	Community-based (outreach)	School-based (outreach)	Facility-based (primary)	Facility-based (secondary/tertiary)
	Lensmeter	No	No	No	Yes
	Manual edger	Yes	Yes	Yes	No
	Frame heater	Yes	Yes	Yes	No
	Pattern cutter	Yes	Yes	Yes	No
	Centration device	Yes	Yes	Yes	No
	Set of optical pliers	Yes	Yes	Yes	No

Table 6 below represents the list of equipment, consumables, and medicines that were incorporated into a ‘typical’ case for each cataract surgical intervention. Note that, as with refractive error, the PECI list included equipment and consumables considered substitutes, In the case of cataract surgery, these were identified in the ‘Substitutes’ column and instructions advised the costing team to use only one (lowest cost) from each ‘phase’ of cataract surgery (*i.e.* only one of the substitutes was needed in a typical intervention). Provider data, supported by review of relevant literature and expert consultation revealed that ‘outreach’ cataract surgeries were typically performed in health facilities and thus required a similar, if not the same, list of ‘typical’ equipment, medicines, and consumables inclusions.

As such, Table 6 defines service types as small-incision cataract surgery (SICS) or phacoemulsification (Phaco) (rather than outreach vs facility-based). Teams responsible for collation of unit costs were instructed to estimate costs for Phaco if Phaco equipment was used by providers, and for SICS if Phaco equipment costs were not provided. This reflects the ‘real life’ distribution of SICS and Phaco amongst providers contributing to our study, and captures the likely shift towards Phaco in many of the countries included in our model (Atima and Dingwoke 2025; Fernandes et al. 2022; Zhu et al. 2014).

Table 6: Cataract Equipment (including useful life), and Medicines,and Consumables (including quantity used per intervention) to be Included in the unit cost calculations

Item	Substitute	Classification	Included in SICS Unit Cost	Included in PHACO Unit Cost	Useful life	Low Volume (<500 surgeries/ year)	Medium Volume (500-2000 /year)	High Volume (>2000/ year)	Quantity Used per Intervention
Bupivacaine hydrochloride, 0.5%, 20 ml injection	Anesthetic	M	Yes	Yes	-	-	-	-	1
Lidocaine hydrochloride 2% 50ml Injection (without or with 1:100,000 epinephrine)	Anesthetic	M	Yes	Yes	-	-	-	-	1
Amethocaine (tetracaine) hydrochloride, 0.5% eye drops, 10 ml	Anesthetic	M	No	Yes	-	-	-	-	0.005
Ofloxacin eye drops, 0.3%	Antibiotic	M	Yes	Yes	-	-	-	-	1
Ciprofloxacin eye drops, 0.3%	Antibiotic	M	Yes	Yes	-	-	-	-	1
Tobramycin eye drops, 0.3%	Antibiotic	M	Yes	Yes	-	-	-	-	1

Item	Substitute	Classification	Included in SICS Unit Cost	Included in PHACO Unit Cost	Useful life	Low Volume (<500 surgeries/ year)	Medium Volume (500-2000 /year)	High Volume (>2000/ year)	Quantity Used per Intervention
Prednisolone sodium phosphate eye drops, 0.5%	Anti-inflammatory	M	Yes	Yes	-	-	-	-	1
Prednisolone, 0.5–1 mg/kg/day P.O.	Anti-inflammatory	M	Yes	Yes	-	-	-	-	1
Povidone-iodine 5%, 10% aqueous solution (200ml)	Antiseptic	M	Yes	Yes	-	-	-	-	0.025
Chlorhexidine aqueous, 0.5%	Antiseptic	M	Yes	Yes	-	-	-	-	0.05
Corneal, 0.12 mm atraumatic tips, angled with tying platform forceps	Corneal forceps	E	Yes	Yes	5	5	10	15	-
Corneal, 1x2 teeth, 0.12 mm, with 6 mm tying platform forceps	Corneal forceps	E	Yes	Yes	5	5	10	15	-
Syringes (2 ml, 5 ml, 10 ml)	Duplicate	C	Yes	Yes	-	-	-	-	0.02
Keratome (bevel up) 2.7–3.5 mm	Duplicate	E	Yes	Yes	5	50	100	200	-

Item	Substitute	Classification	Included in SICS Unit Cost	Included in PHACO Unit Cost	Useful life	Low Volume (<500 surgeries/ year)	Medium Volume (500–2000 /year)	High Volume (>2000/ year)	Quantity Used per Intervention
Syringes (2 ml, 5 ml, 10 ml)	Duplicate	C	Yes	Yes	-	-	-	-	0.02
Trypan blue, 0.06% 1 ml injection	Duplicate	C	Yes	Yes	-	-	-	-	1
MVR 19G knife	Duplicate	C	Yes	Yes	-	-	-	-	0.1
Methylcellulose or other coupling agents	Duplicate	M	Yes	Yes	-	-	-	-	0.2
Trypan blue, 0.06%, 1 ml	Duplicate	M	Yes	Yes	-	-	-	-	1
Keratome (bevel up), 2.7–3.5mm	Duplicate	E	Yes	Yes	5	5	10	15	-
Fixation forceps	Fixation forceps	E	Yes	Yes	5	5	10	15	-
Toothed forceps	Fixation forceps	E	Yes	Yes	5	5	10	15	-
Non-toothed forceps	Fixation forceps	E	Yes	Yes	5	5	10	15	-
Alcohol-based hand rub (isopropyl alcohol 75%)	Handwash	M	Yes	Yes	-	-	-	-	0.006
Antiseptic handwash solution (500 ml)	Handwash	C	Yes	Yes	-	-	-	-	0.008

Item	Substitute	Classification	Included in SICS Unit Cost	Included in PHACO Unit Cost	Useful life	Low Volume (<500 surgeries/ year)	Medium Volume (500-2000 /year)	High Volume (>2000/ year)	Quantity Used per Intervention
30-gauge cannula	Intracameral injections	E	Yes	Yes	3	5	10	15	-
Air injection, 27G cannula	Intracameral injections	E	Yes	Yes	3	5	10	15	-
PMMA posterior chamber IOLs 19–21D, 21–23D, 24–25D, single piece with dialling holes (0.50D and 1D increments for PCIOL)	IOL	C	Yes	No	-	-	-	-	1
Square edge PMMA	IOL	C	Yes	No	-	-	-	-	1
PMMA single piece or multipiece lens	IOL	C	Yes	No	-	-	-	-	1
Hydrophobic acrylic IOL	IOL	C	No	Yes	-	-	-	-	1
Foldable (HEMA) hydrophilic lens, modified C loop with injectable cartridge and disposable plunger (dioptre 10.0D to 30.0D)	IOL	C	No	Yes	-	-	-	-	1
Lens expressor	Iris & IOL Manipulation	E	Yes	No	5	5	10	15	-

Item	Substitute	Classification	Included in SICS Unit Cost	Included in PHACO Unit Cost	Useful life	Low Volume (<500 surgeries/ year)	Medium Volume (500-2000 /year)	High Volume (>2000/ year)	Quantity Used per Intervention
Vectis, lens loop or wire	Iris & IOL Manipulation	E	Yes	No	5	5	10	15	-
Kuglen iris hook and lens manipulator	Iris & IOL Manipulation	E	Yes	Yes	5	5	10	15	-
Sinskey hook straight or angled	Iris & IOL Manipulation	E	Yes	Yes	5	5	10	15	-
Iris spatula or repositor	Iris & IOL Manipulation	E	Yes	Yes	5	5	10	15	-
Simcoe, irrigating/aspirating, 23G, angled cannula	Irrigation/As piration	E	Yes	No	3	5	10	15	-
Irrigating vectis, three ports 23G cannula	Irrigation/As piration	E	Yes	No	3	5	10	15	-
Carboxymethylcellulose eye drops, 0.2–1%	Lubricant	M	Yes	Yes	-	-	-	-	1
Hydroxyethyl cellulose, Hydroxypropyl methylcellulose eye drops, 0.2–2.5%	Lubricant	M	Yes	Yes	-	-	-	-	1

