



DELAYED CATARACT SURGERY IN RURAL AND UNDERSERVED POPULATIONS: A SYSTEMATIC REVIEW OF BARRIERS, CLINICAL CONSEQUENCES, AND STRATEGIES TO IMPROVE SURGICAL UPTAKE

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ABSTRACT

Background: Delayed cataract surgery remains an important barrier to reducing avoidable visual impairment in rural and underserved populations. Delay may occur through delayed presentation, delayed acceptance, or prolonged non-utilization.

Objective: To systematically review barriers, clinical consequences, and strategies associated with delayed cataract surgery in rural and underserved populations.

Methods: A systematic review was conducted of studies evaluating delayed presentation, delayed uptake, or non-utilization of cataract surgery or related services. Data were extracted on barriers, clinical consequences, and strategies to improve surgical uptake. Findings were synthesized descriptively.

Results: Twenty-six studies published from 1991 to 2024 were included. The most frequently reported barriers were financial constraints, geographic and transportation difficulties, lack of perceived need, inadequate knowledge, fear of surgery, and limited family or social support. Delayed or untreated cataract was frequently associated with substantial visual impairment and blindness, with advanced cataract and lens-related complications reported in some settings. Strategies included financial assistance, transportation support, counselling, community education, outreach, and decentralized services. Regular same-location outreach was associated with higher surgical acceptance in one South Indian study.

Conclusions: Delayed cataract surgery is multifactorial, involving financial and geographic barriers, perceived need, knowledge, fear, and social support. Multicomponent strategies addressing affordability, accessibility, and counselling may improve surgical uptake.

Keywords: Cataract surgery; Surgical uptake; Barriers; Rural populations; Underserved populations.

INTRODUCTION

Cataract remains one of the leading causes of blindness and visual impairment worldwide, particularly in populations where access to eye-care services is limited. Cataract surgery is an effective treatment for cataract-related visual impairment; however, the availability of surgical services does not necessarily result in timely treatment. In many low-resource and underserved settings, substantial numbers of patients with operable cataract remain untreated despite the availability of surgical services.^{1,2}

The utilization of cataract surgery is influenced by multiple factors operating at both the individual and health-system levels. Previous studies have identified financial constraints, limited knowledge, fear of surgery, lack of perceived need, transportation difficulties, geographic distance, and inadequate family or social support as important barriers to surgical uptake.^{3,4,5} These barriers may be particularly important in rural populations, where patients often face additional costs and logistical difficulties associated with travelling to surgical facilities.

Importantly, delay in cataract care is not a single phenomenon. Patients may experience delayed presentation, in which they seek eye care only after substantial visual deterioration, or delayed uptake, in which cataract has already been identified but recommended surgery is not undertaken promptly. Other patients may have prolonged non-utilization of available eye-care services. These different pathways may reflect different combinations of socioeconomic, behavioral, geographic, and service-related factors and therefore should not necessarily be considered equivalent.

The consequences of prolonged untreated cataract can be substantial. Progressive visual loss may lead to blindness and limitations in mobility, activities of daily living, and economic productivity. In advanced cases, cataract may become mature or hypermature and may be associated with lens-induced complications.^{6,7} Understanding the factors associated with delayed treatment is therefore important not only for improving cataract surgical coverage but also for preventing avoidable visual disability.

Various approaches have been implemented to improve cataract surgical uptake, including financial assistance, transportation support, community education, counselling, outreach screening, and decentralized or mobile cataract services.⁸ However, the evidence is heterogeneous, with studies differing in their definitions of delay, populations, settings, and outcomes. A synthesis of the available evidence is therefore needed to clarify the different forms of delay, identify consistently reported barriers, describe their clinical consequences, and summarize strategies that have been used to improve timely access to cataract surgery.

Therefore, this systematic review aimed to synthesize the evidence on delayed cataract surgery in rural and underserved populations, focusing on (1) the types and definitions of delay, (2) determinants and barriers associated with delayed presentation or uptake, (3) reported clinical consequences, and (4) interventions and service-delivery strategies intended to improve cataract surgical uptake.

