Effective cataract surgical coverage in adults aged 50 years and older: estimates from population-based surveys in 55 countries

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Summary

Background Cataract is the leading cause of blindness globally. Effective cataract surgical coverage (eCSC) measures the number of people in a population who have been operated on for cataract, and had a good outcome, as a proportion of all people operated on or requiring surgery. Therefore, eCSC describes service access (ie, cataract surgical coverage, [CSC]) adjusted for quality. The 74th World Health Assembly endorsed a global target for eCSC of a 30-percentage point increase by 2030. To enable monitoring of progress towards this target, we analysed Rapid Assessment of Avoidable Blindness (RAAB) survey data to establish baseline estimates of eCSC and CSC.

Methods In this secondary analysis, we used data from 148 RAAB surveys undertaken in 55 countries (2003–21) to calculate eCSC, CSC, and the relative quality gap (% difference between eCSC and CSC). Eligible studies were any version of the RAAB survey conducted since 2000 with individual participant survey data and census population data for people aged 50 years or older in the sampling area and permission from the study's principal investigator for use of data. We compared median eCSC between WHO regions and World Bank income strata and calculated the pooled risk difference and risk ratio comparing eCSC in men and women.

Findings Country eCSC estimates ranged from 3·8% (95% CI 2·1–5·5) in Guinea Bissau, 2010, to 70·3% (95% CI 65·8–74·9) in Hungary, 2015, and the relative quality gap from 10·8% (CSC: 65·7%, eCSC: 58·6%) in Argentina, 2013, to 73·4% (CSC: 14·3%, eCSC: 3·8%) in Guinea Bissau, 2010. Median eCSC was highest among high-income countries (60·5% [IQR 55·6–65·4]; n=2 surveys; 2011–15) and lowest among low-income countries (14·8%; [IQR 8·3–20·7]; n=14 surveys; 2005–21). eCSC was higher in men than women (148 studies pooled risk difference 3·2% [95% CI 2·3–4·1] and pooled risk ratio of 1·20 [95% CI 1·15–1·25]).

Interpretation eCSC varies widely between countries, increases with greater income level, and is higher in men. In pursuit of 2030 targets, many countries, particularly in lower-resource settings, should emphasise quality improvement before increasing access to surgery. Equity must be embedded in efforts to improve access to surgery, with a focus on underserved groups.

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Introduction

Effective service coverage indicators are WHO's preferred measure for countries to monitor progress towards universal health coverage.[1] Effective coverage indicators capture data on the coverage of services in the population (a measure of access), as well as quality of care.[2]

Cataract is the leading cause of blindness globally[3] and, as such, a key focus of eye health services. Treatment can improve quality of life and reduce poverty[4] and, although there is regional variation, the cost-effectiveness of cataract surgery compares favourably to that of other surgical procedures in low-income and middle-income countries (LMICs).[5,6] Cataract surgical coverage (CSC) is a service coverage indicator that measures the number of people in a population who have been operated on for cataract as a proportion of all people operated on or still

requiring surgery. CSC has been reported from eye health surveys for more than two decades.[7] Effective CSC (eCSC)—first defined in 2017—uses postoperative visual acuity to quality-correct cataract surgical coverage.[8] The use of a clinical measure of quality is a key strength of eCSC because effective coverage indicators in most other areas of health care rely on proxy quality measures.[1,9]

Given the large unmet need for cataract surgery—a cost-effective intervention with a standardised calculation method—eCSC represents an important indicator to monitor progress in eye care. In recognition of this need, member states at the 74th World Health Assembly endorsed a new global target for eCSC (a 30-percentage point increase) to be achieved by 2030.[10] Further, the resolution called for countries with a baseline eCSC of 70% or higher to strive for universal coverage. Beyond eye

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Research in context

Evidence before this study

We searched PubMed in January, 2021, without language or
date restrictions, for reviews and secondary analyses of
effective cataract surgical coverage or cataract surgical
coverage using the terms: "effective cataract surg* coverage"
and "cataract surg* coverage". Effective cataract surgical
coverage (eCSC) was first described and reported in 2017
alongside the relative quality gap between eCSC and cataract
surgical coverage (CSC). This analysis used crude estimates
from 20 Rapid Assessment of Avoidable Blindness (RAAB)
surveys of the population aged 50 years and older from
20 countries done between 2005 and 2013. For the 20 surveys,
median CSC was 53·7% and median eCSC was 36·7% (using an
operable cataract visual acuity threshold of <6/60 and a good
outcome threshold of 6/18); men had better eCSC than
women (median risk difference 4·6% [IQR 0·5–7·1], odds
ratio 1·3 [95% CI 1·0–1·5]). In addition, primary studies are
increasingly reporting eCSC. For example, a comprehensive
national eye health survey conducted in Australia in 2016
found eCSC (cataract vision impairment threshold of <6/12
and a good outcome threshold of 6/12) was 89% among the
non-Indigenous population and 52% among Indigenous
Australians. Four systematic reviews with meta-analysis have
found women less likely to access cataract surgical services
(measured by CSC) in surveys from low-income and middle-
income countries globally, in south Asia, and in India. Another
systematic review of studies conducted in Latin America found
no difference in CSC by sex in the areas surveyed.

Added value of this study

Compared with the first report of eCSC in 2017, our study
considerably increases the breadth of data used to calculate
eCSC, including many RAAB survey datasets with no previous

eCSC output. We used 148 RAAB surveys (done from 2003 to
2021) and provided estimates for 55 countries. We used
population data contemporary to the surveys to report age-
adjusted and sex-adjusted estimates in place of crude
estimates used previously. We demonstrated differences in
eCSC by geography (WHO region) and country income level
(World Bank income strata). We confirmed findings of
sex inequality in eCSC and identified regional variation in sex
inequality in eCSC, previously shown in analyses of CSC only.
Additionally, this Article sets out a modification to the CSC
and eCSC calculations recently endorsed at a WHO Technical
Meeting. The indicators now include all people with unilateral
met and unmet need for cataract surgery to alleviate vision
impairment.

Implications of all the available evidence

eCSC has been low in many settings between 2003 and 2021
and the World Health Assembly target for 2030 is ambitious
but not impossible. We found examples from three countries
where eCSC had increased by 15 to 23 percentage points over
8–10 years. In many settings, particularly low-income and
middle-income countries, considerable investment in cataract
services will be required to see improvement in line with the
global target. This study emphasises the relative quality gap
between CSC and eCSC as a metric for countries to consider
when planning cataract service interventions and whether
quality improvement should be prioritised or might be done
in parallel to improving access to services. We identified that
gender inequity in eCSC needs to be addressed in most settings
and recognise that, in addition to women, other underserved
groups should be prioritised to see equitable increases in eCSC.
Finally, improved access to historical data and new population-
based surveys are required to monitor progress.

health, eCSC will be considered for a revised Sustainable
Development Goal monitoring framework in 2025.[11]

Here we present the most comprehensive analysis of
eCSC to date. We have updated sex-disaggregated CSC
and eCSC estimates to establish a baseline of cataract
service coverage and quality, using data collected with the
most commonly used population-based eye health survey
methodology worldwide: the Rapid Assessment of
Avoidable Blindness (RAAB).[12] An update to the groups
of people included in the calculation of CSC and eCSC is
explained here for the first time.

Methods

Data source

In this secondary analysis, data to estimate CSC and
eCSC were collected from population-based surveys
conducted using the standardised RAAB survey
methodology or its predecessor the Rapid Assessment of
Cataract Surgical Services, hereafter both referred to as
RAABs.[12,13] The variables of interest for CSC and eCSC

(visual acuity, lens status, and cause of vision impairment)
have remained consistent across both versions. RAABs
sample only the population aged 50 years and older
(who have the vast majority of cataract-related vision
impairment) and have an historical emphasis on district-
level surveys in LMICs. The use of a certified RAAB
trainer scheme allows for a high level of quality assurance
and comparability between surveys. The RAAB repository
records metadata for surveys undertaken since 2000,
with datasets stored where available.

Ethical approval for analysis of RAAB repository data
was obtained from the London School of Hygiene &
Tropical Medicine Ethics Committee (25471).

Study selection

We identified potentially eligible surveys from the RAAB
repository. Eligible studies were any version of the
RAAB survey conducted since 2000 with a complete
dataset available (ie, individual participant survey data
and census population data showing male and female

5-year age-sex group counts for people aged ≥50 years in the sampling area) and permission from the study's principal investigator for use of data.

Outcome variables

CSC estimates people with operated cataract (aphakia or pseudophakia) as a proportion of people with operated cataract plus people with cataract and best corrected visual acuity (BCVA) worse than a specified surgical threshold (sometimes referred to as operable cataract; panel). eCSC estimates people with operated cataract attaining a defined level of postoperative presenting visual acuity (ie, with optical correction, if available) as a proportion of the same denominator (panel). CSC and eCSC can be reported using different visual acuity thresholds for surgery (cataract surgical threshold) and postoperative good outcome. Due to having the most data, our main analysis used 6/18 for both thresholds unless stated otherwise.

Data analysis

All data management and analyses were conducted using R software (version 4.2.1). We calculated CSC and eCSC for total populations and women and men separately from all available RAAB surveys. In cases where both eyes were operated on, presenting visual acuity in the better eye was used to define postoperative visual acuity. The gap between CSC and eCSC values can be considered a quality gap; we calculated the relative quality gap for each study as (CSC–eCSC)/CSC, with lower values reflecting better quality of cataract surgical services.

We post-stratified all estimates to the age structure of the population aged 50 years and older in the survey area using population data (eg, census data) applicable to the same study area and time period of the survey. Corresponding 5-year age-sex group population counts were provided by principal investigators at the same time as their survey data. We calculated age-adjusted, sex-adjusted estimates (age-adjusted only for sex-disaggregated estimates) from individual participant level data using the numerators and denominators for CSC and eCSC in age-sex strata (male and female for each of the 50–59, 60–69, 70–79, and ≥80 year age groups) in the survey data, multiplied those by an adjustment factor per stratum (number examined in the sample divided by the number in the population) and

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Panel: Visual acuity thresholds in Rapid Assessment of Avoidable Blindness (RAAB) and an updated effective cataract surgical coverage (eCSC) definition

RAAB survey protocols up to RAAB5 screened visual acuity to the 6/18 level (moderate vision impairment), and subsequent versions (2013 onward) also screened visual acuity at the 6/12 level (mild vision impairment). Cataract surgical thresholds have historically been reported as: worse than 3/60 (blindness), worse than 6/60 (severe vision impairment), and worse than 6/18. In 2021, after consultation with member states and eye care stakeholders, WHO proposed that eCSC should also be reported against a cataract surgical threshold of worse than 6/12 (mild vision impairment). The recommendation also included updating the definition of a good surgical outcome from 6/18 or better to 6/12 or better.[14] Here, we outline an update to the previously defined calculations,[8,14] endorsed at a WHO Technical Meeting in July, 2022.

Although cataract is often a bilateral condition, people with cataract in one eye and vision impairment from another cause in the other eye can still benefit from surgery. The recent update now includes two groups of people that were historically excluded from cataract surgical coverage (CSC) and eCSC calculations:

- People with operated cataract in one eye (people included in the x and a variables) are included in the numerator with any cause of vision impairment in the other eye (determined using best corrected visual acuity [BCVA])
- People with an unmet need for surgery (people included in the z variable) are included in the denominator if they have bilateral cataract or unilateral cataract with any cause of vision impairment in the other eye (determined using BCVA)

This update gives a more complete picture of met and unmet need for cataract services, while also being more people-centred by not excluding anyone with vision impairment from cataract.
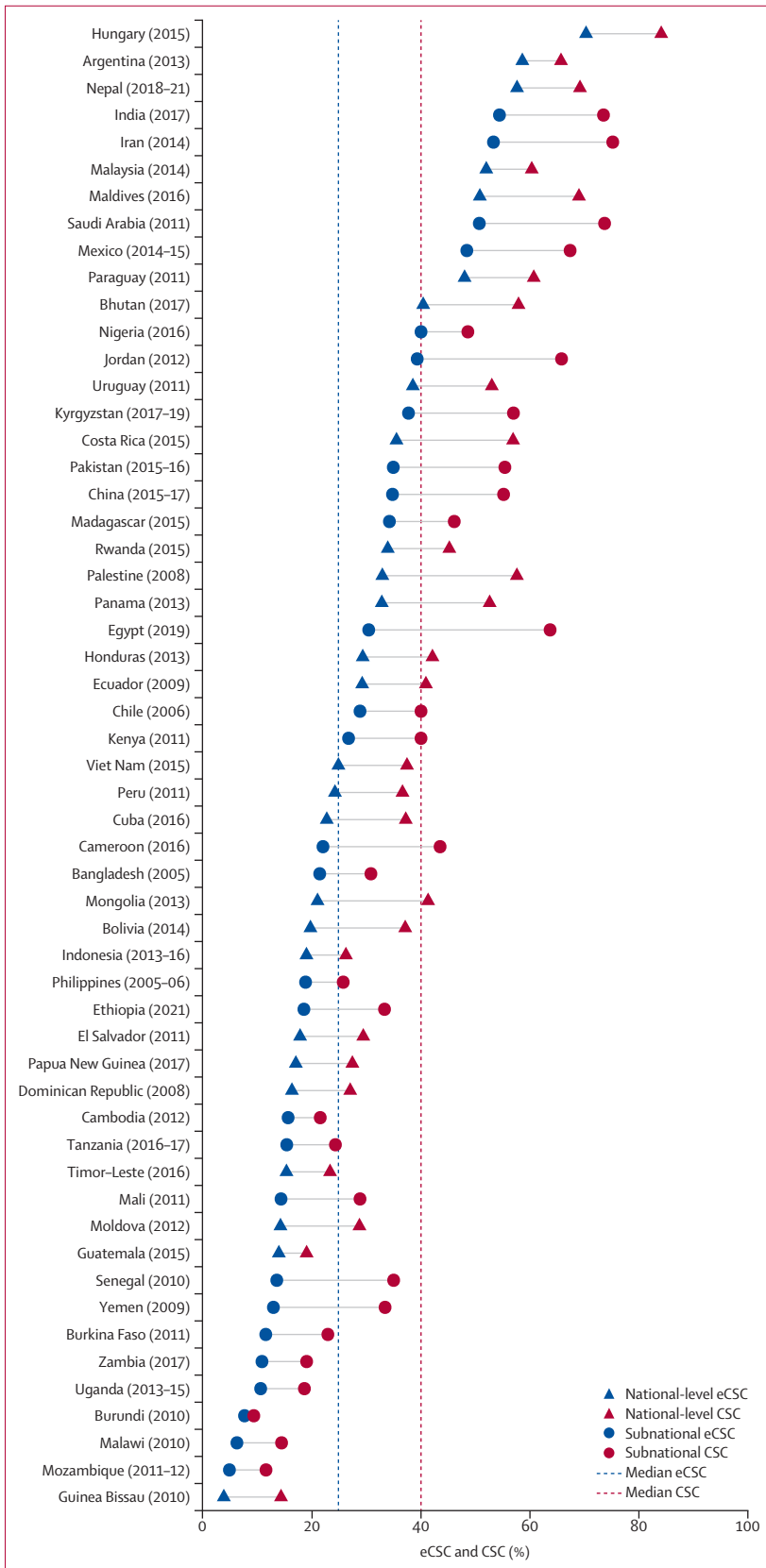
Calculation for CSC

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

where x is individuals with unilateral operated cataract (regardless of visual acuity in the operated eye) and vision impairment (using BCVA*) 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 BCVA*) in both eyes with cataract as the main cause of vision impairment in one or both eyes.†

Calculation for 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 BCVA*) 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.†

*According to the cataract surgical threshold used in the estimate (<6/12, <6/18, <6/60, or <3/60). †Cases of couched eyes are excluded from the count of x, y, a, and b.

Figure 1: Country estimates of eCSC and CSC
Cataract surgical threshold of less than 6/18 and 6/18 threshold for a good outcome. CSC=cataract surgical coverage. eCSC=effective cataract surgical coverage.

calculated adjusted coverage from the summed outputs. To account for RAAB's two-stage cluster sampling strategy,[12] 95% CIs were calculated from standard errors adjusted for the clustering of the sample and the variability between clusters of the denominator using formula six from Bennett and colleagues.[15] This approach, which is consistent with RAAB's standardised automated reporting analysis, gives more conservative standard errors than the exact binomial formula by including parameters to account for clustering and differences in cluster sizes.

Where two or more surveys were available from a country, only one estimate was used according to a predetermined decision tree based on sampling frame representativeness (national or subnational) and the time in years since the studies were completed (appendix p 1); this is referred to as the country estimate. National surveys were either a single survey (typically in smaller countries) or a series of subnational surveys designed for national coverage. Where there was no national estimate available, we pooled any two or more subnational surveys done within 3 years of the most recent single survey. More recent studies and studies with nationally representative sampling frames (either a single survey or a pooled series of subnational surveys) were prioritised. We combined subnational estimates from the same country using an inverse variance weighted average, which was calculated using the metagen command from the meta package in R.[16]

We used country estimates to compare the median, IQR, and range for surveys grouped geographically (by WHO region) and by income level (using World Bank country income level;[17] high, upper middle, lower middle, and low). We used survey estimates in random effects meta-analysis of the risk difference and risk ratio comparing men and women. We also compared eCSC estimates over time where comparable sampling frames had been used in repeat studies.

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

Results
We identified 148 surveys for inclusion in this analysis (appendix pp 2–7), which comprised 24 national and 124 subnational samples undertaken in 55 countries between 2003 and 2021. All six WHO regions were represented. Many more studies were available from 2010 onwards (n=115) than for 2000–09 (n=33).

The 148 datasets were 44% of the 335 RAABs known to have been done as of April 1, 2022; data for the remaining 187 surveys had not been shared with the RAAB repository or permission for use in secondary analysis had not been granted by the study principal investigator (appendix p 8).

The number of participants in each survey ranged from 1171 to 6482 (total 468852; median 2995·5 [IQR 2418·8–3765·5], and the number having had bilateral or unilateral cataract surgery (with <6/18 BCVA in the unoperated eye) in each survey ranged from five to 692 (total 22150; median 113·0 [IQR 59·0–177·3]). 105 of 148 studies were used to generate 55 country estimates (figure 1; appendix pp 9–11). Individual subnational estimates were pooled for 14/54 country results (appendix p 12).

The highest eCSC estimate (6/18 threshold for operable cataract and good outcome) was from Hungary (2015) at 70·3% (95% CI 65·8–74·9) and the lowest was from Guinea Bissau (2010) at 3·8% (95% CI 2·1–5·5; figure 1). From all 55 included countries, the median eCSC estimate was 24·8% (IQR 15·5–38·1) and the median CSC estimate was 40·0% (IQR 27·2–57·3). There was variation in the quality gap between CSC and eCSC across countries, as indicated by the length of the line between point estimates in figure 1. The smallest relative quality gap was 10·8% in Argentina (2013; CSC 65·7%, eCSC 58·6%), and the largest relative gap was in Guinea Bissau (2010) at 73·4% (CSC 14·3%, eCSC 3·8%; appendix pp 9–11). 15 countries had CSC higher than 50% but a relative quality gap of more than 25% (appendix p 13).

By World Bank income strata, median eCSC was highest in the high-income group (60·5% [IQR 55·6–65·4]; n=2 surveys; 2011–15) and got progressively lower moving down to 14·8% (IQR 8·3–20·7; n=14 surveys; 2005–21) in the low-income group (figure 2). The median regional eCSC was highest in the South-East Asia region (40·4% [IQR 20·2–52·6]; n=7 surveys; 2005–21) and in the European region (37·7% [IQR 26·0–54·0]; n=3 surveys; 2012–19) and lowest in the African region (13·9% [IQR 9·8–23·2]; n=16 surveys; 2010–21; figure 2). The Eastern Mediterranean region had the highest median CSC at 63·7% (IQR 56·5–69·8; n=7 surveys; 2008–19), but the quality gap meant the median eCSC in the region was lower than in the South-East Asia region, or the European region (figure 2).

There were four settings for which data were available from two timepoints. In Bhutan, eCSC improved from 25·3% (95% CI 19·3–31·3) in the first national survey in 2009 to 40·4% (95% CI 35·2–45·5) in the second in 2017. Pooled eCSC estimates from two series of subnational surveys done in Nepal in 2008–10 (n=10 surveys) and 2018–21 (n=7 surveys) showed that eCSC increased from 38·1% (95% CI 30·3–45·9) to 57·6% (95% CI 50·4–64·8) across the decade. The relative quality gap in Bhutan remained similar (30·3% to 30·2%), and in Nepal it decreased from 25·5% to 16·7%. At a subnational level,
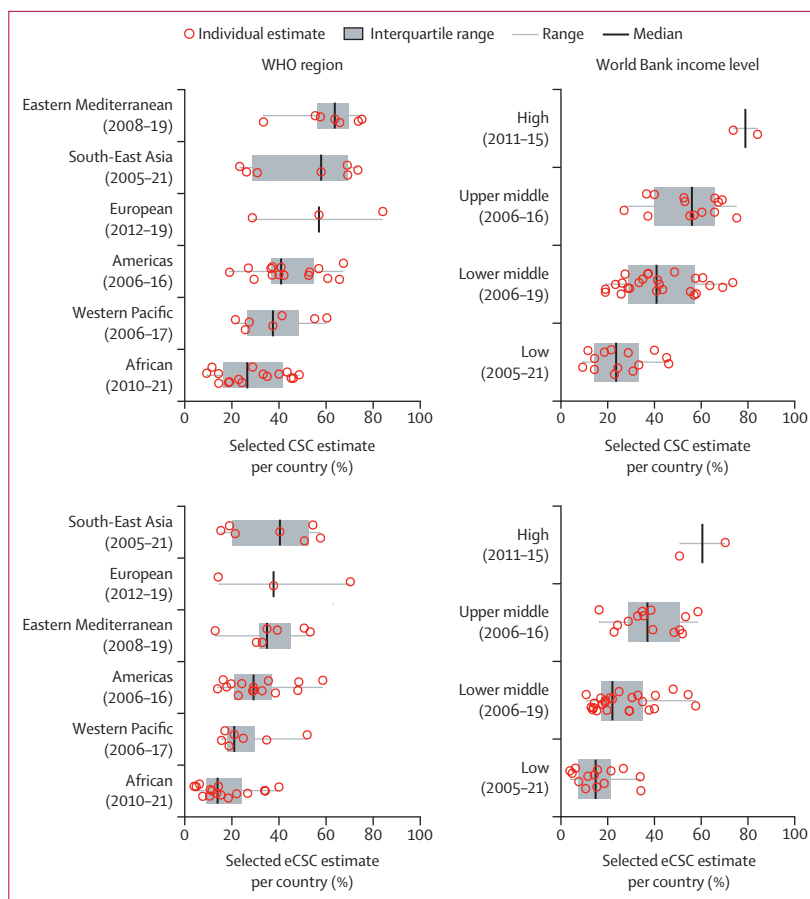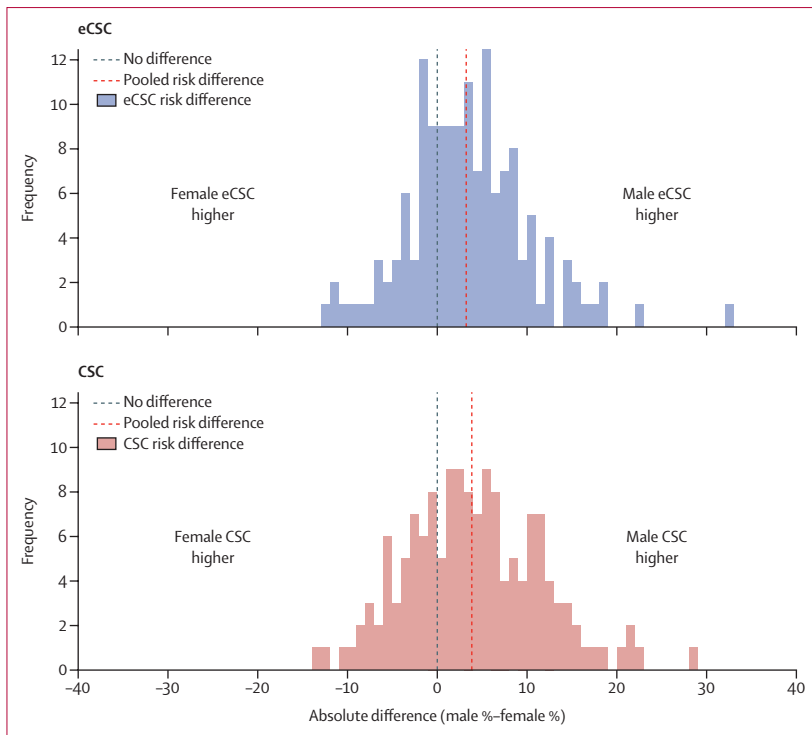

Figure 2: Country estimates of eCSC and CSC by WHO region and World Bank income strata
Cataract surgical threshold of less than 6/18 and 6/18 threshold for a good outcome. CSC=cataract surgical coverage. eCSC=effective cataract surgical coverage.

in Nuevo León state, Mexico, eCSC increased from 30·7% (95% CI 25·0–36·4%) to 54·1% (95% CI 49·1–59·1%) between 2005 and 2014 (the relative quality gap decreased from 33·4% to 25·3%), and in Koulikoro region, Mali, eCSC did not increase significantly between surveys in 2008 (10·8% [95% CI 8·0–13·6%]) and 2011 (14·3% [95% CI 9·4–19·2%]).

eCSC was higher in men than women (148 studies pooled risk difference 3·2% [95% CI 2·3–4·1]; figure 3; and pooled risk ratio of 1·20 [95% CI 1·15–1·25]). For CSC, the absolute difference (3·9% [95% CI 2·7–5·0]; figure 3) and prevalence ratio (1·15 [95% CI 1·11–1·19]) in favour of men were similar to effective coverage (appendix pp 14–21). There was no evidence of an absolute or relative pooled difference in male and female eCSC or CSC in the region of the Americas (20 studies, 2003–16) or the Europe region (four studies, 2012–19) with the CIs including null (no difference; appendix pp 14–21).

Data to calculate eCSC at the 6/12 visual acuity threshold were available for 63 studies from 19 countries. For these country estimates (determined using the same decision-tree process outlined above), there was

See **Online** for appendix

***Figure 3*: The absolute difference in male and female eCSC and CSC**
Cataract surgical threshold of less than 6/18 and 6/18 threshold for a good outcome. Risk differences calculated for 148 surveys. CSC=cataract surgical coverage. eCSC=effective cataract surgical coverage.

considerable variation in eCSC (using 6/12 as a good outcome) across four cataract surgical thresholds (figure 4). This variation was largest in Malaysia (2014) where eCSC was 65·4% using a surgical threshold of less than 3/60, 61·9% at a threshold of less than 6/60, 43·8% at a threshold of less than 6/18 and 29·2% at a threshold of less than 6/12. At the worse than 6/12 cataract surgical threshold, no country had eCSC greater than 50% and four had eCSC under 10%.

Discussion

We conducted a secondary analysis of 148 population-based eye health surveys (from 55 countries, between 2003 and 2021) to generate new estimates of eCSC. This analysis serves as a basis to monitor progress towards the global eCSC target, a 30-percentage point increase by 2030, that was endorsed at the 74th World Health Assembly, while also highlighting important data gaps to address through future surveys.[10] We used an updated, more inclusive definition of CSC and eCSC (panel). The median eCSC across 55 countries was 24·8% and median CSC was 40·0%. We found wide variation in eCSC by country and a gradient of increasing eCSC with increasing World Bank country income level stratum, reflecting the tendency for greater resources and subsequent cataract service output in countries with higher income.[6,18] The South-East Asia and European regions had the highest eCSC, and the African region had the lowest. The Eastern Mediterranean

region had the highest crude coverage but had a lower effective coverage than South-East Asia and European regions.

These results reveal that there can be a large gap between CSC and eCSC and highlight the need for countries to consider both components of eCSC—ie, access and quality—as they set about meeting their 2030 target. The range of interventions needed to increase quality and access or quantity of cataract services can be quite different. The relative quality gap and the level of crude coverage could help determine the relative emphasis providers might place on quality improvement and scaling up services. For example, countries with a relative quality gap of less than perhaps 25% might want to focus on improving access while maintaining or improving quality. In contrast, countries with a larger quality gap of 25% or higher might choose to particularly invest in quality improvement initiatives before focusing on actions to increase access or output. Our results highlighted 15 countries with CSC of 50% or higher that could make considerable progress towards the 2030 eCSC target by improving quality alone.

Countries can gain additional context by considering recent facility-based surgical outcome data and their cataract surgical rate (number of operations per million people per year). Contemporary outcome monitoring is important because eCSC reflects the results of all surgeries received by participants, some of which might have been decades earlier using superseded techniques, or after which postoperative comorbidities unrelated to surgery had developed. Cataract surgical rate is commonly low in LMICs;[6,18] surgeries might be more frequently done on eyes with more advanced cataract and comorbidities, meaning good postoperative visual outcomes are less probable. Moreover, if individual surgeons are performing relatively few cataract operations, they might not gain enough experience to improve and maintain skills. Here, surgeons should not be disincentivised to operate but should be supported to deliver quality outcomes while increasing output. For example, trial evidence from multiple African countries indicates that a training intervention package combining surgical simulation with deliberate sustained practice can substantially improve patient safety and surgeon productivity.[19]

Although quality is captured in eCSC through postoperative visual acuity (ie, effectiveness), there are other important components of quality health care[20] not captured (eg, safety, efficiency, people centredness, and timeliness) that should be considered in quality improvement initiatives, particularly in high-resource settings where visual outcomes are already routinely good.[21] Measuring effectiveness using presenting visual acuity rather than best-corrected acuity reflects patients' lived experience of postoperative visual outcomes. Residual refractive error can be caused by limitations in availability of ocular biometry and a range of intraocular lens powers, particularly in low-resource settings.

Alongside investment in surgical equipment, training, and point-of-care monitoring of surgical outcomes, increasing the availability and affordability of refractive and optical services, including through better integration with surgical services, will help reduce residual refractive error.[21] This last strategy offers the opportunity to improve effective refractive error coverage[14,22] for distance and near vision as well as eCSC.[6]

There have been encouraging examples of improvements in eCSC, which countries can draw on, with increases ranging from 15 to 23 percentage points over 8 to 10 years. For example, over the period Nepal increased its eCSC by 20 percentage points, the proportion of surgeries with an intraocular lens increased from 86% to 98%. A further driver of improvement was a major funder of outreach cataract surgery in the country making biometry mandatory in 2007, meaning people were much more likely to receive the most appropriate intraocular lens and therefore achieve better postoperative visual acuity (unpublished data).

To overcome inequities in cataract vision impairment that are ubiquitous within countries, efforts to improve access to good-quality cataract services should focus on historically underserved groups that might include vulnerable populations (eg, low socioeconomic position or low social support) and people living in rural communities.[6] For example, in Australia, a country with high-quality services, a national survey estimated that the eCSC for non-Indigenous Australians (89%) was substantially higher than that for Indigenous Australians (52%).[23] Due to data availability, our analysis focused on sex disparities. Our findings were consistent with previous analyses which found that men were more likely to have accessed cataract surgery than women in various LMICs globally, in south Asia, and in India (all measured by CSC),[24–26] while a study from Latin America found no overall difference in eCSC by sex in the areas surveyed.[27]

A recent exercise to identify the most relevant eye health indicators for universal health coverage recommended that indicators be disaggregated by sex, place of residence, socioeconomic position, and disability status.[28] Once the population groups with lowest eCSC are identified, countries can implement strategies to improve access for these groups. Unfortunately, evidence on how to do this is currently limited, but includes patient counselling, transport provision, and free surgery.[29–31] Financial protection, the third dimension of universal health coverage,[32] is an important strategy to improve access to health services. Although cataract surgery is a cost-effective intervention, cost is frequently reported as a barrier to access,[33] and the availability of financial protection for cataract surgery is largely unknown.[6] WHO has developed a package of eye care interventions to support countries in planning and budgeting for integrating eye care interventions into their health systems.[34] This package recommends that high-priority eye care interventions,
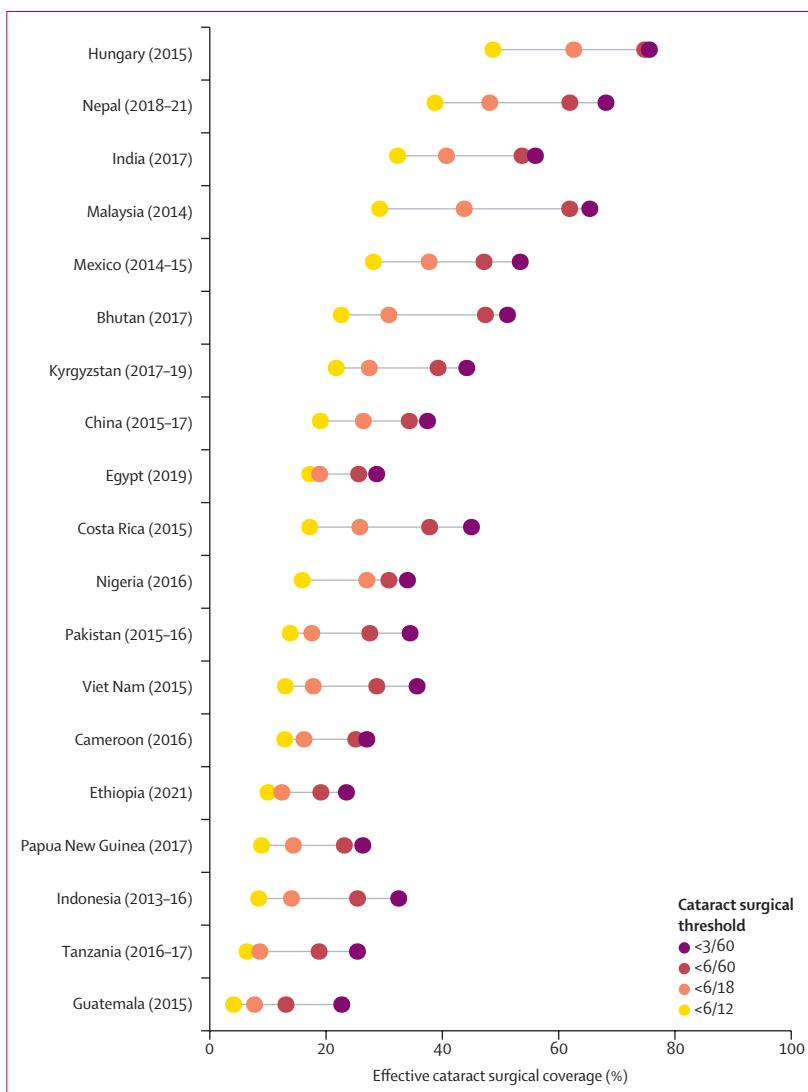

Figure 4: Range of effective cataract surgical coverage across four cataract surgical thresholds
6/12 threshold for a good outcome.

including cataract surgery, should be included in service packages covered by pre-paid pooled financing.

WHO anticipates that the shift to a 6/12 threshold for a good outcome and cataract surgical threshold will stimulate quality improvement and encourage providers to offer surgery earlier with less vision loss. At the same time, WHO proposed that countries also report effective coverage at the cataract surgical thresholds most applicable to their context.[14] We found a marked reduction in eCSC (at the 6/12 threshold for a good outcome) with lower cataract surgical thresholds. Our results highlight that there are still settings where people with cataract blindness have been unable to access services and, here, the relevance of monitoring eCSC at multiple cataract surgical thresholds is clear. Countries might (arguably rightly) prioritise using limited resources to provide

services to people with more vision loss, meaning less progress will be observed at the 6/18 and 6/12 thresholds.[35]

In some settings, service providers might find patients with early cataract easier to reach and treat effectively, thereby increasing effective coverage. However, this approach will only serve to widen inequalities between population subgroups. Preoperative visual acuity among cataract surgery patients is a recommended indicator in WHO's eye care indicator menu and could be monitored to assess if surgical output is tailored to populations at greater risk of cumulative disadvantage.[36,37]

The strengths of this analysis of historical survey data include the breadth of RAAB survey data available compared to previous studies.[8,27] All studies were conducted using a comparable RAAB sampling and examination protocol, were overseen by centrally accredited survey trainers, and supported by standardised software, providing assurance of the internal and external validity of the estimates. We used individual participant level data to estimate new cluster-adjusted, age-adjusted, and sex-adjusted eCSC and CSC in place of the crude estimates previously reported and presented an estimate per country according to a decision tree that prioritised newer, nationally representative data.

Our study also had several limitations. First, estimates were unavailable for most countries. Second, data were only available from two high-income countries. Because high-income countries would be expected to have higher eCSC, our regional results probably underestimate the true eCSC. For example, a recent survey in Australia[23] found an eCSC of 89% at the 6/12 threshold among the non-Indigenous population, which suggests the true gap between high-income and low-income countries might be wider than we report here. Third, it is possible that in low-income regions, countries with population-based data might have more mature eye care services than countries that have no population-based data. Therefore, our median value for such regions might overestimate effective coverage if the situation in countries with no data is in fact less favourable. Fourth, there were 187 surveys from 25 additional countries listed on the RAAB repository that were not available for inclusion in this analysis. These studies were similar to included studies in terms of being national or subnational and decade of completion, and as such we believe those included are a reasonable representation of all RAABs done to date. Fifth, we included RAABs done between 2003 and 2021 and, as such, estimates were not directly comparable across countries or regions. Finally, just under half of the country estimates (27/55) were nationally representative; the remainder report results from subnational areas which might underestimate or overestimate effective coverage at the national level depending on whether services in the subnational area are stronger or weaker than the national average.

A 30-percentage point global increase in eCSC by 2030 is an ambitious target, which, if adequately supported by investment in services, could stimulate necessary improvements in cataract surgical quality and coverage, particularly in LMICs. In most such countries, quality improvement should be prioritised before increasing population access to surgery, but strategies to improve access and affordability for traditionally underserved groups are also required. More population-based surveys are needed to monitor eCSC through to 2030 with an emphasis on greater geographical coverage of data gaps, particularly in the European region, the Eastern Mediterranean region, and the region of the Americas.

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