Item	Substitute	Classification	Included in SICS Unit Cost	Included in PHACO Unit Cost	Useful life	Low Volume (<500 surgeries/ year)	Medium Volume (500-2000 /year)	High Volume (>2000/ year)	Quantity Used per Intervention
Propylene glycol, polyethylene glycol, glycerin eye drops, 0.2–1%	Lubricant	M	Yes	Yes	-	-	-	-	1
Disposable crescent (bevel up) blade	Main incision	C	Yes	No	-	-	-	-	0.1
Razor fragments OR blade slit knife (disposable)	Main incision	C	Yes	Yes	-	-	-	-	0.1
Mosquito, curved forceps	Manipulation forceps	E	Yes	Yes	5	5	10	15	-
Mosquito, straight forceps	Manipulation forceps	E	Yes	Yes	5	5	10	15	-
Atropine sulphate eye drops, 0.5–1%	Mydriatic	M	Yes	Yes	-	-	-	-	0.01
Cyclopentolate hydrochloride, 0.5–1% eye drops	Mydriatic	M	Yes	Yes	-	-	-	-	0.01
Tropicamide, 0.5–1% eye drops	Mydriatic	M	Yes	Yes	-	-	-	-	0.01

Item	Substitute	Classification	Included in SICS Unit Cost	Included in PHACO Unit Cost	Useful life	Low Volume (<500 surgeries/ year)	Medium Volume (500-2000 /year)	High Volume (>2000/ year)	Quantity Used per Intervention
Erythromycin eye ointment, 0.5%	Ointment Antibiotic	M	Yes	Yes	-	-	-	-	1
Tetracycline eye ointment, 1%, 5 gm	Ointment Antibiotic	M	Yes	Yes	-	-	-	-	1
15-degree stab knife	Side incision 1	C	Yes	Yes	Single-use	-	-	-	0.1
Blade breaker and holder	Side incision 2	E	Yes	No	5	5	10	15	-
Surgical blades for blade handle	Side incision 2	C	Yes	No	Single-use	-	-	-	0.1
Blade handle for No. 15	Side incision 2	E	Yes	No	5	5	10	15	-
Metal handle for single use knives	Side incision 3	E	Yes	Yes	5	5	10	15	-
Knife: MVR 19G	Side incision 3	C	No	Yes	-	-	-	-	0.1
Speculum	Speculum	C	Yes	Yes	-	-	-	-	1
Wire speculum, adjustable	Speculum	E	Yes	No	5	5	10	15	-

Item	Substitute	Classification	Included in SICS Unit Cost	Included in PHACO Unit Cost	Useful life	Low Volume (<500 surgeries/ year)	Medium Volume (500-2000 /year)	High Volume (>2000/ year)	Quantity Used per Intervention
Speculum, 12 mm blade (adult and child); Speculum (newborn wire – 2 mm blades; child wire – 8 mm blades)	Speculum	E	Yes	Yes	5	5	10	15	-
Instrument sterilizers	Sterilization	E	Yes	Yes	10	5	10	15	-
Autoclave machine	Sterilization	E	Yes	Yes	15	1	1	2	-
Sterilizing drums or ETO machine	Sterilization	E	Yes	Yes	15	5	10	15	-
Nylon, spatulated 6 mm needle, double armed and single armed (10-0, 9-0)	Sutures	C	Yes	No	-	-	-	-	0.08
Vicryl spatulated and cutting 6 mm needle, single armed (10-0, 8-0, 7-0, 6-0)	Sutures	C	Yes	No	-	-	-	-	0.08
10- 0 prolene suture (spatulated side-cutting needle)	Sutures	C	Yes	No	-	-	-	-	0.08

Item	Substitute	Classification	Included in SICS Unit Cost	Included in PHACO Unit Cost	Useful life	Low Volume (<500 surgeries/ year)	Medium Volume (500-2000 /year)	High Volume (>2000/ year)	Quantity Used per Intervention
9- 0 prolene suture (spatulated side-cutting needle)	Sutures	C	Yes	No	-	-	-	-	0.08
Sterile cotton surgical swabs	Swabbing	C	Yes	Yes	-	-	-	-	0.08
Triangular swabs (micro sponges)	Swabbing	C	Yes	Yes	-	-	-	-	0.1
Adrenaline, 1 mg/ml injection	Vasoconstric tor	M	Yes	Yes	-	-	-	-	1
Epinephrine (adrenaline), 2% eye drops	Vasoconstric tor	M	Yes	Yes	-	-	-	-	0.01
Methylcellulose HPMC in pre-filled syringes with cannula, 2 ml (glass syringes, where applicable)	Viscoelastics	M	Yes	Yes	-	-	-	-	1
Sodium hyaluronate, 1.4% 1 ml	Viscoelastics	M	Yes	Yes	-	-	-	-	1
Intravenous flexible cannula	None	C	Yes	Yes	-	-	-	-	0.02

Item	Substitute	Classification	Included in SICS Unit Cost	Included in PHACO Unit Cost	Useful life	Low Volume (<500 surgeries/ year)	Medium Volume (500-2000 /year)	High Volume (>2000/ year)	Quantity Used per Intervention
Pulse-oximeter system	None	E	Yes	Yes	7	1	1	1	-
Operating table with adjustable height and tilting mechanism with accessories	None	E	Yes	Yes	15	1	1	2	-
4-0 black braided silk on reel, superior rectus	None	C	Yes	No	-	-	-	-	0.1
Oxygen concentrator cannula, humidifier, adaptor kit, humidifier bottle, long-life intake filter	None	E	Yes	Yes	7	5	10	15	-
Personal protective equipment	None	C	Yes	Yes	-	-	-	-	2
Surgical eye drapes (disposable or reusable)	None	C	Yes	Yes	-	-	-	-	1
Sterile surgeon's gowns (for surgeons, assistants, and patients), reusable or disposable, where applicable	None	C	Yes	Yes	-	-	-	-	3

Item	Substitute	Classification	Included in SICS Unit Cost	Included in PHACO Unit Cost	Useful life	Low Volume (<500 surgeries/ year)	Medium Volume (500–2000 /year)	High Volume (>2000/ year)	Quantity Used per Intervention
Sterile pre-powdered or powder-free gloves (6.0, 6.5, 7.0, 7.5, 8.0)	None	C	Yes	Yes	-	-	-	-	0.02
Hypodermic sterile needles	None	C	Yes	Yes	-	-	-	-	0.02
Peribulbar needle, 25G	None	C	Yes	Yes	-	-	-	-	0.02
Sub-Tenon anaesthesia cannula, 19G	None	C	Yes	Yes	-	-	-	-	0.1
1 ml Tuberculin syringe	None	C	Yes	Yes	-	-	-	-	0.01
Cotton wool	None	C	Yes	Yes	-	-	-	-	0.08
Gauze roll	None	C	Yes	Yes	-	-	-	-	1
Eye pad	None	C	Yes	Yes	-	-	-	-	0.02
Plastic eye shield	None	C	Yes	Yes	-	-	-	-	0.1
Electric suction machine (with battery back-up) and accessories	None	E	Yes	Yes	7	1	1	1	-
Cheatle forceps	None	E	Yes	Yes	5	5	10	15	-
Instrument soaking tray	None	E	Yes	Yes	5	5	10	15	-
Distilled water unit	None	E	Yes	Yes	10	5	10	15	-

Item	Substitute	Classification	Included in SICS Unit Cost	Included in PHACO Unit Cost	Useful life	Low Volume (<500 surgeries/ year)	Medium Volume (500-2000 /year)	High Volume (>2000/ year)	Quantity Used per Intervention
Zoom magnification microscope on table stand (for cataract surgery)	None	E	Yes	Yes	15	1	1	2	-
Floor stand	None	E	Yes	Yes	10	5	10	15	-
Spare bulbs and fuse pack for microscope	None	E	Yes	Yes	1.5	5	10	15	-
Knife: slit/keratome, angled 3.2 mm (bevel up)	None	C	No	Yes	-	-	-	-	0.1
Portable surgical light	None	E	Yes	Yes	10	1	2	2	-
Phacoemulsification machine with anterior vitrector	None	E	No	Yes	15	1	1	1	-
Phaco hand piece, tip and accessory pack with silicone sleeve	None	E	No	Yes	5	5	10	15	-
Irrigation-aspiration tip (co-axial)	None	E	No	Yes	5	5	10	15	-
Phaco chopper	None	E	No	Yes	5	5	10	15	-
Fine iris spatula	None	E	No	Yes	5	5	10	15	-

Item	Substitute	Classification	Included in SICS Unit Cost	Included in PHACO Unit Cost	Useful life	Low Volume (<500 surgeries/ year)	Medium Volume (500-2000 /year)	High Volume (>2000/ year)	Quantity Used per Intervention
IOL folding and inserting forceps	None	E	No	Yes	5	5	10	15	-
Spare bulb and fuse pack for portable surgical light	None	E	Yes	Yes	1.5	5	10	15	-
Dressing trolley	None	E	Yes	Yes	10	5	10	15	-
Surgeon's stool with cushion and adjustable height	None	E	Yes	Yes	10	5	10	15	-
Operating table with adjustable height and tilting mechanism with accessories	None	E	Yes	Yes	15	1	1	2	-
Superior rectus forceps	None	E	Yes	Yes	5	5	10	15	-
Suture tying forceps	None	E	Yes	Yes	5	5	10	15	-
Lens introducing, angle to tip 8–12 mm, smooth jaw forceps	None	E	Yes	Yes	5	5	10	15	-
Capsulorhexis, angle to tip 11 mm, sharp tip to	None	E	Yes	Yes	5	5	10	15	-

Item	Substitute	Classification	Included in SICS Unit Cost	Included in PHACO Unit Cost	Useful life	Low Volume (<500 surgeries/ year)	Medium Volume (500-2000 /year)	High Volume (>2000/ year)	Quantity Used per Intervention
use as a cystotome, utrata forceps									
Straight needle holder for 4-0, 5-0, 6-0 or 7-0 suture for larger sutures	None	E	Yes	Yes	5	5	10	15	-
Curved or straight needle holder, overall length 10–11 mm, jaws 8 mm, for 8-0 to 10-0 suture	None	E	Yes	Yes	5	5	10	15	-
Conjunctival scissors	None	E	Yes	No	5	5	10	15	-
Corneal section (corneoscleral) scissors, 10 mm blades	None	E	Yes	No	5	5	10	15	-
Angled, 10 mm, extra thin blades, Barraquer scissors	None	E	Yes	Yes	5	5	10	15	-
Ordinary scissors (for cutting big sutures and threads)	None	E	Yes	Yes	5	5	10	15	-
Anterior chamber (AC) infusion cannula (AC	None	E	Yes	No	3	5	10	15	-

Item	Substitute	Classification	Included in SICS Unit Cost	Included in PHACO Unit Cost	Useful life	Low Volume (<500 surgeries/ year)	Medium Volume (500-2000 /year)	High Volume (>2000/ year)	Quantity Used per Intervention
maintainer) 23G or 25G, infusion tube									
Hydrodissection cannula, 23G to 30G, 32 degrees angled shaft, 8 mm from bend to tip, with flattened smooth oval-shaped tip	None	E	Yes	Yes	3	5	10	15	-
Viscoelastic, 22G cannula	None	E	Yes	Yes	3	5	10	15	-
Towel clip, cross action	None	E	Yes	Yes	5	5	10	15	-
Cautery ball or electric cautery	None	E	Yes	No	6	5	10	15	-
Ringers lactate solution, 1 litre bags with IVI set	None	M	Yes	No	-	-	-	-	0.05
Scrubbing brush	None	E	Yes	Yes	1.5	5	10	15	-

Step 3: Calculation of Equipment, Consumables, and Medicines Unit Costs

Calculation of unit costs for equipment, consumables, and medicines for each intervention required first determining the average useful life of equipment, and the average quantity per intervention for consumables and medicines, which was used to model the total amount used per intervention for items that typically come in larger or multiple quantities (*e.g.* nylon, vicryl, epinephrine eye drops). This information was primarily derived from the Vision and Eye Screening Implementation Handbook (*Vision and Eye Screening Implementation Handbook* 2024), Miller et al. 2022, Patnaik et al. 2025, manufacturer data (*Ultimate Guide to Extend the Lifespan of Your Ophthalmic Equipment* 2024) and the WHO Essential Medicines List (*WHO Model List of Essential Medicines - 23rd List, 2023* 2023).

We assumed different quantities of equipment required based on service volume. This allowed us to account for high-volume providers, with multiple facilities that may have more than one item of large equipment likely to significantly impact unit cost calculations (*e.g.* ultrasound scanners, autoclave machine).

For cataract surgery, these values are included in table 6 above. The useful life of equipment and quantity used per intervention for medicines and consumables for refractive error, as well as the quantity of equipment necessary by volume is included in Table 7 below.

Table 7: Assumptions for Useful Life and Quantities Required for Each Piece of Equipment

Intervention	**Item**	**Equipment (E) or Consumable (C)**	**Useful Life (E)**	**Quantity of Equipment Required (E)**			**Quantity per intervention (C)**
				Low screening volume (up to 5,000 total screened)	Medium screening volume (5,000 to 20,000 total screened)	High screening volume (more than 20,000 total screened)	
Vision screening	Torch	E	3	2	4	10	-
	Snellen visual acuity charts	E	5	2	4	10	-
	Measuring tape/rope	E	3	2	4	10	-
	Occluder	E	3	2	4	10	-
	Pin hole	E	3	2	4	10	-
	LogMAR charts	E	5	2	4	10	-
	LEA Symbols	E	5	2	4	10	-
	Sloan letters	E	5	2	4	10	-
	HOTV charts	E	5	2	4	10	-
	Kay's pictures	E	5	2	4	10	-
	Toys with detail for fixation (illuminated and non- illuminated)	E	3	2	4	10	-
	Teller acuity cards	E	5	2	4	10	-
	Cardiff acuity test	E	5	2	4	10	-
	LEA Gratings	E	5	2	4	10	-

Intervention	Item	Equipment (E) or Consumable (C)	Useful Life (E)	Quantity of Equipment Required (E)			Quantity per intervention (C)
				Low screening volume (up to 5,000 total screened)	Medium screening volume (5,000 to 20,000 total screened)	High screening volume (more than 20,000 total screened)	
Vision exam	Slit Lamp Biomicroscope	E	10	1	2	5	-
	Lens 60D, 78D or 90D	E	10	1	2	5	-
	Manually adjustable slit lamp table	E	10	1	2	5	-
	Manually adjustable chair	E	10	1	2	5	-
	Autorefractor	E	8	1	2	5	-
	Photoscreener	E	8	1	2	5	-
	Universal trial frame	E	10	1	2	5	-
	Trial lens set (full diameter with minimum number of trial lenses)	E	10	1	2	5	-
	Lens bars	E	8	1	2	5	-
	Cross cylinder	E	8	1	2	5	-
	Light box	E	5	1	2	5	-

Intervention	Item	Equipment (E) or Consumable (C)	Useful Life (E)	Quantity of Equipment Required (E)			Quantity per intervention (C)
				Low screening volume (up to 5,000 total screened)	Medium screening volume (5,000 to 20,000 total screened)	High screening volume (more than 20,000 total screened)	
	Full aperture trial lens set	E	10	1	2	5	-
	Pediatric trial frame	E	10	1	2	5	-
	Retinoscope	E	8	1	2	5	-
	Retinoscopy lens rack	E	10	1	2	5	-
	Standard automated perimeter with progression software	E	10	1	2	5	-
	Amsler grid chart	E	5	1	2	5	-
	Pelli-robson chart	E	5	1	2	5	-
	Bailey Lovie chart	E	5	1	2	5	-
	Ishihara plates	E	5	1	2	5	-
	HRR plates	E	5	1	2	5	-
	Applanation tonometer	E	10	1	2	5	-
	Non-contact tonometer	E	10	1	2	5	-

Intervention	**Item**	**Equipment (E) or Consumable (C)**	**Useful Life (E)**	**Quantity of Equipment Required (E)**			**Quantity per intervention (C)**
				Low screening volume (up to 5,000 total screened)	Medium screening volume (5,000 to 20,000 total screened)	High screening volume (more than 20,000 total screened)	
	Fluorescein strips	C	-	-	-	-	0.01
	Keratometer	E	10	1	2	5	-
	Hand held keratometer	E	8	1	2	5	-
	Optical and/or ultrasound biometer	E	10	1	2	5	-
	Direct Ophthalmoscope	E	8	1	2	5	-
	Indirect ophthalmoscope	E	8	1	2	5	-
	20D and 28D lens	E	10	1	2	5	-
	Pan retinal lens.	E	10	1	2	5	-
	Direct gonioscopy lenses	E	10	1	2	5	-
	Coupling agent	C	-	-	-	-	0.008
	Indirect gonioscopy lenses (adult and child sizes).	E	10	1	2	5	-

Intervention	Item	Equipment (E) or Consumable (C)	Useful Life (E)	Quantity of Equipment Required (E)			Quantity per intervention (C)
				Low screening volume (up to 5,000 total screened)	Medium screening volume (5,000 to 20,000 total screened)	High screening volume (more than 20,000 total screened)	
	Ultrasound scanner Mode A and B	E	10	1	2	5	-
	Ultrasound/optical pachymeter	E	10	1	2	5	-
	Computer and monitor	E	5	1	2	5	-
	Pachymetry software	E	3	1	2	5	-
	Non-Mydriatic fundus camera	E	10	1	2	5	-
	Cards for diagnosis of fundus	E	5	1	2	5	-
	Fundus charts	E	5	1	2	5	-
	Random dot and Lateral disparity	E	5	1	2	5	-
	Stereo Smile design for young children	E	5	1	2	5	-
	TNO test	E	5	1	2	5	-
	Titmus fly test	E	5	1	2	5	-

Intervention	**Item**	**Equipment (E) or Consumable (C)**	**Useful Life (E)**	**Quantity of Equipment Required (E)**			**Quantity per intervention (C)**
				Low screening volume (up to 5,000 total screened)	Medium screening volume (5,000 to 20,000 total screened)	High screening volume (more than 20,000 total screened)	
	Worth 4 dot test equipment with red- green glasses or bagolini glasses	E	5	1	2	5	-
	Prism bar (horizontal and vertical)	E	10	1	2	5	-
	Loose prisms	E	10	1	2	5	-
	Duochrome test chart	E	5	1	2	5	-
	Schirmer's strips	C	-	-	-	-	0.01
	Sodium fluorescein dye	C	-	-	-	-	0.01
	Corneal topography machine	E	10	1	2	5	-
	Antiseptic handwash solution (500 ml)	C	-	-	-	-	0.02
	Atropine sulphate eye drops, 0.5–1%	C	-	-	-	-	0.02

Intervention	Item	Equipment (E) or Consumable (C)	Useful Life (E)	Quantity of Equipment Required (E)			Quantity per intervention (C)
				Low screening volume (up to 5,000 total screened)	Medium screening volume (5,000 to 20,000 total screened)	High screening volume (more than 20,000 total screened)	
	Cyclopentolate hydrochloride, 0.5–1% eye drops	C	-	-	-	-	0.02
	Tropicamide, 0.5–1% eye drops	C	-	-	-	-	0.02
	Homatropine, 2% eye drops, 5 ml	C	-	-	-	-	0.02
	Epinephrine (adrenaline), 2% eye drops	C	-	-	-	-	0.02
Provision of readymade glasses	Readymade reading spectacles (+1.50, +2.00, +2.50, +3.00) - Please provide the cost for one unit of the most commonly used type	C	-	-	-	-	1
Provision of custom	Frames for adults (single vision)	C	-	-	-	-	1

Intervention	**Item**	**Equipment (E) or Consumable (C)**	**Useful Life (E)**	**Quantity of Equipment Required (E)**			**Quantity per intervention (C)**
				Low screening volume (up to 5,000 total screened)	Medium screening volume (5,000 to 20,000 total screened)	High screening volume (more than 20,000 total screened)	
made glasses	Frames for children	C	-	-	-	-	1
	Single vision lenses	C	-	-	-	-	1
	Auto-edger	E	10	1	2	5	-
	Lensmeter	E	10	1	2	5	-
	Manual edger	E	10	1	2	5	-
	Frame heater	E	8	1	2	5	-
	Pattern cutter	E	10	1	2	5	-
	Centration device	E	8	1	2	5	-
	Set of optical pliers	E	10	1	2	5	-

Provider data and the estimates provided in Table 5 to Table 7 were then used to calculate the equipment, medicines, and consumables unit cost for each intervention, as follows:

Refractive Error

$$Total\ Equipment\ and\ Consumables\ Unit\ Cost = \sum_{e} \left[\frac{(c_e \times n_e)}{l_e} / v\right] + \sum_{c} \left[(c_c \times q_c)\right] \tag{20}$$

Where:
c_e = cost of one unit of equipment item e
n_e = number of units of equipment e required
l_e = useful life years of one unit of equipment
c_c = cost of one unit of consumable item c
q_c = quantity of consumable item c used per intervention
v = volume of services at the specific intervention and location

The above calculation, in plain language, is the sum of: the cost of each equipment item multiplied by the estimated number of units (based on volume), divided by the useful life years of the equipment, then divided by the volume of services by intervention and location, and the cost of each consumable item multiplied by the quantity used per intervention.

Cataract Surgery

$$Total\ Equipment\ and\ Consumables\ Unit\ Cost = \sum_{e} \left[\frac{(c_e \times n_e)}{l_e} / v\right] + \sum_{c} \left[(c_c \times q_c)\right] \tag{21}$$

Where:
c_e = cost of one unit of equipment item e
n_e = number of units of equipment e required
l_e = useful life years of one unit of equipment
c_c = cost of one unit of medicine or consumable item c
q_c = quantity of medicine or consumable item c used per intervention
v = volume of services at the specific intervention and location

The above calculation, in plain language, is the sum of: the cost of each equipment item multiplied by the estimated number of units (based on volume), divided by the useful life years of the equipment, then divided by the volume of services by intervention and location, and the cost of each medicine and consumable item multiplied by the quantity used per intervention.

Step 4: Calculation of Workforce Costs

For both refractive error and cataract workforce unit costs, we specified the likely range of workforce cadres involved with service delivery but also allowed providers to define their own specific clinical or non-clinical workforce types contributing to eye care service delivery based on the WHO Eye Care Competency Framework (*Eye Care Competency Framework* 2022).

The classifications in Table 8 were first used to identify clinical and non-clinical workforce classification.

Table 8: Classification of Workforce Type

Workforce Type	**Classification**	**Proportion of Non-Clinical Time Allocated**	
		Eye-Health-Specific Service Provider[2]	**General Health Service Provider**[3]
Optometrist	Clinical	-	-
Community Health Worker	Clinical		
Refractionist	Clinical		
Optical technician (dispenses)	Clinical		
Ophthalmologist	Clinical		
Cataract surgeon	Clinical		
Basic eye doctor	Clinical		
Ophthalmic Nurse	Clinical		
Ophthalmic Clinical Officer	Clinical		
Theatre nurse	Clinical		
Theatre assistant	Clinical		
General Nurse	Clinical		
Nurse Aide	Clinical		

[2] Based on global causes of VI with 76% caused by URE or cataract (Bourne et al. (2021), The Lancet Global Health Commission on Global Eye Health: Lancet Eye Health Commission)
[3] Assumption based on figures from Australia estimating that cataract surgeries account for approximately 9.5% of all public hospital elective surgical admissions. Using eCSC as a proxy for service delivery, Australia's eCSC is approximately 90% while LMIC average is 15-20%. Applying these ratios to cataract surgical delivery gives us approximately 2% as an assumption in comprehensive hospitals in LMICs.

Workforce Type	Classification	Proportion of Non-Clinical Time Allocated	
		Eye-Health-Specific Service Provider[2]	General Health Service Provider[3]
Accounts and Finance Administrator	Non-Clinical	75%	2%
Driver	Non-Clinical	75%	2%
Equipment Maintenance	Non-Clinical	75%	2%
Laboratory Technician	Non-Clinical	75%	2%
Housekeeping & Chefs	Non-Clinical	75%	2%
Program Coordinator	Non-Clinical	75%	2%
Pharmacy Technician	Non-Clinical	75%	2%
Health Records Administrator	Non-Clinical	75%	2%
IT Support	Non-Clinical	75%	2%
Security Personnel	Non-Clinical	75%	2%
Any other non-clinical cadres	Non-Clinical	75%	2%

Clinical Workforce

Using the provider data on total FTE by location and the time taken to deliver a 'typical' service, we identified the clinical workforce responsible for delivering each intervention across each location.

To account for multiple clinical workforce types delivering the same intervention at the same location (*e.g.* using both ophthalmologists and cataract surgeons to deliver surgeries), and to ensure we captured only those involved in a 'typical' intervention (*i.e.* to prevent double-counting), a list of workforce types to be included in each clinical workforce calculation was used (see Table 9 below). In cases where multiple workforce types were reported, the lowest-cost salary of the workforce type was included.

Table 9: Workforce Assumptions Used in Costing Exercise

Intervention	One of	One of	One of

Vision screening	Optometrist, Refractionist, Ophthalmic Clinical Officer Community Health Worker, General Nurse, Ophthalmic Nurse, Teacher	-	-
Vision exam	Optometrist, Refractionist, Ophthalmic Clinical Officer, Ophthalmologist	-	-
Provision of readymade glasses	Optometrist, Refractionist, Ophthalmic Clinical Officer Community Health Worker, General Nurse, Ophthalmic Nurse	-	-
Provision of custom-made glasses	Optometrist, Refractionist, Ophthalmic Clinical Officer, Ophthalmologist,	Optical Technician	-
Cataract surgery	Ophthalmologist, Cataract Surgeon	Ophthalmic Nurse, Theatre Nurse, Theatre Assistant, General Nurse	Optometrist

For each clinical workforce type that was been identified as contributing to the intervention, the total cost per minute for each was calculated by taking the annual salary of one workforce type and divide this by 81,000, which is the estimated number of 'clinically active' working minutes per year.[4]

Formally, this calculation is:

$$C_m = \frac{S}{81000} \quad (22)$$

Where C_m is the cost per minute and S is the total annual salary for each FTE.

The clinical workforce unit costs were calculated using the above the cost per minute value multiplied by the provider reported minutes of each workforce type at each intervention.

Non-Clinical Workforce

The total cost of the non-clinical workforce (sum of annual salary multiplied by the FTE of each cadre) was multiplied by the percentage time allocation for non-clinical workforce by service-provider types (see Table 9 above).

If providers specifically indicated that the non-clinical workforce FTE provided were for cataract and/or RE services *only* the total cost was multiplied by 100% (rather than the percentage time allocation in Table 8).

This total was then multiplied by the proportion of *total clinical costs* (calculated above) for each intervention and location and then divide each by the total volume of each intervention and location, as follows:

$$U_{ij} = \frac{\left(N * \frac{C_{ij}}{M}\right)}{V_{ij}} \quad (23)$$

Where:
U_{ij} = non-clinical workforce unit cost of intervention *i* at location *j*
N = total non-clinical workforce costs across all interventions and locations
C_{ij} = unit cost of clinical workforce of intervention *i* at location *j*
M = total clinical workforce costs across all interventions and locations
V_{ij} = total volume of services of intervention *i* at location *j*

[4] Calculated based on assumption of 7.5 hour work days, 5 day work weeks, and 48 work weeks per year, at a rate of 75% clinically active time.

Step 5: Calculation of Transport and Accommodation Costs

Transport

Staff transport costs were calculated for community-based (outreach) services for refractive error, school-based (outreach) services for refractive error, and community-based (outreach) services for cataract and divided by the total staff transport costs by the volume of services delivered for each intervention delivered at each location.

For the cost per patient allocated to transport of patients to/from the facility for *facility-based* cataract surgery. The total volume of facility-based cataract surgeries was multiplied by 0.5 (to estimate 50% of the total facility-based cataract surgical volume of patients requiring transport). This was then divided by the estimated volume of patients requiring transport to estimate this portion of the unit cost for facility-based cataract surgery.

Accommodation

Staff accommodation costs were calculated for community-based (outreach) services for refractive error, school-based (outreach) services for refractive error, and community-based (outreach) services for cataract by first multiplying the number of overnight stays required by the average overnight accommodation cost. Next, the total staff transport costs was divided by the volume of services delivered for each intervention. Finally, the per diem cost was multiplied by the total number of overnight stays and added to this portion of the unit cost.

The formula for the above is:

$$C_{ij} = \frac{O_j * A}{V_{ij}} + (D \times O_j) \quad (24)$$

Where:

C_{ij} = unit cost of accommodation for intervention *i* at location *j*

O_j = total overnight stays at location *j*

A = average overnight accommodation cost

V_{ij} = volume of services for intervention *i* at location *j*

D = per diem cost per staff member on travel days

Step 6: Imputation of Provider-Based Missing Values

Missing values (*e.g.* instances where providers indicated that equipment, medicines, and consumables were used for an intervention but no costs were provided) were imputed using regional averages, once Steps 1 to 3 were completed (in order to be able to obtain regional averages and assess the level of missingness by provider).

In cases where provider spreadsheets lacked volume data, clinical workforce data, or less than 15% of equipment, medicines, and consumables costs associated with the 'typical' cases defined in Step 2, these interventions provided by these service providers were removed from further analysis.

3.4. Approach to Model Unit Costs Across All Countries

After constructing the provider-based unit costs from the costing tools (as above) we were provided with unit costs covering 30 countries (and a range of interventions within each country). To model the unit costs across all LMICs, we again followed a stepwise, consistent approach for each individual component of the unit cost for each of the fifteen interventions in the 111 countries included in the model. This section presents the six steps that the research team conducted to consistently estimate the unit costs associated with cataract and refractive error service delivery in LMICs.

Step 1: Outlier Removal

There was large variation in the costs reported in provider spreadsheets. Some of this variation was expected, particularly due to the different workforce cadres and professional salaries associated with clinical service delivery across providers and countries. However, there was some unexpected variation in costs of equipment, medicines, and consumables, likely due to different public and private procurement mechanisms (including the use of intermediaries for smaller providers and the ability of larger providers to directly procure from the supplier.

As such, we conducted a process of outlier identification and removal. We first plotted the distributions to visually inspect outliers for equipment, medicines, and consumables costs by region. Next, we formally assessed outliers by region using the interquartile range method[5], which was deemed the most appropriate method given limitations in our data (Leys et al. 2013). This process identified several very high-cost items of equipment, medicines, and consumables that were removed from subsequent analysis.

Step 2: Imputation of Equipment, Medicines and Consumables Unit Costs

Provider spreadsheets were first used to calculate volume-based weighted averages to provide country-level unit costs for equipment, medicines, and consumables, as follows:

$$Country\ Average\ Unit\ Cost\ for\ Equipment,\ Medicines,\ and\ Consumables\ =\ \frac{\Sigma(C_{peci} \times V_{peci}}{\Sigma V_{pi}} \tag{25}$$

Where:

C_{peci} = unit cost of equipment *e* and consumables (including medicines) *c* for provider *p* and intervention *i*

V_{pi} = service volume for provider *p* and intervention *i*

Next, country-level unit costs were used to calculate volume-based weighted averages to provide region-level unit costs for equipment, medicines, and consumables, as follows:

$$Regional\ Average\ Unit\ Cost\ for\ Equipment,\ Medicines,\ and\ Consumables\ =\ \frac{\Sigma(C_{keci} \times V_{keci}}{\Sigma V_{ki}} \tag{26}$$

Where:

C_{keci} = unit cost of equipment *e* and consumables (including medicines) *c* for country *k* and intervention *i*

V_{keci} = service volume for country *k*, intervention *i*, equipment *e* and consumables (including medicines) *c*

$Volume_{ki}$ = service volume for country *k* and intervention *i*

[5] The Interquartile Range (IQR) method is a common statistical technique for detecting outliers. It uses the first quartile (Q1) and the third quartile (Q3) of a dataset to establish boundaries outside of which data points are considered outliers. Any data point that lies below the Lower Bound (Lower Bound = Q1 - 1.5 × IQR) or above the Upper Bound (Upper Bound = Q3 + 1.5 × IQR) is considered an outlier.

The regional weighted averages were then applied consistently across all countries within each region. This function embeds the assumption that, adjusting for USD, the costs of equipment, medicines, and consumables should be largely consistent within-region (see Step 1: Outlier Removal). By first weighting the costs by volume, this assumption accounts for the variation seen between provider, within-country, and within-region. For the purposes of this investment case, it is important to capture this variation while allowing for estimation of country-level costs of a 'typical' intervention.

Step 3: Imputation of Clinical Workforce Unit Costs

Clinical workforce costs were not assumed to be consistent within-region. This is due to the significant workforce implications associated with the interventions modelled in this investment case, as well as the significant variation we allowed for in cadres delivering services across each provider. In addition, salaries for different workforce cadres are much more likely to vary between-country (*i.e.* within-region) due to the scarcity of these resources (as opposed to equipment, medicines, and consumables, which would typically have standardised manufacturer-set prices at the origin). Further, clinical workforce data at the provider-level relied less on regional-based imputations than for equipment, medicines, and consumables. Therefore, we had sufficient data to impute the clinical workforce costs across countries.

As with equipment, medicines, and consumables, the first step was to calculate the weighted average of clinical workforce costs by intervention using provider data for each country we received data as follows:

$$Country\ Average\ Unit\ Cost\ for\ Clinical\ Workforce_{wi} = \frac{\Sigma(C_{pwi} \times V_{pwi}}{\Sigma V_{pi}} \qquad (27)$$

Where:

C_{pwi} = unit cost of clinical workforce *w* for provider *p* and intervention *i*

$Volume_{pwi}$ = service volume for provider *p* and intervention *i* and clinical workforce *w*

$Volume_{pi}$ = service volume for provider *p* and intervention *i*

These costs were then imputed across countries using ratios taken from the WHO-CHOICE outpatient and inpatient bed costs study (Stenberg et al. 2018). The WHO-CHOICE model provides modelled median costs for provision of various 'general' health services by location, and leverages a much larger set of data to parametrically estimate these costs (over 9,000 outpatient observations). By leveraging the WHO-CHOICE model data, we are able to estimate the variation in country-level clinical workforce costs based on intervention type. Our interventions, and the corresponding country-level WHO-CHOICE values are presented in Table 10 below.

Table 10: Investment case intervention by location and service and associated WHO-CHOICE value used for clinical workforce imputation

Location	Service	WHO-CHOICE Value
Community-based (outreach)	Vision screening	Outpatient (health centre, no bed)
	Vision exam	Outpatient (health centre, no bed)
	Provision of readymade glasses	Outpatient (health centre, no bed)
	Provision of custom-made glasses	Outpatient (health centre, no bed)
	Cataract surgery	Outpatient (health centre, no bed)
School-based (outreach)	Vision screening	Outpatient (health centre, no bed)
	Vision exam	Outpatient (health centre, no bed)
	Provision of custom-made glasses	Outpatient (health centre, no bed)
Facility-based (primary)	Vision exam	Outpatient (primary health facility, with beds)
	Provision of readymade glasses	Outpatient (primary health facility, with beds)
	Provision of custom-made glasses	Outpatient (primary health facility, with beds)
Facility-based (secondary/tertiary)	Vision exam	Outpatient (tertiary hospital)
	Provision of readymade glasses	Outpatient (tertiary hospital)
	Provision of custom-made glasses	Outpatient (tertiary hospital)
	Cataract surgery	Outpatient (tertiary hospital)

By using the WHO-CHOICE data, we assume that variation in 'general' outpatient health service costs (by setting) vary in the same way that clinical workforce costs for refractive error and eye health interventions vary. Given that clinical workforce costs are a large component of the WHO-CHOICE reported outpatient costs, using these ratios to calculate the variation in clinical workforce costs is the most appropriate method for estimating this component of costs within the investment case.

The following formula was used to impute the clinical workforce unit costs associated with delivering refractive error and cataract interventions in countries where data was missing:

$$Clinical\ Workforce\ Costs_{ui} = C_{ai} \times \frac{WHOCHOICE_{ui}}{WHOCHOICE_{ai}} \quad (28)$$

Where:
c = unit cost of clinical workforce
WHOCHOICE = specific outpatient cost per person taken from WHO-CHOICE data
u = the unknown country
i = intervention
a = anchor (country, region, or global median) in which the value of clinical workforce costs associated with delivering the refractive error or cataract surgical intervention is *known*

The choice of anchor value in the above calculation is of critical importance. We followed a hierarchical structure for estimating these unit costs where we modelled first using the regional average as an anchor, followed by the next-nearest regional average (based on average GDP in the region), followed by the global average if these costs were not available.

Finally, to account for downtime specifically associated with provision of cataract surgery, and to inform a conservative assumption about the number of individuals an ophthalmologist or cataract surgeon could reasonably be expected to treat, we doubled the clinical workforce costs associated with cataract surgical delivery in each country. This conservative assumption allowed us to account for variation in surgical capacity within-countries.

Step 4: Imputation of Non-Clinical Workforce Unit Costs

There was significant variation in the non-clinical workforce costs reported by providers. Indeed, the tool allowed for significant variability from small providers with little use of a non-clinical workforce to large providers with a large, dedicated team of non-clinical professionals. To account for this variation and best reflect a 'typical' service, we used a simple median of the weighted averages of non-clinical unit costs across *all countries* in the study and applied this weighted average to each intervention in all countries. The formula for this calculation is as follows:

$$Non - Clinical\ Workforce\ Unit\ Cost_{ki} = \frac{\sum(Non{-}Clinical\ Workforce\ Unit\ Cost_{pi}}{\sum Volume_{pi}} \quad (29)$$

Where k is country, i is the intervention, and p is the provider.

The non-clinical workforce costs represent a very small proportion of overall unit costs and this conservative assumption accounts for unknown heterogeneity in non-clinical workforce costs across countries and provider types within-country.

Step 5: Transport and Accommodation Unit Costs

Similarly, there was significant variation in the transport and accommodation costs reported by providers. Some providers conducted extensive outreach work and incurred significant transport and accommodation costs, while others conducted limited outreach work and transport and accommodation costs were negligible. To account for this variation and best reflect a 'typical' service, we used a simple median of the weighted averages of transport and accommodation costs (grouped) across *all countries* in the study and applied this weighted average to each required intervention (community refractive error and cataract interventions, school eye health interventions). For facility-based cataract surgeries we included only transport costs (as per the costing tool) to capture transport of patients to/from the facility. The formula for this calculation is as follows:

$$Transport\ and\ Accommodation\ Unit\ Cost_{ki} = \frac{\sum(C_{pi}}{\sum V_{pi}} \quad (30)$$

Where:
c = transport and accommodation unit cost
v = service volume
k = country
i = intervention
p = provider

Step 6: Imputation of Overheads

To account for variation in provider types within countries, and for the purposes of the investment case modelling which would require service delivery from a large range of providers, we assumed consistent overheads across all countries and interventions (at 30%). This is towards the upper end of reported overhead costs in our survey, and three times the average reported rate of 10%. We adopted the more conservative overhead rate to account for a balance of in-country variation for providers that have very low overheads (such as community providers of readymade glasses) to providers that have very high overheads associated with eye health service delivery (*e.g.* large general-purpose tertiary hospitals).

Step 7: Calculation of Total Unit Costs

The total unit cost associated with service delivery of each intervention was calculated as follows:

$$Total\,UC_{k,i} = (UC_{k,i}^{ECM} + UC_{k,i}^{CWF} + UC_{k,i}^{NWF} + UC_{k,i}^{TA}) \times (1 + \tau) \quad (31)$$

Where:
k = country
i = intervention
$Total\,UC_{k,i}$ = total unit cost in country k for intervention i
$UC_{k,i}^{ECM}$ = equipment, consumables and medicine unit cost
$UC_{k,i}^{CWF}$ = clinical workforce unit cost
$UC_{k,i}^{NWF}$ = non-clinical workforce unit cost
$UC_{k,i}^{TA}$ = transport and accommodations unit cost
τ = percentage overheads estimate (30%)

3.5. Applying Unit Costs to Interventions

3.5.1. Early detection through screenings in the community

The primary cost drivers for this intervention are the numbers of individuals screened for vision impairment, disaggregated by delivery setting and age group, and the number of newly trained community health workers (CHWs). These volumes quantify the operational scale of screening and, when paired with per-person unit costs and training costs, determine total expenditure.

Community vision screening (Adults)

This driver is the total number of adults aged 15+ who receive community-based screening delivered by CHWs. Annual screening volumes are determined by the size of the CHW workforce, their annual screening capacity, and their time allocation to adult activities (assumed 70%). The total cost contribution of this driver is calculated by multiplying the number of adults screened in community settings by the unit cost for community screening.

School vision screening (Children)

This driver is the number of children aged 5–14 screened in school settings by CHWs. Volumes reflect the portion of CHW time dedicated to school outreach (assumed 30%) and the size of the school-age population reached each year. The total cost contribution is the number of children screened in schools multiplied by the unit cost for school-based vision screening.

Both of these drivers are modeled annually (2026–2030) and vary over time with planned CHW scale-up, capacity, and demographic composition.

Community health worker training

The cost of training new CHWs was estimated using a reference value of $125 (USD) per worker reported in Bangladesh. This figure is based on personal communication with VisionSpring with regard to their *Reading Glasses for Improved Livelihoods* (RGIL) program. The $125 per CHW value serves as a general reference for CHW training expenses and incorporates the following:

- Two days of classroom training
- Training hall rental and logistics
- Travel support for participants and trainer
- Trainer lodging and per diem
- Job aids and vision charts
- Trainer facilitation time

To account for variation in economic context across countries, this value was adjusted proportionally to each country's GDP per capita (in USD). Specifically, the training cost for country i was calculated as:

$$CHW\ Training_i = Cost_{BGD} \times \left(\frac{GDPpc_i}{GDPpc_{BGD}}\right) \quad (32)$$

Where:
i = country index
$CHW\ Training_i$ = per-CHW training cost
$Cost_{BGD}$ = per-CHW training cost in Bangladesh (USD)
$GDPpc_i$ = GDP per capita for country i (USD)
$GDPpc_{BGD}$ = GDP per capita in Bangladesh (USD)

3.5.2. Give out reading glasses on the spot

Near vision glasses dispensed in the community

This cost driver counts adults with presbyopia identified during community screening who can be fitted on the spot with ready-made spectacles. Annual volumes reflect the scale and yield of adult screening and assumed uptake rates, and grow over the 2026–2030 analytic period as screening expands. Total costs are computed by multiplying the number of community-dispensed ready-made near-vision spectacles by the total unit cost for community dispensing of ready-made near-vision spectacles.

3.5.3. Increase capacity in the workforce for eye exams and dispensing glasses

Vision exams provided in the community (Adults)

This driver is the number of vision exams delivered in the community to adults (15+) by mobile vision technicians in countries that scale up the optometrist workforce, determined by outreach deployment and exam capacity. The total cost equals the number of adult community exams multiplied by the unit cost per community-based vision exam (mobile vision technician, adults).

Vision exams in community settings (School-age children)

This driver is the number of community exams provided to children aged 5–14 by mobile vision technicians in middle-income countries, reflecting outreach time allocated to schools and exam capacity. Costs are calculated as the number of child community exams times the unit cost per community-based vision exam (mobile vision technician, school-age).

Vision exams in facilities (All ages)

This driver counts all facility-based vision exams delivered either to walk-ins (modeled via facility footfall) or to individuals referred from community screening without a mobile vision technician present. To reflect service delivery patterns, we split facility exams between primary and secondary/tertiary levels using income-specific proportions: low-income countries: 5% primary / 95% secondary–tertiary; lower-middle income countries: 20% / 80%; upper-middle income countries: 40% / 60%. The cost calculation is then the sum of level-specific volumes multiplied by the corresponding unit costs—one unit cost for primary-level exams and a separate (shared) unit cost for secondary/tertiary exams.

In middle-income countries where optometrist capacity is scaled up, we assume integration of telehealth support for facility exams. Accordingly, we apply an additional 10% cost uplift to the facility-exam subtotal in those countries to account for telehealth (i.e., the summation of primary and secondary/tertiary exam costs is multiplied by 1.10 Wong, Singh, Khanna, Ravilla, Kuyyadiyil, et al. 2022).

Near-vision (ready-made) spectacles dispensed in facilities (All ages)

We first total the number of ready-made near-vision spectacles dispensed in facilities combining walk-ins and referrals conditioning on diagnosis, referral success, and uptake. We then apportion that total between primary and secondary/tertiary facilities using the same level split as for facility exams. The primary share is valued with the unit cost for ready-made spectacles at primary care, and the secondary/tertiary share with the unit cost for ready-made spectacles at secondary/tertiary care. Summing these two components yields the total cost for this driver in each year.

Distance (custom-made) spectacles dispensed in facilities (All ages)

We aggregate all facility-dispensed custom distance spectacles from walk-ins and referrals, again conditional on diagnosis, referral success, and uptake. That total is split between primary and secondary/tertiary levels using the same level proportions applied to facility exams. We then value the primary share using the unit cost for custom-made spectacles at primary care and the secondary/tertiary share using the unit cost for custom-made spectacles at secondary/tertiary care. The sum of these level-specific costs is the annual total for this driver, which varies year-to-year with the modeled service volumes.

Distance glasses provided in community (Adults)

This driver counts all custom-made distance spectacles dispensed through community outreach by mobile vision technicians working alongside CHW teams. Volumes reflect the subset of adults who (i) are identified in community settings, (ii) receive a refraction on-site, and (iii) accept custom-made distance correction. It excludes referrals completed at facilities and all pediatric cases. Annual totals evolve with the deployment and capacity of mobile vision technicians over the analytic period. The total cost contribution is calculated by multiplying the number of community-dispensed custom distance glasses by the unit cost for custom-made glasses provided in the community.

Distance glasses provided in schools (Children)

This driver counts all custom-made distance spectacles dispensed through school-based outreach following vision screening. It includes children aged 5–14 who (i) are identified via school screening, (ii) receive a refraction in the school setting (by visiting vision technician/optometrists), and (iii) accept custom-made distance correction; it excludes adult recipients, near-vision spectacles, and any prescriptions fulfilled later in facilities. Annual volumes vary with the scale of school screening and on-site refraction capacity over 2026–2030. The total cost contribution is calculated by multiplying the number of school-dispensed custom distance glasses by the unit cost for custom-made glasses provided in school-based outreach.

Second pair of custom- or ready-made glasses

The cost driver is the number of individuals who require a replacement pair within the analytic period, given a 3-year spectacle life. Concretely, everyone who received glasses in 2026 or 2027 is modeled to receive a second pair in 2029 or 2030, respectively. All second-pair dispensing occurs in facilities and volumes are derived from the modeled counts of successfully treated glasses recipients in 2026–2027 including both ready-made near-vision and custom distance-vision spectacles.

For each country, second-pair volumes are multiplied by the corresponding facility unit costs using the same primary vs. secondary/tertiary split applied elsewhere in Intervention 3:

$$Second\ Glasses_i = s_P(Cost_{i,R,P} + Cost_{i,C,P}) + s_S(Cost_{i,R,S} + Cost_{i,R,S}) \qquad (33)$$

Where:
$Second\ Glasses$ = total cost to replacement pairs of glasses in country i

i = country index
R = ready made (near vision) glasses
C = custom made (distance) glasses
P = primary facilities
S = secondary or tertiary facilities
$Cost_{i,m,f}$ = unit cost in country i for modality $m \in \{R, C\}$ at facility level $f \in \{P, S\}$
s_p, s_S = facility split share ($constants;\ s_P + s_S = 1$)

Ready-made near-vision spectacles: primary-level share × (ready-made unit cost at primary) plus secondary/tertiary share × (ready-made unit cost at secondary/tertiary).

Custom distance-vision spectacles: primary-level share × (custom unit cost at primary) plus secondary/tertiary share × (custom unit cost at secondary/tertiary).

Each replacement pair incurs a repeat vision exam delivered in facilities. This is calculated as the sum of all replacement pairs of glasses (ready- and custom-made) multiplied by the facility level-specific unit cost for vision examinations using the same constant split between primary and secondary/tertiary facilities. The resulting total cost is presented as a single country-level total:

$$Replacement_i = Second\ exam_i + Second\ Glasses_i \quad (34)$$

Where:
$Replacement_i$ = total cost of replacing glasses after three years in country i
$Second\ Exam_i$ = total cost of conducting second vision exams in country i

Training new optometrists and vision technicians

Training costs for new vision technicians were estimated using a reference value of USD 5,000 from India (LVPEI, n.d.). This value was adjusted to each country by scaling with the ratio of country-specific GDP per capita (in USD) relative to India's GDP per capita:

$$Vision\ Technician\ Training_i = Cost_{IND} \times \left(\frac{GDPpc_i}{GDPpc_{IND}}\right) \quad (35)$$

Where:
i = country index

$Vision\,Technician\,Training_i$ = per-technician training cost

$Cost_{IND}$ = per-CHW training cost in India (USD)

$GDPpc_i$ = GDP per capita for country i (USD)

$GDPpc_{IND}$ = GDP per capita in India (USD)

The resulting unit cost was multiplied by the number of new vision technicians in each country. This approach applies equally to mobile vision technicians and those based in vision centers. Training is assumed to take two years, with costs apportioned evenly across the year prior to entry into the workforce and the year of entry.

Training costs for vision center optometrists were derived from regional values reported in a 2007 study (The Fred Hollows Foundation 2013), inflated to 2025 USD. These unit costs were multiplied by the number of new optometrists added in each country. Optometrist training is assumed to take four years, and the associated costs were distributed evenly across the four years prior to new optometrists entering the workforce, beginning in 2029 and 2030.

All drivers are modeled annually for 2026–2030 and vary with the planned scale-up of outreach and facility throughput.

3.5.4. Boost surgical productivity and teams

Additional surgeries performed by existing surgeons

The number of additional cataract surgeries performed by the current surgical workforce as a result of modeled productivity gains (i.e., incremental cases attributable to workflow optimization, task-shifting, and mentorship) is the cost driver in this context.

For each country-year, we isolate the incremental surgical volume generated by productivity improvements among existing surgeons (separate from volumes attributable to new surgeons). These additional cases are then allocated to delivery settings using income-specific splits: low-income: 40% community / 60% facility; lower-middle-income: 20% community / 80% facility; upper-middle-income: 0% community / 100% facility.

Setting-specific volumes are costed by multiplying by the corresponding per-surgery unit cost (community or facility). To reflect the cost of systematic capacity building that underpins productivity gains, we add a per-surgery mentorship increment derived from regional averages reported in a multi-country hospital strengthening study (Judson et al. 2017) and inflated to constant 2025 USD using GDP deflators, to the unit cost before applying volumes. Thus, for each setting:

$$Adjusted\ Unit\ Cost_i = Surgical\ Unit\ Cost_d + Mentorship_{reg} \tag{36}$$

Where:
$i = country\ index$
$d = delivery\ approach\ (community\ or\ facility)$
$reg = region\ index$

The community and facility subtotals are summed to obtain the total cost of new surgeries performed by existing surgeons after productivity enhancement for each country.

Additional surgeries performed by new surgeons

This category captures the incremental cataract operations attributable to adding surgeons under Intervention 4. For each country–year in which new surgeons come online, we estimate the additional surgical volume and allocate it across delivery settings using the same income-group splits as above: low-income (40% community, 60% facility), lower-middle-income (20%, 80%), and upper-middle-income (0%, 100%).

Setting-specific volumes are multiplied by the corresponding per-surgery unit costs for community and facility delivery. Unlike the calculation for productivity gains among existing surgeons, no mentorship cost uplift is applied here. Community and facility subtotals are then summed to produce the total cost of surgeries performed by new surgeons, with results aggregated to country totals over the analytic period.

Training new surgeons

The cost of training new ophthalmic surgeons was estimated by taking the per-optometrist training cost derived from the regional values and doubling it to reflect the additional requirements for surgical training. This cost was then multiplied by the number of new surgeons in each country. Training is assumed to take four years, with costs apportioned evenly across the four years prior to surgeons entering the workforce. Two cohorts of new surgeons are modeled to enter in 2029 and 2030, with training costs distributed accordingly.

3.5.5. Remove barriers to access

Transport and counselling support for cataract surgeries

This category captures the per-patient support needed to overcome access barriers for cataract surgery. The cost driver is the total number of new surgeries modeled under the investment case (i.e., additional procedures attributable to surgeon productivity gains and to newly added surgeons).

Per-patient counselling cost is derived from an observed annual counsellor cost in India of $2,800 (Wong, Singh, R. C. Khanna, et al. 2022). We assume counsellor throughput mirrors the optometrist productivity ceilings: 4,000 patients/year in low-income countries and 4,800 patients/year in middle-income countries. The implied Indian unit cost per patient is therefore $2,800 divided by the relevant annual throughput. To obtain country-specific counselling costs, the India-specific cost is scaled in proportion to relative GDP per capita rates in 2025 USD:

$$Counselling_i = Counselling_{IND} \times \left(\frac{GDPpc_i}{GDPpc_{IND}}\right) \quad (37)$$

Where:
i = country index
$Counselling_i$ = unit cost of patient counselling in country i
$Counselling_{IND}$ = observed per-patient cost of transport in India
$GDPpc_i$ = GDP per capita in 2025 for country i (USD)
$GDPpc_{IND}$ = GDP per capita in 2025 for India (USD)

Per-patient transport cost is taken from an observed $4.60 per patient in India (Wong, Singh, R. C. Khanna, et al. 2022) and scaled analogously by GDP per capita:

$$Transport_i = Transport_{IND} \times \left(\frac{GDPpc_i}{GDPpc_{IND}}\right) \quad (38)$$

Where:
i = country index
$Transport_i$ = unit cost of providing patient transportation
$Transport_{IND}$ = observed per-patient cost of transport in India
$GDPpc_i$ = GDP per capita in 2025 for country i (USD)

$GDPpc_{IND}$ = GDP per capita in 2025 for India (USD)

The support unit cost per surgery is the sum of the country-specific counselling and transport components. Total expenditure for this intervention is then calculated by multiplying this support unit cost by the modeled number of new surgeries in each country-year and aggregating over the analytic period.

3.5.6. Make cataract surgery even better

The cost driver for this component is the total number of new surgeries modeled under the investment case. For each surgery, we assign a per-patient biometry unit cost comprising three elements (equipment, consumables, and nurse time) and the cost of post-operative refraction in applicable countries.

Biometry cost

1. Equipment (per-use) — $1.93 per surgery (constant across countries).

This value is the weighted average per-use cost of biometry equipment across service levels. District hospitals are assumed to use an ultrasound A-scan (acquisition $6,000 ("A-Scan Plus Connect," n.d.), useful life 6 years, 800 patients per year), implying $1.25 per patient; tertiary hospitals are assumed to use a swept-source OCT biometer (acquisition $38,000 ("ZEISS IOL Master 700," n.d.), useful life 6 years, 3,000 patients per year), implying $2.11 per patient. The resulting weighted average equipment cost applied in the model is $1.93 per surgery.

2. Consumables — $0.03 per surgery (constant across countries).

Includes ultrasound gel where applicable (4 ml per patient; $0.01 per surgery based on $0.70 per 250 ml bottle), alcohol disinfectant swabs (two per patient; $0.01 per surgery from a 100-swab pack at $0.48), and thermal printer paper for biometry printouts ($0.014 per patient assuming 270 prints/roll, 5 rolls/$9.63). These items sum to $0.03 per surgery. All unit cost figures were drawn from the UNICEF Supply Catalogue.

3. Staff (nurse) time — region-specific.

We assume 10 minutes of nurse time per biometry measurement. Region-specific nurse salaries are taken from data provided during the costing exercise, and converted to an hourly rate using 240 workdays per year and 8 hours per day. The per-patient staff cost equals the hourly rate multiplied by 10 divided 60 (0.167).

Postoperative refraction

We assume every patient receiving cataract surgery in countries implementing postoperative refraction also receives a postoperative vision exam at a secondary/tertiary facility. The modeled number of new surgeries therefore serves as the count for postoperative examinations; multiplying this count by the secondary/tertiary facility vision exam unit cost yields the total cost of postoperative examinations.

To restore visual acuity targets, we also model the dispensing of distance spectacles after surgery. For each country, the required number of postoperative spectacles is computed as the gap needed to raise clear-vision outcomes to 80%: specifically, the difference between 0.80 and the region-specific baseline surgical success rate multiplied by the number of new surgeries. This quantity is then multiplied by the secondary/tertiary facility unit cost for dispensing custom-made distance spectacles to obtain the dispensing cost.

The postoperative refraction cost for MICs equals the sum of the secondary/tertiary postoperative examination cost and the postoperative distance-spectacle cost. Low-income countries incur no postoperative refraction cost, as no postoperative refraction is assumed.

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The Value of Vision: The case for investing in eye health is available online. We also provide detailed data and visualizations at both the global and country levels, which can be explored on the IAPB Vision Atlas: **https://visionatlas.iapb.org/** offering comprehensive insights to support evidence-based investment in eye health.

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Assam tea pickers; **by Sarah Day Photography**

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