METHODS

Study Design

This study was conducted as a systematic review of published evidence on delayed cataract surgery among rural and underserved populations. The review was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement.⁹ The review used a descriptive and narrative approach to synthesize evidence regarding the different forms of delay in the cataract care pathway, determinants and barriers associated with delayed care, reported clinical consequences, and interventions or service-delivery strategies intended to improve cataract surgical uptake. No quantitative meta-analysis or statistical pooling was performed.

Eligibility Criteria

Studies were considered eligible if they met the following criteria:

1. **Population:** participants living in rural, remote, underserved, or otherwise resource-limited settings;

2. **Condition/intervention:** cataract or cataract-related visual impairment and access to cataract surgery;
3. **Phenomenon of interest:** delayed presentation, delayed uptake or non-acceptance of recommended cataract surgery, delayed care-seeking, non-utilization of cataract services, or barriers relevant to timely cataract treatment;
4. **Outcomes:** studies reporting determinants or barriers, clinical consequences of delayed or untreated cataract, or interventions and service-delivery strategies intended to improve cataract surgical uptake; and
5. **Publication:** full-text study available for assessment.

Studies were excluded if they did not address cataract surgical access or delay, were conducted in populations without a relevant rural or underserved context, or did not provide information relevant to the objectives of the review. Studies evaluating broader eye-care utilization were considered when their findings were relevant to cataract-related access or utilization. Because the included literature used heterogeneous definitions of delay, studies were not required to use a single predefined duration of delay.

Information Sources and Search Strategy

A systematic literature search was conducted in PubMed, Embase, and Cochrane Library from database inception to 5 October 2026. The search strategy was developed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 recommendations.⁹The search strategy combined terms related to cataract and cataract surgery, delayed presentation and treatment-seeking, surgical uptake and acceptance, barriers and access to care, and rural or underserved populations. Keywords and their synonyms were combined using Boolean operators (AND/OR). The main search concepts included: *cataract*, *cataract surgery*, *delayed presentation*, *delay*, *treatment-seeking*, *uptake*, *acceptance*, *non-acceptance*, *barriers*, *access*, *rural*, *remote*, and *underserved*.

No restriction on publication year was applied. Studies published in English were considered eligible. Duplicate records identified across databases were removed before title and abstract screening. In addition to database searching, the reference lists of relevant studies were

969

manually screened to identify potentially eligible publications that were not retrieved through the electronic search.

Study Selection

Study selection was performed sequentially. Records identified through the literature search were initially screened based on title and abstract. Records considered potentially relevant were retrieved for full-text assessment. At the full-text stage, studies were evaluated against the predefined eligibility criteria. Reasons for exclusion were recorded during the full-text assessment. The overall study-selection process was summarized in a PRISMA flow diagram.⁹ A total of 26 studies were included in the final qualitative synthesis.

Data Extraction

Data were extracted using a predefined structured extraction framework. The following information was collected from each included study:

- Study characteristics: first author, publication year, country, study setting, and study design;
- Population and sample: target population, sample size, relevant subgroups, and denominators;
- Delay characteristics: definition, type, and duration of delay when reported;
- Determinants and barriers: socioeconomic, financial, geographic, transportation, knowledge, perceived need for surgery, fear, family or social support, occupational, cultural, and health-system factors;
- Clinical consequences: visual acuity, blindness or visual impairment, cataract severity, mature or hypermature cataract, lens-induced complications, intraoperative or postoperative complications, and postoperative visual outcomes when reported;
- Interventions and strategies: financial assistance, transportation support, counselling, community education, outreach, mobile or decentralized services, referral strategies, and other service-delivery interventions;
- Comparators: comparator or control groups when applicable;
- Intervention outcomes: uptake, acceptance, surgical utilization, or other reported outcomes following an intervention; and

- Authors' conclusions and reported limitations.

For determinants and barriers, descriptive data were prioritized. Where available, the number of participants reporting each barrier (n/N) and the corresponding percentage were extracted. Measures of association, including odds ratios (ORs), risk ratios (RRs), prevalence ratios (PRs), confidence intervals (CIs), and *P* values, were extracted when reported by the original study. Data were not recalculated when the original study did not provide sufficient information for calculation. Variables or outcomes that were not reported were recorded as NR (not reported), while variables that were not applicable to a particular study were recorded as NA (not applicable).

Classification of Delay

Because the included studies evaluated different stages of the cataract-care pathway, the phenomenon of delayed cataract treatment was classified into four categories :

- **Delayed presentation** referred to patients presenting for cataract care only after prolonged symptoms or substantial visual deterioration. This category primarily reflected delay occurring before patients reached or sought cataract services.
- **Delayed uptake or non-acceptance** referred to patients who had already been identified as having operable cataract or had been advised to undergo surgery but did not accept or undergo surgery promptly.
- **Delayed care-seeking or non-utilization** referred to broader failure or delay in utilizing available eye-care services, including studies in which cataract-related access was evaluated as part of general eye-care utilization.
- **Access or service-delivery evidence** referred to studies primarily evaluating geographic, transportation, organizational, outreach, referral, or service-availability factors without directly quantifying a specific delay in cataract surgery.

This classification was used to distinguish different mechanisms within the cataract-care pathway and to avoid treating delayed presentation, delayed surgical acceptance, and broader non-utilization as equivalent phenomena.

Risk of Bias Assessment

Risk of bias was assessed across five methodological domains: selection bias, measurement bias, confounding, outcome and analysis, and follow-up or intervention-related bias. Each domain was judged as low risk, unclear, or not applicable, based on the methodological characteristics and information reported in each included study. An overall judgement was assigned based on the domain-level assessments. No numerical quality score was calculated. The risk-of-bias assessments were used to support interpretation of the evidence and were summarized using a traffic-light plot generated with the robvis visualization tool.¹⁰ No quantitative synthesis or statistical pooling of risk-of-bias assessments was performed.

Data Synthesis

Because of substantial heterogeneity in study populations, settings, definitions of delay, study designs, and reported outcomes, findings were synthesized descriptively and narratively. The synthesis focused on four main domains:

1. Types and characteristics of delay;
2. Determinants and barriers associated with delayed cataract care;
3. Reported clinical consequences of delayed or untreated cataract; and
4. Interventions and service-delivery strategies intended to improve cataract surgical uptake.

Descriptive frequencies and proportions were presented where available. Measures of association were reported only when provided by the original studies and were not recalculated or statistically pooled. Where multiple studies reported similar barriers, findings were compared descriptively while preserving the denominator and context of each study. Because the included studies differed in populations and definitions, percentages were not combined across studies to generate an overall prevalence.

Similarly, clinical outcomes were reported according to the definitions and denominators used in the original studies. Findings describing visual impairment, blindness, cataract severity, or lens-induced complications were interpreted as reported consequences or clinical characteristics associated with delayed or untreated cataract, rather than being assumed to demonstrate a causal effect of delay unless supported by the original study design. Interventions were also distinguished according to whether they represented a tested or comparative intervention, an observed programme

strategy, or an author recommendation. Comparative intervention outcomes were reported using the measures provided by the original studies. No quantitative meta-analysis, pooled effect estimate, or statistical heterogeneity analysis was performed.

RESULTS

Study Selection

The literature search identified 5,126 records. After removal of 1,934 duplicates, 3,192 records were screened based on title and abstract. Of these, 2,407 records were excluded. A total of 785 reports were assessed at the full-text stage. Following full-text assessment, 759 reports were excluded and 26 studies were included in the final systematic review. The study-selection process is presented in the PRISMA flow diagram (Figure 3.1).

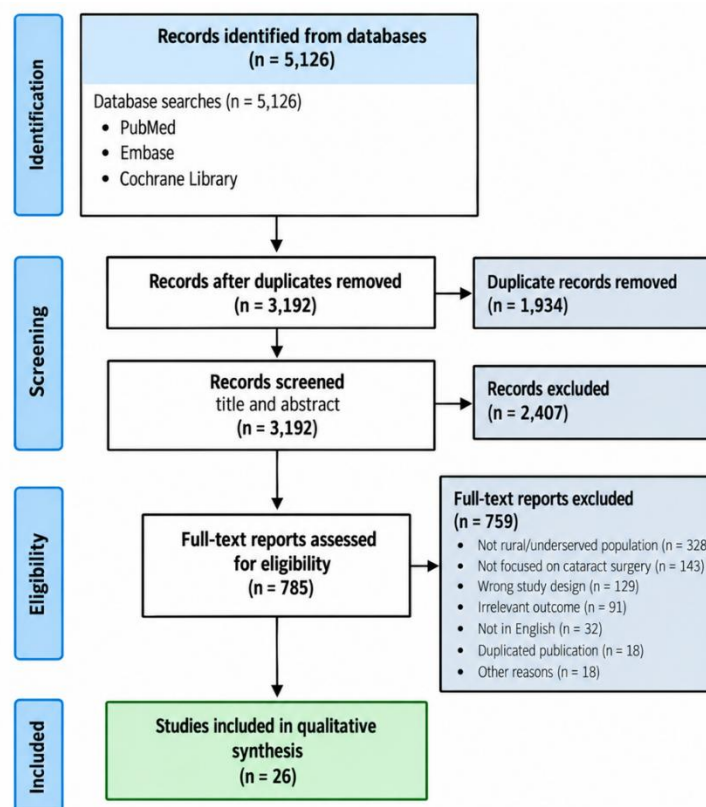


Figure 3.1. PRISMA 2020 Flow Diagram

Characteristics of the Included Studies

A total of 26 studies published between 1991 and 2024 were included. The studies were conducted across rural and underserved populations in India, Nepal, Nigeria, South Africa, Kenya, Tanzania, Ghana, China, Malawi, Ethiopia, Madagascar, Bangladesh, and Uganda. The included studies used heterogeneous designs, including cross-sectional studies, prospective cohorts, qualitative studies, programme evaluations, comparative observational studies, and intervention studies. The studies also evaluated different stages of the cataract-care pathway. Most investigated delayed uptake or non-acceptance after cataract identification or recommendation for surgery, while a smaller number focused on delayed presentation, broader non-utilization of eye-care services, or access and service-delivery factors. The characteristics of all included studies are summarized in **Table 1**.

Table 1. Characteristics of the included studies

Study	Country	Setting	Study Design	Population/Sample	Primary Delay Phenomenon
Brilliant et al., 1991 ¹¹	India	Rural South India	Community intervention/operations research	NR	Delayed uptake/non-acceptance
Ellwein et al., 1991 ¹²	India	Rural South India	Intervention/economic evaluation	NR	Delayed uptake/non-acceptance
Snellingen et al., 1998 ¹³	Nepal	Rural Nepal	Prospective community study	319; 96 non-acceptors	Delayed uptake/non-acceptance
Fletcher et al., 1999 ¹⁴	India	Rural Tamil Nadu	Cross-sectional/mixed-methods community study	749 participants; 48 villages	Delayed care-seeking/non-utilization

Rabiu, 2001 ¹⁵	Nigeria	Rural Katsina	Population-based cross-sectional	1,461; 15 villages	Delayed uptake/non-utilization
Rotchford et al., 2002 ¹⁶	South Africa	Rural Hlabisa	Qualitative study	20 non-attenders	Delayed uptake/non-attendance
Lewallen et al., 2005 ¹⁷	Kenya/Tanzania	Rural programme settings	Programme evaluation	NR	Access/service delivery
Chandrashekar et al., 2007 ¹⁸	India	Rural Karnataka	Population-based cross-sectional	1,505; 15 villages	Delayed uptake/non-utilization
Finger et al., 2007 ¹⁹	India	Rural/underserved Andhra Pradesh	Observational study	71 non-acceptors	Delayed uptake/non-acceptance
Gyasi et al., 2007 ²⁰	Ghana	Rural Upper East Region	Cross-sectional/qualitative	66 non-acceptors	Delayed uptake/non-acceptance
Kessy et al., 2007 ²¹	Tanzania	Rural Tanzania	Prospective cohort	198 non-acceptors	Delayed uptake/non-acceptance
Chibuga et al., 2008 ²²	Tanzania	Rural Hai	Prospective cohort	NR	Delayed uptake/non-acceptance
Yin et al., 2009 ²³	China	Rural Handan/Yan	Population-based cross-sectional	NR	Delayed uptake/non-

		gjiang			acceptance
Zhang et al., 2010 ²⁴	China	Rural Jiazi	Comparative cross-sectional	240	Access/uptake
Dean et al., 2011 ²⁵	Malawi	Rural Central Malawi	Cross-sectional/follow-up survey	156 with VA ≤6/60	Delayed uptake/non-acceptance
Finger et al., 2011 ²⁶	India	Rural Tamil Nadu	Comparative observational/intervention	398	Delayed uptake/non-acceptance
Mehari et al., 2013 ²⁷	Ethiopia	Rural Central Ethiopia	Cross-sectional	146	Delayed uptake/non-acceptance
Nkumbe et al., 2013 ²⁸	Madagascar	Rural Sava region	Outreach/programme evaluation	955 mobile-clinic participants	Access/service delivery
Li et al., 2014 ²⁹	China	Rural northern China	Population-based study	10,384 examined	Delayed uptake/non-acceptance
Marmamula et al., 2014 ³⁰	India	Rural/urban Andhra Pradesh	Cross-sectional	NR	Non-utilization of eye care
Tanchangya et al., 2015 ³¹	Bangladesh	Rural/remot e Bangladesh	Retrospective clinical study	NR	Delayed presentation
Sangameswaran et al., 2016 ³²	India	Rural/remot e Tamil Nadu	Prospective service evaluation	NR	Access/service delivery

Sebabi et al., 2021 ³³	Uganda	Underserved referral setting	Hospital-based cross-sectional	82 delayed-uptake patients	Delayed uptake
Shakya et al., 2022 ³⁴	India	Rural/underserved population	Cross-sectional	731	Delayed presentation
Ma et al., 2024 ³⁵	China	Rural Yongnian	Population-based intervention component	596 surveyed; 99 offered surgery	Delayed uptake/non-acceptance
Chatterjee et al., 2024 ³⁶	India	Rural/underserved Chhattisgarh	Cross-sectional	1,026 completed barrier survey	Delayed uptake/non-acceptance

* NR, not reported; VA, visual acuity.

Risk of Bias

Risk-of-bias assessment was performed for all 26 included studies across five methodological domains: selection bias, measurement bias, confounding, outcome and analysis, and follow-up or intervention-related bias. Overall, most studies were judged to have low risk of bias in the selection and measurement domains, while unclear judgements were more frequently identified in the confounding and follow-up or intervention-related domains. No study was assigned a high-risk judgement. The domain-level assessments are presented in figure 3.2.

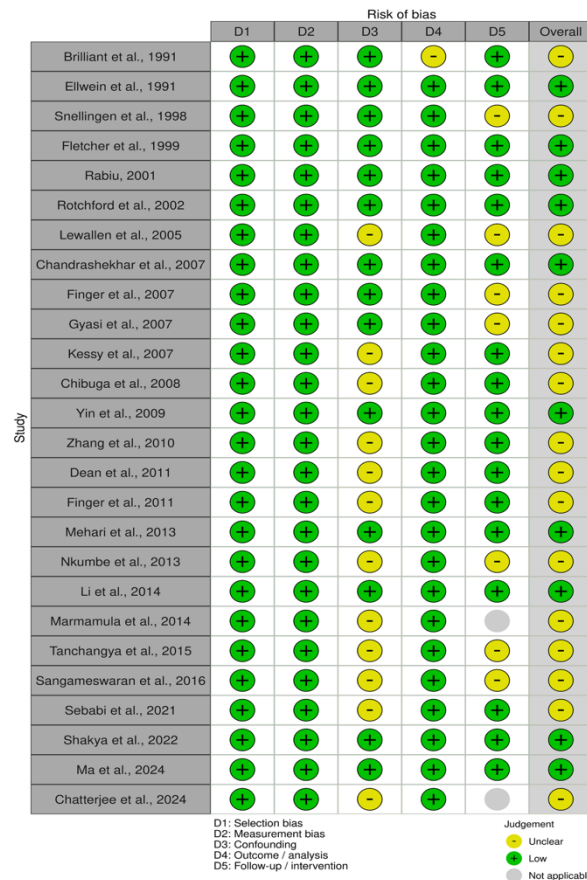


Figure 3.2 Risk of Bias

Determinants and Barriers to Cataract Surgical Uptake

Across the included studies, delayed cataract treatment was associated with multiple interacting barriers. The most consistently reported domains were financial constraints, geographic and transportation barriers, lack of perceived need, inadequate knowledge, fear of surgery, and lack of family or escort support. The detailed extraction of determinants is presented in **Table 2**.

Table 2. Determinants and barriers associated with delayed cataract surgery

Study	Determinants/barriers	Quantitative findings
Brilliant et al., 1991 ¹¹	Lack of perceived need/desire; lack of escort; affordability; lack	Among 786 unilaterally blind participants, lack of need/desire 24.3%, no one to bring

	of knowledge about where to seek treatment; fear; adequate fellow-eye vision; cataract perceived as not mature	them 17.3%, inability to afford 13.0%, and not knowing where to go 5.0%. Among 466 blind participants, lack of need/desire 20.7% and fear 16.5%. Gender OR 1.51 (95% CI 1.18–1.96); agriculture OR 1.53 (95% CI 1.18–1.98).
<i>Ellwein et al., 1991</i> ¹²	Financial barriers; transport; motivation/case identification; health education; logistical support	Individual barrier n/N and association estimates: NR
<i>Snellingen et al., 1998</i> ¹³	Economic; logistical; fear; lack of time; adequate vision; lack of faith	Among 96 non-acceptors: economic 48/96 (50.0%), logistics 43/96 (44.8%), fear 32/96 (33.3%), lack of time 18/96 (18.8%), adequate vision 13/96 (13.5%), lack of faith 13/96 (13.5%). Male sex RR 1.31 (95% CI 1.04–1.67); blindness RR 1.74 (95% CI 1.36–2.22).
<i>Fletcher et al., 1999</i> ¹⁴	Fear; cost; family/work obligations; ageism/fatalism; geographic access; poor local surgical outcomes	Distance ≤ 3 km aOR 4.54 (95% CI 1.67–12.50), $P=.003$; male sex aOR 2.29 (95% CI 1.18–4.46), $P=.01$; bus availability OR 2.34 (95% CI 1.12–4.86), $P=.02$; scheduled caste OR 2.75 (95% CI 1.42–5.31), $P=.003$; village with ≥ 1 poor postoperative outcome OR 2.40 (95% CI 1.11–5.17), $P=.02$.
<i>Rabiu, 2001</i> ¹⁵	Affordability; fellow-eye vision; lack of awareness; fatalism; lack of trust; distance; lack of escort	Among 154 barrier responses: inability to afford 94/154 (61.0%); other eye 29/154 (18.8%); unaware where treatment was

		available 16/154 (10.4%); God's will 7/154 (4.5%); lack of trust 3/154 (1.9%); distance 2/154 (1.3%); couching 2/154 (1.3%); no escort 1/154 (0.6%).
<i>Rotchford et al., 2002</i> ¹⁶	Fear; fatalism/untreatable belief; lack of perceived need	Among 20 non-attenders: fear 9/20 (45.0%), fatalism/untreatable 8/20 (40.0%), no perceived need 6/20 (30.0%).
<i>Lewallen et al., 2005</i> ¹⁷	Geographic access; transport; referral burden; limited service availability; awareness; organization	Quantitative barrier estimates: NR
<i>Chandrashekhar et al., 2007</i> ¹⁸	Affordability; fear; perceived need; escort; treatment denied; fellow-eye vision; contraindication; competing priorities; distance; information	Among 161 participants: cannot afford 37/161 (22.9%); fear 31/161 (19.2%); no need 21/161 (13.0%); no escort 19/161 (11.8%); treatment denied 13/161 (8.1%); fellow-eye vision 11/161 (6.8%); contraindication 10/161 (6.2%).
<i>Finger et al., 2007</i> ¹⁹	Family support; fear; financial barriers; awareness; escort; health problems; perceived need; wage loss	Among 71 participants: no family support 27%; fear 21%; financial 15%; awareness 13%; no escort 9%; health problems 9%; no perceived need 2%; wage loss 4%.
<i>Gyasi et al., 2007</i> ²⁰	Cost; escort; fear; perceived need; sociocultural factors; awareness	Among 66 participants: cost 60/66 (90.9%); lack escort 10/66 (15.2%); fear 8/66 (12.5%); no need 6/66 (9.1%); sociocultural factors 5/66 (7.6%); awareness 1/66 (1.5%).
<i>Kessy et al.,</i>	Poverty/financial constraints; other	Among 198 non-acceptors, lack of funds

2007 ²¹	barriers	157/198 (79.0%); other reasons 41/198 (20.7%).
Chibuga et al., 2008 ²²	Older age; other reported barriers	Older patients were less likely to accept surgery; exact effect estimate NR.
Yin et al., 2009 ²³	Knowledge; perceived quality of local surgery; cost; transport	Knowledge OR 1.28 (95% CI 1.13–1.46), $P<.001$; perceived quality OR 1.25 (95% CI 1.12–1.41), $P<.001$; cost OR 1.15 (95% CI 0.94–1.41), $P=.18$; transport OR 1.07 (95% CI 0.98–1.17), $P=.26$.
Zhang et al., 2010 ²⁴	Knowledge; perceived quality; habitual vision; sex; socioeconomic characteristics	Screening participants had lower perceived surgical quality ($P<.001$), better habitual vision ($P=.02$), and were more often women ($P=.002$). Screening participants who agreed to surgery had higher knowledge ($P<.001$).
Dean et al., 2011 ²⁵	Cost; awareness; fear; lack of expectation; distance; poor service	Among 156 participants with VA $\leq 6/60$: cost 58.3%; awareness 18.6%; fear 15.4%; lack of expectation 3.8%; distance 2.6%; poor service 1.3%.
Finger et al., 2011 ²⁶	Family responsibilities; fear; distance; waiting for outreach; cost; transport	Among 158 non-acceptors: family responsibilities 116/158 (75.3%); fear 67/158 (43.5%); distance 41/158 (26.6%); waiting for outreach 13/158 (8.4%); cost 11/158 (7.1%); no transport 2/158 (1.3%).
Mehari et al., 2013 ²⁷	Cost; insufficient family income; ability to perform daily activities; distance; fellow-eye vision	Among 146 participants: cost 91.8%; insufficient family income 78.1%; ability to perform daily activities 52.0%; hospital

		too far 47.9%; fellow eye clear 39.7%. Delay was associated with age, monthly income, residence, education, and distance ($P<.05$).
<i>Nkumbe et al., 2013</i> ²⁸	Information/community mobilisation channels	Among 955 mobile-clinic participants, cataract was diagnosed in 16.2% of men and 8.1% of women ($P=.0001$). Radio was more effective among men ($P=.044$), while churches were more effective among women ($P<.001$).
<i>Li et al., 2014</i> ²⁹	Cost; service availability; knowledge; unilateral cataract; fear; cataract maturity; escort	Among unoperated surgical candidates: cost 73.9%; service unavailable 13.4%; lack of knowledge 5.5%; unilateral cataract 3.3%; fear 2.0%; cataract not mature 1.6%; lack of escort 0.3%.
<i>Marmamula et al., 2014</i> ³⁰	Affordability; perceived need; accompaniment; accessibility	Among participants reporting broader eye-care utilization barriers: affordability 76.1%; lack perceived need 61.1%; lack accompanying person 20.3%; accessibility 12.7%. These were not cataract-specific barriers.
<i>Tanchangya et al., 2015</i> ³¹	Sex and delayed presentation	Female sex was associated with delayed presentation: aOR 1.19 (95% CI 1.10–1.29), $P<.001$.
<i>Sangameswaran et al., 2016</i> ³²	Geography; distance; service decentralization	Primarily service-delivery/access evidence; individual-level effect estimates NR.

<i>Sebabi et al., 2021</i> ³³	Financial constraint; no felt need; ability to see with one eye	Financial constraint aOR 6.126 (95% CI 1.117–33.586), $P=.037$; no felt need aOR 19.713 (95% CI 1.640–237.000), $P=.019$; ability to see with one eye aOR 0.026 (95% CI 0.002–0.432), $P=.011$.
<i>Shakya et al., 2022</i> ³⁴	Seasonal waiting; good fellow eye; financial constraint; distance; lack of caretaker; medical illness; fear	Waiting until winter 58.27%; good fellow eye 14.36%; financial 11.63%; distance >50 km 7.11%; no caretaker 6.89%; medical illness 1.78%; fear 0.55%.
<i>Ma et al., 2024</i> ³⁵	Financial/access barriers and acceptance factors	Among 99 patients offered free surgery, 77 accepted and 22 refused. Determinant estimates were reported descriptively; no eligible pooled/effect estimate was extracted.
<i>Chatterjee et al., 2024</i> ³⁶	Lack escort; cost; awareness; fear; perceived need/fellow-eye vision; waiting outreach; waiting maturity; knowledge of service location; work; distance; age; transport; fatalism	Among 1,026 respondents: lack escort 349/1,026 (34.0%); cost 182/1,026 (17.7%); awareness 98/1,026 (9.6%); fear 70/1,026 (6.8%); no need/manage fellow eye 65/1,026 (6.3%); waiting outreach 61/1,026 (5.9%); waiting maturity 47/1,026 (4.6%); work 38/1,026 (3.7%); far 20/1,026 (1.9%); no road/transport 6/1,026 (0.6%).

Financial barriers

Financial constraints were among the most consistently reported determinants across studies. The proportion citing cost was particularly high among non-acceptors in Ghana (60/66, 90.9%), Tanzania (157/198, 79.0%), Ethiopia (91.8%), northern Nigeria (94/154,

61.0%), and Malawi (58.3%).^{15,20,21,25,27} The findings indicate that financial barriers were not limited to the direct cost of surgery. Studies also described indirect costs, including transportation, food, accommodation, lost wages, and the need for an accompanying person.^{11,12,14,18,19,26}

Geographic and transportation barriers

Geographic accessibility was another recurring barrier. Distance, transportation availability, and service location were reported across several settings. In rural India, living within 3 km of an eye-care facility was associated with greater uptake (aOR 4.54, 95% CI 1.67–12.50).¹⁴ Other studies reported distance or transportation as barriers, including Ethiopia, Malawi, South India, and rural China.^{23,25-27,29} In several studies, geographic barriers appeared to interact with the organization of outreach services and the availability of decentralized surgical care rather than representing distance alone.

Perceived need and fellow-eye vision

Lack of perceived need was frequently reported, particularly among patients who retained useful vision in the fellow eye. In South India, lack of need or desire was reported by 24.3% of unilaterally blind participants, while in South Africa 30.0% of non-attenders reported no perceived need.^{11,16} Among delayed-uptake patients in Uganda, the absence of felt need was strongly associated with delayed uptake (aOR 19.713, 95% CI 1.640–237.000). Conversely, being able to see with one eye was associated with lower odds of delayed uptake (aOR 0.026, 95% CI 0.002–0.432).³³

Knowledge and perceived quality of surgery

In rural China, knowledge and perceived quality of cataract surgery were significantly associated with cataract surgical uptake. Knowledge was associated with greater uptake (OR 1.28, 95% CI 1.13–1.46), as was perceived surgical quality (OR 1.25, 95% CI 1.12–1.41).²³ Lack of awareness was also reported in India, Malawi, Ethiopia, and other settings.^{11,18,25,27,29,36}

Fear and social support

Fear of surgery was another recurring barrier. It was reported by 45.0% of non-attenders in rural South Africa, 43.5% of non-acceptors in South India, 33.3% of non-acceptors in Nepal, and 21% of participants in another South Indian study.^{13,16,19,26} Social and family support also influenced uptake. Family responsibilities were reported by 116/158 (75.3%) non-acceptors in South India, while lack of escort was reported in several other studies.^{11,18,26,36}

Clinical Consequences Associated with Delayed or Untreated Cataract

Clinical consequences varied according to the stage of disease and the definition of delayed care used by each study. Several studies reported substantial visual impairment or blindness among patients who had not undergone surgery. The extracted clinical consequences are summarized in Table 3.

Table 3. Reported clinical consequences associated with delayed or untreated cataract

<i>Study</i>	<i>Clinical consequences</i>
<i>Snelling et al., 1998</i> ