Effective cataract surgical coverage in adults aged 50 years and older: empirical estimates from population-based surveys in 68 countries and modelled estimates for 2000–30

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Summary

Background Cataract is the leading cause of blindness worldwide despite treatment being very cost-effective. To stimulate efforts to address the large unmet need for affordable, good-quality cataract services, member states at the 74th World Health Assembly endorsed a global target of a 30 percentage-point increase in effective cataract surgical coverage (eCSC) by 2030. In this Article, we report on progress towards that target.

Methods We did a secondary analysis of 233 participant-level population-based survey datasets (Rapid Assessment of Avoidable Blindness [RAAB] surveys and other population-based cross-sectional surveys) from 68 countries (2003–24) to estimate eCSC with a cataract surgical threshold of worse than 6/18 pinhole visual acuity and a threshold of 6/18 or better for postoperative presenting visual acuity ($eCSC_{6/18}$) for each country. Eligible studies included people aged 50 years and older, without any further age restrictions. eCSC was calculated as the number of people who had received surgery and had a good visual outcome as a proportion of all people who had received or were still to receive surgery. For countries with only one survey estimate available, we reported the survey as the country estimate; for each country with two or more surveys, we used more recent and nationally representative survey to generate estimates. We included 228 of 233 datasets (excluding five datasets from the European region) in a mixed-effects logistic regression to estimate global and WHO regional temporal trends in $eCSC_{6/18}$ from 2000 to 2030. For global estimates, we used eCSC in the Americas region as a proxy for the European region. We used 120 RAAB surveys that measured visual acuity at the 6/12 threshold to analyse causes of non-good outcomes (postoperative presenting visual acuity worse than 6/12) and estimated potential gains in eCSC (with a cataract surgical threshold of worse than 6/12 pinhole visual acuity and a 6/12 or better threshold for postoperative presenting visual acuity [$eCSC_{6/12}$]) from correcting residual postoperative refractive errors. Potential gains were estimated by comparing $eCSC_{6/12}$ calculated using postoperative presenting visual acuity with $eCSC_{6/12}$ calculated using pinhole visual acuity (a proxy for visual acuity with optical correction of refractive error).

Findings We used 130 studies to report 68 country estimates of $eCSC_{6/18}$. Country estimates for $eCSC_{6/18}$ from surveys ranged from 2·1% (95% CI 0·9–3·4) in Burundi (2024) to 77·7% (72·9–82·5) in Qatar (2023). Globally, we predicted $eCSC_{6/18}$ of 48·2% (39·7–57·2) in 2025, increasing by 8·4 percentage points (8·1–8·6) between 2020 and 2030 (from 43·9% [36·6–51·2] to 52·3% [41·4–62·7]). Uncorrected refractive error accounted for a median 26·4% of non-good outcomes per survey; we estimated that treating this condition could yield a median 3·7 percentage-point gain in $eCSC_{6/12}$ globally.

Interpretation Global efforts are not on track to meet the target of a 30 percentage-point increase in eCSC between 2020 and 2030—immediate and substantial investment in cataract services is, therefore, required. Survey data indicated which elements of the cataract care pathway could be targeted for quality-improvement initiatives. A suite of cataract surgery quality indicators should be collected to better inform service providers.

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Introduction

Cataract is the leading cause of blindness and second leading cause of vision impairment globally.[1] Due to the ageing global population, the number of people with vision-impairing cataract continues to increase.[2] Cataract surgery can be a highly cost-effective intervention to restore vision, improve quality of life, and reduce poverty;[3] however, equitable access to affordable, good-quality cataract services remains an aspiration in many countries.[4]

Effective coverage indicators are WHO's preferred approach to monitoring health service coverage because

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Research in context

Evidence before this study

In 2021, the 74th World Health Assembly endorsed a global target of a 30 percentage-point increase in effective cataract surgical coverage (eCSC) by 2030. In 2022, to inform WHO's *Report of the 2030 targets on effective coverage of eyecare,* we did a secondary analysis of 148 Rapid Assessment of Avoidable Blindness (RAAB) surveys from 2003 to 2021 and reported 55 country estimates of eCSC. We showed differences in median eCSC by WHO region and World Bank income strata and found that eCSC was higher in men than in women in most WHO regions. We searched PubMed in April, 2025, using the terms "effective cataract surg* coverage" or "eCSC" for any publications on eCSC since our last search in January, 2021. We found no systematic reviews reporting eCSC but identified one secondary analysis of eCSC among a subset of RAAB survey participants aged 60 years and older in Latin America and the Caribbean. We also identified a range of primary studies reporting national or subnational estimates of eCSC. We included the datasets from most of these studies in the analysis reported here, including a report from Malaysia that compared eCSC estimates over time in two provinces; reports from national RAAB surveys in Qatar and Armenia and subnational surveys in Kogi State, Nigeria; and four district surveys in Telangana State, India. A further subnational analysis (6-year follow-up study) in Yangxi County, Guangdong Province, China, reported no statistically significant change in $eCSC_{6/18}$ between 2014 and 2020; we included the 2014 baseline data included in this study. We also identified studies reporting eCSC estimates with datasets not available for inclusion in this study; these studies included a nationally representative 31-district RAAB survey series from India, two district surveys from Odisha State in India, and one district survey from Kabul Province in Afghanistan.

Added value of this study

Compared with our analysis in 2022, this study included a greater breadth of data to report eCSC (233 surveys *vs* 148 surveys) and, for the first time, modelled global and WHO regional temporal trends for eCSC at the 6/18 threshold ($eCSC_{6/18}$) from 2000 to 2030. Empirical survey estimates were available for 68 countries rather than the 55 countries for which there were data in 2022. In addition to reporting $eCSC_{6/18}$, we expanded our secondary analysis of participant-level data to report causes of non-good outcomes (ie, worse than 6/12 presenting visual acuity) in cataract-operated eyes and quantified potential gains in eCSC that could be attained if people were to have access to refractive error services after undergoing cataract surgery.

Implications of all the available evidence

The 8·4 percentage-point increase in $eCSC_{6/18}$ from 2020 to 2030 predicted in this study suggested that, at the current rate of progress, the global target is unlikely to be met. Nonetheless, empirical survey estimates repeated in the same location identified examples of considerable absolute increases in $eCSC_{6/18}$ over time in some settings. We showed that addressing postoperative refractive error would contribute to increasing eCSC. Ideally, to guide quality improvement initiatives, service providers should strengthen the capacity of their routine health information systems to monitor a suite of cataract surgery indicators. Despite our increased number of data sources, geographical evidence gaps remain, especially for high-income countries.

they incorporate access and quality dimensions of universal health coverage in a single metric. Progress in expanding cataract services to meet increasing need can be evaluated using effective cataract surgical coverage (eCSC). Cataract surgical coverage (CSC) is a crude service coverage indicator that measures the number of people who have had cataract surgery as a proportion of all people who have had surgery or still require surgery, irrespective of the outcome of treatment. eCSC estimates the number of people who have had both surgery and effective treatment (in terms of postoperative visual acuity) as a proportion of the same denominator.[4,5] Both CSC and eCSC are reported from population-based eye health surveys from which the total unmet need for cataract surgery can be estimated.

For more on the **RAAB repository** see https://www.raab.world/

For more on the **Global Vision Database** see https://globalvisiondata.net/

In 2021, member states at the 74th World Health Assembly endorsed a global target to increase eCSC by 30 percentage points by 2030 (ie, an absolute increase of 30%).[6] In response, WHO published the 2022 *Report of the 2030 targets on effective coverage of eyecare*[7] to establish a baseline understanding of eCSC globally. To inform the 2022 report, we published eCSC estimates from 148 population-based surveys done in 55 countries between 2003 and 2021.[4]

In this update to the 2022 analysis, we report on an expanded list of primary data sources, include new modelled temporal trends in eCSC from 2000 to 2030 at the global level and WHO region level, and describe potential gains in eCSC that might be attainable if uncorrected refractive errors were adequately addressed among patients with operated cataract.

Methods

Data sources

In this secondary analysis, we used data from Rapid Assessment of Avoidable Blindness (RAAB) surveys and other population-based cross-sectional surveys listed in the Global Vision Database, a record of population-based vision and eye health surveys (including RAAB surveys). RAAB uses standardised methodology to sample people aged 50 years and older and is typically done in low-income and middle-income countries at the subnational level.[8] We included all open access participant-level RAAB datasets since 2000 and contacted principal investigators of surveys for which data had not yet been made open access to request permission to include their data. The Global Vision Database is maintained by the

Vision Loss Expert Group, a global eye health epidemiology consortium, and was most recently updated from a systematic review of published and grey literature in 2020.[9] In 2023, the International Agency for the Prevention of Blindness convened a task group to support access to these sources and any other relevant data sources published since 2020. Principal investigators of potentially eligible non-RAAB studies since 2000 were invited to share the participant-level dataset required to calculate eCSC in their sample. Eligible studies sampled people aged 50 years and older without any further age range restrictions. We excluded any datasets that had insufficient information to define cataract-related vision impairment or a history of cataract surgery.

Ethical approval for this analysis was obtained from the London School of Hygiene & Tropical Medicine Ethics Committee (25471–1).

Outcomes

eCSC, CSC, and relative quality gap were the main outcomes (panel). Since 2021, eCSC has preferentially used a presenting visual acuity of 6/12 or better to define an effective outcome in an operated eye.[10] However, older surveys often only measured visual acuity to a 6/18 threshold and do not have 6/12 data. Therefore, to maximise the data available for our main analysis, we used 6/18 as a threshold for both postoperative visual acuity (numerator) and cataract surgery (denominator). eCSC that uses a cataract surgical threshold of worse than 6/18 pinhole visual acuity and a postoperative presenting visual acuity threshold of 6/18 or better is hereafter referred to as $eCSC_{6/18}$. CSC that uses a cataract surgical threshold of worse than 6/18 is referred to as $CSC_{6/18}$.

The gap between CSC and eCSC can be considered a quality gap, with lower values reflecting better quality of cataract surgical services. For our main analysis, the relative quality gap represents people who were operated and did not achieve an outcome of 6/18 or better as a proportion of all people operated and allows for a comparison of quality across surveys.

Visual acuity outcomes after cataract surgery that do not meet the definition of good are described as suboptimal (presenting visual acuity worse than 6/12 but at least 6/60 or better) or poor (presenting visual acuity worse than 6/60).[11] In this Article, in our analysis of data from RAAB surveys that measured 6/12 visual acuity, we refer to these outcomes collectively as non-good outcomes—ie, presenting visual acuity worse than 6/12. We categorised non-good outcomes in operated eyes according to the following causes: ocular comorbidity (eg, diabetic retinopathy), intraoperative complications (eg, posterior capsular rent), posterior capsular opacification (a common sequela of surgery, treatable with yttrium-aluminium-garnet laser capsulotomy), other sequelae of surgery

Panel: Visual acuity thresholds and calculations for cataract surgical coverage, effective cataract surgical coverage, and the relative quality gap

Understanding visual acuity

Visual acuity is a measure of an eye's ability to resolve high contrast spatial detail. Snellen visual acuity notation (eg, 6/6, 6/12, 6/18, 6/60, and 3/60) denotes distance visual acuity and describes the size of letters or characters (optotypes) an individual can see. The numerator describes the distance at which the test is carried out, and the denominator shows from what distance a person with standard vision could read the same line. For example, if a person's visual acuity at 6 m is 6/60, a person with standard vision could see the same (6/60) optotype at 60 m. In this way, a larger denominator indicates worse visual acuity.

Distance visual acuity measures used as thresholds to define vision impairment

- ≥6/12: normal vision
- <6/12–6/18: mild vision impairment
- <6/18–6/60: moderate vision impairment
- <6/60–3/60: severe vision impairment
- <3/60: blindness

Calculation for cataract surgical coverage (CSC)

$$CSC = \frac{(x+y)}{(x+y+z)}$$

where *x* is individuals with unilateral operated cataract (regardless of visual acuity in the operated eye) and vision impairment (using pinhole or best-corrected visual acuity*) in the other eye, *y* is individuals with bilateral operated cataract (regardless of visual acuity in the operated eyes), and *z* is individuals with vision impairment (using pinhole or best-corrected visual acuity*) in both eyes, with cataract as the main cause of vision impairment in one or both eyes.

Calculation for effective cataract surgical coverage (eCSC)

$$eCSC = \frac{(a+b)}{(x+y+z)}$$

where *a* is individuals with unilateral operated cataract attaining a specified threshold of postoperative presenting visual acuity in the operated eye, who have vision impairment (using pinhole or best-corrected visual acuity*) in the other eye, and *b* is individuals with bilateral operated cataract attaining a specified threshold of postoperative presenting visual acuity in at least one eye.

Calculation for relative quality gap (RQG)

$$RQG = \frac{(CSC-eCSC)}{(CSC)}$$

*According to the cataract surgical threshold used in the estimate (<6/12, <6/18, <6/60, or <3/60).

(eg, retinal detachment), and residual refractive error (ie, presenting visual acuity worse than 6/12 that improves to 6/12 with pinhole correction—a proxy for best visual acuity after optical correction of refractive error).[8] Residual refractive error following cataract surgery can result from inaccurate biometry, inappropriate intraocular lens power selection, malposition of the intraocular lens, or surgically induced astigmatism.

Empirical analysis of eCSC

For individual survey estimates, we calculated age–sex-weighted eCSC and CSC from all available RAAB datasets for total populations and for women and men separately according to the method described previously.[4] For each non-RAAB survey dataset, we excluded any individuals aged 49 years or younger and used the relevant primary variables to calculate the terms *a*, *b*, *x*, *y*, and *z* (panel). For those countries with only one survey estimate available, we reported the survey as the country estimate. For each country with two or more surveys, we reported a country estimate using a decision tree such that more recent and nationally representative estimates were prioritised, as described previously[4] (appendix p 2).

See Online for appendix

The percentage contributions of the causes of non-good outcomes were estimated per cause across RAAB surveys that measured 6/12 visual acuity. We reported the median and IQR of the values for each cause per WHO region and overall. We used RAAB surveys that measured 6/12 visual acuity to estimate the potential gain in eCSC (with 6/12 as the threshold for both cataract surgery and a good outcome in terms of postoperative presenting visual acuity [hereafter referred to as $eCSC_{6/12}$]) and reduction in the relative quality gap that could be made by addressing uncorrected refractive error in operated people; for this analysis, we substituted pinhole visual acuity for presenting visual acuity in the *a* and *b* terms in the numerator (panel), summarising the percentage-point change in eCSC and relative quality gap per survey. We used $eCSC_{6/12}$ to align with the 6/12 threshold typically used to define refractive error in epidemiological studies.[10,12] We summarised causes of non-good outcomes in operated eyes by reporting the median percentage contribution of each cause per survey by WHO region. We did a subgroup analysis of eyes operated less than 3 years since the year of the survey and 3 or more years since the year of the survey because increasing time between surgery and survey increases the chance that factors unrelated to the quality of surgery might influence visual acuity.

We compared $eCSC_{6/18}$ in locations where surveys had been repeated more than 3 years apart. All estimates were age–sex-weighted to the population data provided with the survey data for each timepoint.

Modelling temporal trends in eCSC

We compared several statistical models for predicting changes in $eCSC_{6/18}$ over time and evaluated their performance using root mean square error calculated through year-wise cross-validation (appendix pp 3–8).[13] We used an expert elicitation process to guide the selection of country-level covariates to include in the model (appendix pp 9–12); however, due to insufficient data availability and multicollinearity over the modelling period, it was only feasible to test the Global Burden of Disease Study's Socio-Demographic Index (SDI) and education covariates.[14,15] The final model, selected on the basis of predictive accuracy, was a mixed-effects logistic regression, implemented using the GLMMadaptive package (version 0.9–7)[16] in R (version 4.5.0). This model was fitted to all participant-level survey data, with $eCSC_{6/18}$ defined as a binary outcome per participant (yes or no for met need with respect to receiving surgery and having postoperative visual acuity of 6/18 or better [*a* plus *b* terms in the panel]). Fixed effects included age as a categorical variable (50–59 years, 60–69 years, 70–79 years, and ≥80 years), sex (male or female), SDI (2021 values applied to all observations), year of study (2002–24; studies spanning more than 1 year were assigned a single year value according to the year in which most observations were recorded), and WHO region interacting with year of study and sex to allow region-specific temporal and sex trends. The model used country as a random effect to account for between-country heterogeneity. Due to empirical survey data limitations for the European region (only data from four countries—all in central or eastern Europe—were available), predictions for the European region were not possible; therefore, we excluded all observations from this region and trained the model on the other five WHO regions. To maintain representation of all world regions in our global estimates, we generated predictions for $eCSC_{6/18}$ across all combinations of region, country, age group, sex, and year for the period 2000 to 2030, assuming that countries in the European region had the same eCSC as countries in the region of the Americas with the same SDI (appendix p 8) and that the temporal trends observed between 2002 and 2024 continued to 2030. Global and regional estimates for the female, male, and total population aged 50 years and older were calculated as population-weighted averages, adjusted for the age–sex structure in each country using data from official UN population estimates and projections (2024 revision).[17] CIs for the estimated eCSC values were derived directly from the final model, incorporating uncertainty from both fixed and random effects.

The study is reported in accordance with GATHER guidelines (appendix pp 36–37).

Role of the funding source

The funders had no role in the study design, data collection, data analysis, data interpretation, or writing of the report.

Results

In this analysis, we included 233 surveys, 42 national studies, and 191 subnational studies from 68 countries between 2003 and 2024 (appendix pp 13–24). Of these, 223 (96%) were RAAB surveys (appendix p 25). The number of participants aged 50 years and older in each survey ranged from 1171 to 13 552 (total 779 706; median 3024 [IQR 2668–3868]).

We used 130 studies to report 68 country estimates of $CSC_{6/18}$ and $eCSC_{6/18}$ from empirical survey data (appendix pp 25–29). The highest $eCSC_{6/18}$ estimate was for Qatar, in 2023, at 77·7% (95% CI 72·9–82·5), and the lowest was for Burundi, in 2024, at 2·1% (0·9–3·4; figure 1; appendix pp 26–29). The smallest relative quality gap was 9·5%, in Malaysia, in 2023 ($CSC_{6/18}$ was 60·3%, and $eCSC_{6/18}$ was 54·6%), and the largest relative quality gap was 79·4%, in Burundi, in 2024 ($CSC_{6/18}$ was 10·2%, and $eCSC_{6/18}$ was 2·1%).

We used data from 120 RAAB surveys that measured visual acuity to a 6/12 threshold (2013–24) to calculate the overall and WHO regional median and IQR percentage contributions of the causes of non-good outcomes in 22 841 operated eyes (table 1). Across the six WHO regions, uncorrected or undercorrected residual refractive error was responsible for 26·4% (IQR 17·8–33·2) of all non-good outcomes (ranging from 20·7% [15·7–29·6] for the Western Pacific region [32 studies] to 29·5% [16·7–33·8] for South-East Asia [24 studies]). Ocular comorbidities were responsible for 26·5% (11·5–37·4) of non-good outcomes overall, but variation between regions was greater than that observed for refractive error (ranging from 11·5% [5·8–18·5] for the Eastern Mediterranean region [24 studies] to 48·2% [43·1–53·2] for the European region [four studies]). Intraoperative complications were responsible for 20·2% (10·8–27·9) of non-good outcomes overall (ranging from 12·9% [7·6–21·8] for the Western Pacific region [32 studies] to 27·5% [20·7–36·3] in the African region [32 studies]). Posterior capsular opacification was responsible for 11·0% [5·8–19·7] of all non-good outcomes (ranging from 8·0% [7·7–13·3] in the region of the Americas [four studies] to 14·8% [6·4–29·7] in the Western Pacific region [32 studies]). The distribution of causes of non-good outcomes was largely similar for surgeries done less than 3 years and 3 or more years since the year of the survey (appendix p 31).

Across all surveys, the median percentage-point gain in $eCSC_{6/12}$ that could be attained with new or improved refractive error correction for people who had had previous cataract surgery was 3·7 (IQR 2·3–6·6) percentage points. By WHO region, this ranged from 2·6 (1·7–3·0) in the Western Pacific region to 7·0 (4·3–12·4) in the Eastern Mediterranean region (table 2). The median percentage-point decrease in the relative quality gap that could be attained with new or improved refractive error correction ranged from 7·9 (5·9–10·3) in

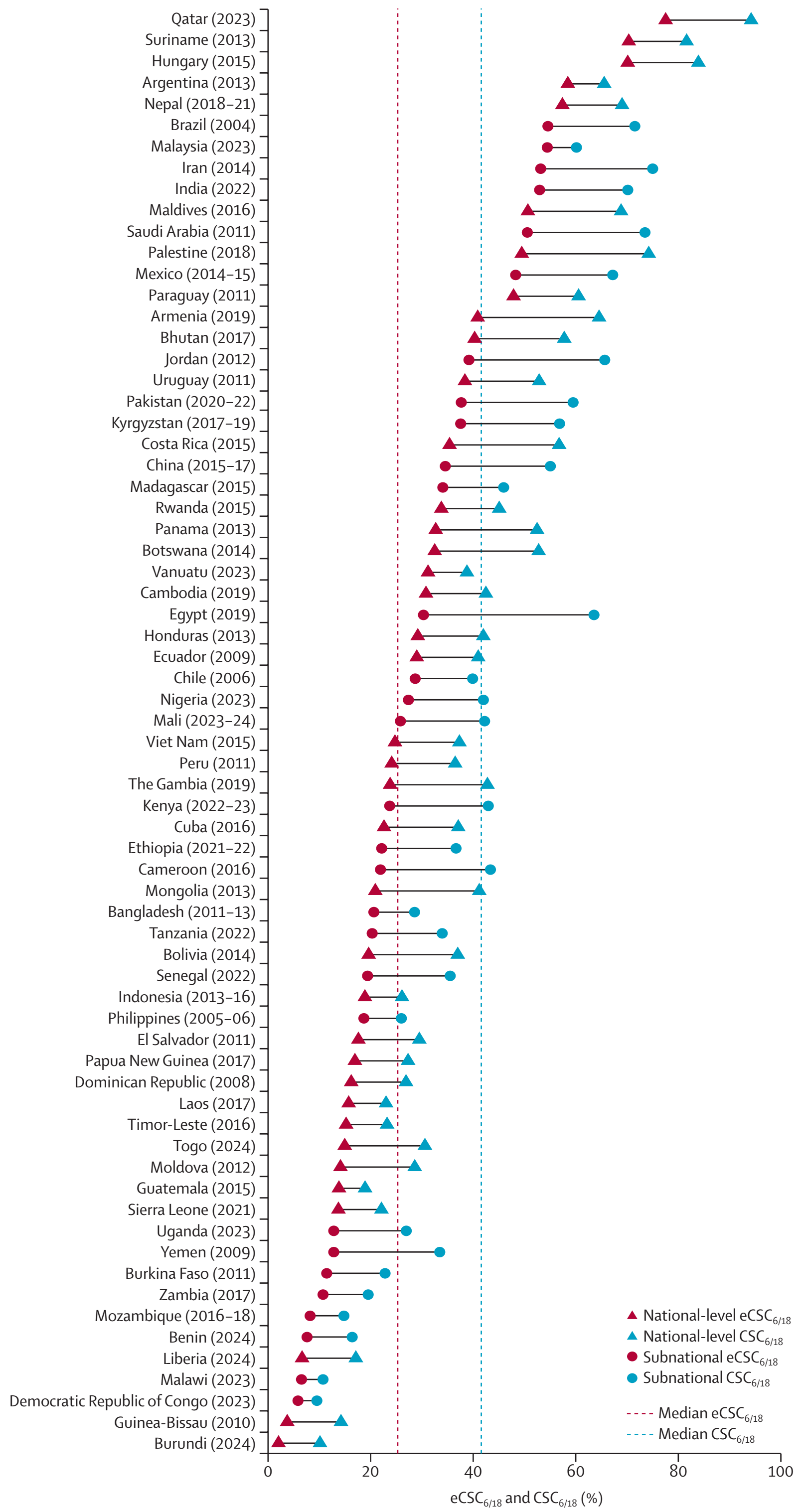

Figure 1: **Country estimates of $eCSC_{6/18}$ and $CSC_{6/18}$ from empirical survey data**
$CSC_{6/18}$=cataract surgical coverage with a threshold for cataract surgery of pinhole visual acuity worse than 6/18. $eCSC_{6/18}$=effective cataract surgical coverage with a threshold for cataract surgery of pinhole visual acuity worse than 6/18 and a threshold of 6/18 for postoperative presenting visual acuity.

	Surveys	Operated eyes with presenting visual acuity worse than 6/12	Cause of postoperative presenting visual acuity worse than 6/12, regional median percentages				
			Refractive error (IQR)	Ocular comorbidity (IQR)	Intraoperative complications (IQR)	Posterior capsular opacification (IQR)	Other sequelae (IQR)
African	32	4310	27·8% (22·8–34·1)	25·5% (17·9–31·1)	27·5% (20·7–36·3)	10·2% (5·7–15·4)	7·6% (3·5–11·9)
Americas	4	714	23·2% (22·4–27·9)	32·9% (20·6–46·0)	17·4% (14·3–19·6)	8·0% (7·7–13·3)	10·5% (7·8–12·4)
Eastern Mediterranean	24	8769	27·6% (21·9–41·1)	11·5% (5·8–18·5)	23·5% (9·8–34·7)	13·9% (6·5–21·9)	5·2% (3·3–9·0)
European	4	599	26·6% (21·5–30·7)	48·2% (43·1–53·2)	13·9% (7·3–20·4)	9·1% (5·3–12·2)	4·4% (2·4–6·0)
South-East Asia	24	4893	29·5% (16·7–33·8)	32·5% (26·5–42·1)	17·0% (10·6–22·8)	9·9% (5·6–16·5)	6·3% (3·3–12·7)
Western Pacific	32	3556	20·7% (15·7–29·6)	26·2% (10·7–46·5)	12·9% (7·6–21·8)	14·8% (6·4–29·7)	4·8% (2·0–11·4)
Total	120	22 841	26·4% (17·8–33·2)	26·5% (11·5–37·4)	20·2% (10·8–27·9)	11·0% (5·8–19·7)	5·8% (2·9–11·8)

Data are n or %. Median and IQR values were calculated from 120 Rapid Assessment of Avoidable Blindness surveys reporting to the 6/12 threshold. Median percentage contributions of each cause per survey by WHO region are calculated separately and, therefore, do not sum to 100%.

Table 1: **Median percentage contributions of five causes of postoperative presenting visual acuity worse than 6/12, by WHO region**

	Surveys	Regional median $eCSC_{6/12}$	Median percentage-point gain in $eCSC_{6/12}$ with pinhole correction *vs* presenting visual acuity (IQR)	Relative quality gap	
				Regional median percentage	Median percentage-point decrease in relative quality gap with pinhole correction *vs* presenting visual acuity (IQR)
African	32	10·5%	4·8 (2·7–6·2)	60·9%	17·3 (13·8–19·7)
Americas	4	19·0%	4·4 (3·6–5·2)	54·6%	12·7 (10·0–16·2)
Eastern Mediterranean	24	20·4%	7·0 (4·3–12·4)	57·1%	13·5 (10·1–22·5)
European	4	23·8%	5·7 (4·6–6·8)	53·3%	11·5 (7·9–14·8)
South-East Asia	24	13·4%	2·7 (1·7–6·0)	43·0%	11·4 (8·9–14·0)
Western Pacific	32	15·2%	2·6 (1·7–3·0)	45·0%	7·9 (5·9–10·3)
Total	120	15·5%	3·7 (2·3–6·6)	52·8%	12·4 (8·4–17·6)

Median values were calculated from 120 Rapid Assessment of Avoidable Blindness surveys reporting to the 6/12 threshold. $eCSC_{6/12}$=effective cataract surgical coverage with a threshold for cataract surgery of pinhole visual acuity worse than 6/12 and a threshold of 6/12 for postoperative presenting visual acuity.

Table 2: **Median $eCSC_{6/12}$, median percentage-point increase attainable with pinhole correction, median relative quality gap, and median percentage-point decrease in relative quality gap attainable with pinhole correction, by WHO region**

the Western Pacific region to 17·3 (13·8–19·7) in the African region.

17 locations had $eCSC_{6/18}$ estimates available for two timepoints. The largest percentage-point increase in age–sex-weighted $eCSC_{6/18}$ was 26·8, in Qatar, between 2009 and 2023 (from 50·9% [95% CI 43·7–58·1] to 77·7% [72·9–82·5]). There was little evidence of increasing $eCSC_{6/18}$ in the African region (n=8 locations), with only two survey locations showing an increase (Koulikoro region, Mali: from 14·5% [9·6–19·3] in 2011 to 29·0% [22·4–35·7] in 2024; Fatick region, Senegal: from 10·0% [7·0–13·1] in 2010 to 17·3% [13·7–20·9] in 2022; figure 2; appendix p 32).

We used 228 of 233 datasets (excluding five from Europe) to model global and WHO region estimates of $eCSC_{6/18}$ for the period 2000 to 2030. For 2025, the model predicted a global $eCSC_{6/18}$ of 48·2% (95% CI 39·7·6–57·2). We estimated that, between 2000 and 2020, $eCSC_{6/18}$ increased by 15·6 percentage points (15·3–15·9) globally (from 28·2% [20·7–32·2] to 43·9% [36·6–51·2]). Between 2020 and 2030, assuming that a similar temporal trend continues, we estimated an increase in $eCSC_{6/18}$ of 8·4 percentage points (8·2–8·7) globally (from 43·9% [36·6–51·2] to 52·3% [41·4–62·7]; figure 3; appendix p 33).

Across the five WHO regions for which regional estimates were possible, estimated $eCSC_{6/18}$ for 2025 was 23·6% (95% CI 22·0–25·1) in the African region. Estimates for 2025 were similar for the other four regions: Americas 50·3% (47·5–53·2), Eastern Mediterranean 54·1% (50·1–58·2), South-East Asia 55·0% (50·1–59·9), and Western Pacific 53·8% (50·6–57·0). Estimated increases between 2020 and 2030 ranged from 4·0 percentage points (95% CI 3·8–4·2) in the African region (21·6% [20·1–23·1] to 25·6% [24·0–27·2]) to 18·2 percentage points (18·0–18·4) in the Western Pacific region (44·5% [41·4–47·6] to 62·7% [59·4–66·0]; figure 3; appendix pp 34–35).

We estimated that in 2025, eCSC was 47·1% (95% CI 39·9–54·8) in women and 49·2% (39·6–59·2) in men, globally. In the African region, the 2025 estimates for women (20·2% [18·0–22·4]) and men (26·9% [24·8–29·0]) were statistically significantly different and, in this region, the predicted percentage-point increase from 2020 to 2030 was also significantly lower for women (3·6 [3·4–3·8]) than for men (4·4 [4·2–4·6]; appendix pp 33–35).

Discussion

We updated our 2022 analysis of eCSC with data from 85 additional studies and provided 28 new or updated country estimates. We predicted that, globally, $eCSC_{6/18}$ would increase by 8·4 percentage points between 2020 and 2030, assuming a consistent rate of change in cataract services. This increase represents considerably less progress than the global target of a 30 percentage-point increase endorsed at the 74th World Health Assembly.[6]

Our predictions for $eCSC_{6/18}$ in 2025 were similar for the Americas, Eastern Mediterranean, South-East Asia, and Western Pacific regions, ranging from 50·3% to 55·0%; the prediction for the African region was lower, at 23·6% (predictions for the European region were not possible). Predicted regional increases in $eCSC_{6/18}$ from 2020 to 2030 ranged from 4 percentage points in the African region to 18 percentage points in the Western Pacific region. In some regions, repeated estimates from the same survey location showed more substantial increases over periods of around 10 years and offer grounds for optimism. Indeed, it is likely beneficial for countries to set locally relevant targets and focus on implementing and monitoring tangible improvements that will contribute to global gains.

eCSC is estimated directly from intermittent population-based surveys and, as such, is not available for routine monitoring purposes. Facility-level data would, ideally, be used to inform quality improvement initiatives; indeed, in 2023, WHO published guidance on collecting and reporting cataract indicators from routine health information systems.[18] In the absence of facility data, we analysed survey data to show the potential value of such information for guiding quality improvement initiatives.

Better integration of cataract and refractive error services offers the potential to increase both eCSC and effective refractive error coverage simultaneously.[4] Here, we showed that correcting refractive error in operated eyes would eliminate approximately a quarter of non-good outcomes across all WHO regions, with corresponding gains in eCSC and reductions in the relative quality gap. The contribution of unaddressed refractive error to non-good outcomes in high-income settings might be higher still.[19] Universal access to good pre-operative biometry, matched with availability of required intraocular lens power ranges, would reduce residual postoperative refractive error.[20,21] Patients' desired postoperative refractive status should be taken into consideration, as some might prefer to optimise uncorrected near vision over distance vision. A forthcoming WHO publication[22] setting out minimum quality standards for cataract surgery management indicates that biometry should be done wherever surgery is done, but there is little evidence regarding adherence to this practice globally.

Other vision-impairing comorbidities caused a similar proportion of non-good outcomes to refractive error. These comorbidities might have existed at the time of surgery or developed after successful surgery. In a 2024 preprint of a survey in China, Li and colleagues[23] proposed that people with comorbidities should be excluded from the eCSC calculation to better emphasise surgical quality. However, eCSC estimates reflect populations' lived experiences following cataract surgery rather than providing a reflection of the immediate postoperative outcome. Building on the suggestion made by Li and colleagues, future reports of eCSC might include a breakdown of the causes of the relative quality gap and could be made in conjunction with reports of routine facility data from postoperative follow-up visits, which promise better information about the quality of surgery and existence of comorbidities.[11]

Improved surgeon training will reduce the amount of non-good outcomes attributed to intraoperative complications and reduce the overall need for refractive error correction by minimising residual refractive error among operated individuals.[24] Posterior subcapsular opacification was another common cause of reduced visual acuity after cataract surgery. However, there is little evidence globally about the availability of yttrium-aluminium-garnet laser equipment and training, the cost of care and financial protection, or strategies to inform patients with cataract about the possibility of developing secondary cataract and the option of further treatment to restore good vision.[23]

There is a risk that an over-emphasis on eCSC gains nationally and globally could lead service providers to deprioritise cataract surgery for people with any pre-existing ocular comorbidity that could limit possible improvement in visual acuity. The threshold-based

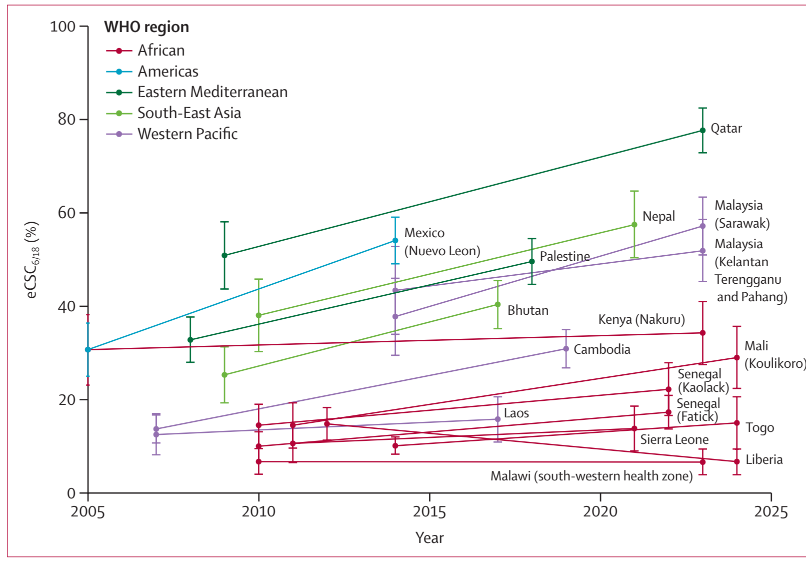

***Figure 2:* Age–sex-weighted $eCSC_{6/18}$ over time at 17 survey locations with empirical survey estimates at two timepoints**

Points represent point estimates of $eCSC_{6/18}$; whiskers represent 95% CIs. Nationally representative estimates are labelled with country name only; subnational estimates are labelled with the country and subnational area name. $eCSC_{6/18}$=effective cataract surgical coverage with a threshold for cataract surgery of pinhole visual acuity worse than 6/18 and a threshold of 6/18 for postoperative presenting visual acuity.

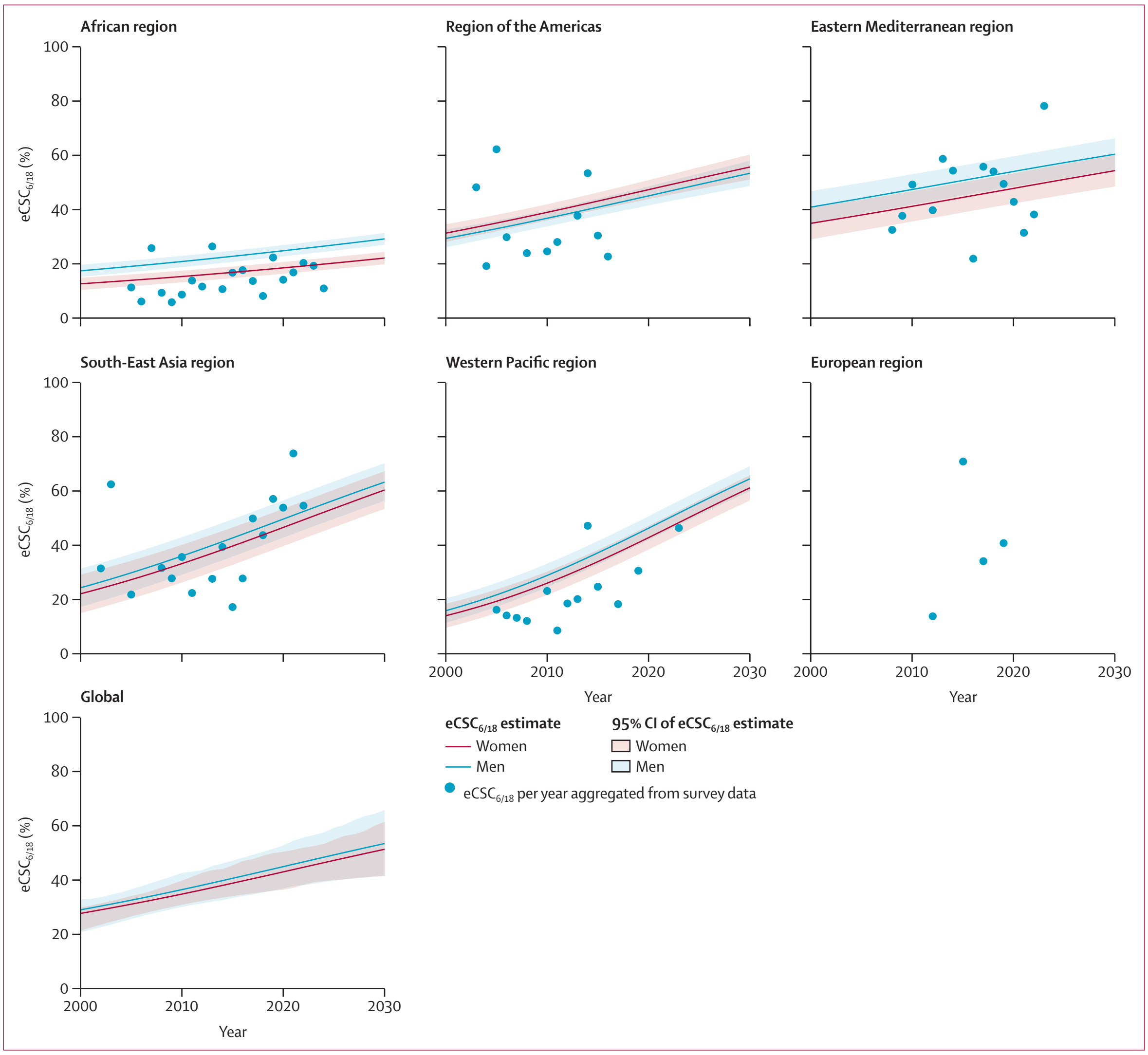

Figure 3: **Modelled $eCSC_{6/18}$ among people aged 50 years and older globally and by WHO region in 2000–30**
Global and regional $eCSC_{6/18}$ estimates were aggregated from population age–sex-weighted predictions for all countries per year. 95% CIs for global and regional $eCSC_{6/18}$ estimates were derived directly from the fitted model. $eCSC_{6/18}$=effective cataract surgical coverage with a threshold for cataract surgery of pinhole visual acuity worse than 6/18 and a threshold of 6/18 for postoperative presenting visual acuity.

nature of the eCSC definition means that an individual who improves from blindness (<3/60) to moderate vision impairment (eg, 6/60) is not included in the category of met need; however, both the individual and their provider might consider surgery to have been successful due to improvements in vision functioning and quality of life. We caution against an over-emphasis on gains in eCSC at a population level to the detriment of maximising the functional ability and wellbeing of individuals with vision-impairing cataract.[25] This more holistic assessment of quality would be enabled by monitoring patient-reported outcomes alongside visual acuity with a short questionnaire such as Cat-PROM5.[26]

Here, we have focused primarily on strategies to promote the quality of cataract surgery, but we recognise that the scarcity of context-specific evidence for strategies to improve access to cataract surgery, particularly among underserved groups, remains an important issue to be addressed.[4,27] Our modelling identified a sex-related disparity in $eCSC_{6/18}$ only in the African region, highlighting the need for more gender-responsive services in the region. However, given that empirical data have shown that eCSC is worse in women[4] and that gender inequity is ubiquitous in eye health,[3] the absence of significant differences in the modelled estimates for other regions is not cause for complacency. Apart from women, other population groups are routinely underserved by cataract services.[27] Most RAAB datasets do not include sociodemographic variables other than sex; however, since 2018, some have collected disability

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data using Washington Group questions.[28] A nationally representative 2015–19 RAAB survey series from India (data unavailable for this study) reported $eCSC_{6/12}$ disaggregated by sex and two additional equity dimensions; the India study showed that $eCSC_{6/12}$ was higher in urban settings than in rural settings and increased with increasing years of education.[29] Pilot testing of an appropriate socioeconomic position indicator in RAAB is underway; collecting place of residence (urban or rural) would also be useful in national or larger subnational sampling areas.[30] Similarly, data disaggregation by key equity dimensions should be routine for facilities reporting cataract indicators.

One key factor that will influence change in eCSC globally is the affordability of good-quality surgery. Financial risk protection for cataract surgery is a core indicator in WHO's Eye Care Indicator Menu;[11] however, neither financial risk protection for cataract surgery nor the affordability of surgery[31] have been routinely reported to date. The ongoing development of an eye health economics questionnaire for use in RAAB surveys might help address this evidence gap.[8]

The strengths of this updated analysis include the expanded number of data sources compared with 2022, including non-RAAB data. For the first time, we presented modelled global and regional temporal trends (from 2020 to 2030) relating to the global target. Our study also had several limitations. Despite the increase in data sources since 2022, empirical survey data were still unavailable for most countries. We face an almost total absence of data from high-income countries, such that we were unable to generate meaningful estimates for the European region and had to use eCSC in the Americas as a proxy for the European region in global estimates. Less than 5% of non-RAAB studies from the Global Vision Database were available for inclusion in this study. A renewed effort to increase the availability of these data sources will be important for strengthening estimates of progress towards the global target. Only half of the available studies had data at the 6/12 threshold; therefore, we reported country eCSC estimates at the 6/18 threshold and used this threshold for modelling eCSC. WHO preferentially use $eCSC_{6/12}$ as the indicator for the 2030 target. Although estimates of $eCSC_{6/12}$ are typically lower than those of $eCSC_{6/18}$ we believe that the shortfall between our predicted percentage-point increase in $eCSC_{6/18}$ and the target increase for 2030 is indicative of the challenge at both thresholds. There are limitations to the diagnostic accuracy for the causes of non-good outcomes reported from RAAB data. Surgery might have taken place many years before the survey, and diagnoses rely on a brief ocular examination with simple equipment. The use of pinhole visual acuity in RAAB might underestimate the proportion of non-good outcomes that are correctable to 6/12 and, therefore, categorised as refractive error. However, we believe that the estimates remain useful in highlighting how informative similar data from facilities could be for service providers attempting to prioritise quality-improvement initiatives. Finally, our model for $eCSC_{6/18}$ estimation did not account for variation in the representativeness of surveys (national *vs* subnational). This heterogeneity in coverage might have introduced bias or limited the generalisability of our model, particularly in countries with substantial regional disparities. Additionally, due to insufficient availability of data over the modelling period, we were unable to include several expert-prioritised country-level covariates, such as the number of ophthalmologists and optometrists per capita. Therefore, the projections we made were based on relatively simplistic modelling assumptions. Including such covariates in future model iterations as more complete data become available will be important for improving global and regional estimates.

The increase in global and regional $eCSC_{6/18}$ over the decade thus far predicted in this study suggests that the 2030 target for eCSC will not be attained without immediate and substantial investment in cataract services, particularly in the African, Eastern Mediterranean, and Americas regions. However, there are national and subnational examples of considerable progress over time. We estimated that at least 50% of non-good outcomes were likely to be preventable (eg, intraoperative complications) or treatable (eg, residual refractive error or posterior capsular opacification). Alongside measures by service providers to increase people's access to surgery in an equitable way, quality improvement initiatives have the capacity to reduce the relative quality gap between CSC and eCSC.

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Contributors

IM contributed to the methodology, data curation, formal analysis, project administration, and writing of the original draft. YO and DM contributed to the methodology, formal analysis, and review and editing of the manuscript. AH, MVC, and TS contributed to data curation, validation, and review and editing of the manuscript. EJ and YH contributed to data curation and review and editing of the manuscript. MG, MAS, and SKM contributed to investigation and review and editing of the manuscript. TDR and NW contributed to methodology and review and editing of the manuscript. RRAB, SR, and SK contributed to conceptualisation, review, and editing of the manuscript. MJB contributed to conceptualisation, methodology, funding acquisition, and review and editing of the manuscript. JR contributed to the conceptualisation, methodology, and writing of the original draft. All authors contributed to interpretation of data. IM, YO and DM had access to and verified the data reported in the manuscript. All authors had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Declaration of interests

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Data sharing

RAAB data used in the study are available online at https://www.raab.world/ or requests to data owners can be processed via raab_team@lshtm.ac.uk. Requests for access to non-RAAB datasets can be sent to the Vision Loss Expert Group via Prof R Bourne (rb@rupertbourne.co.uk). The statistical code for calculating eCSC from surveys is available at https://github.com/raabteam/raab7-analysis. The statistical code for the prediction model is available at https://github.com/yamnao/eCSC_forecasting_RAAB.

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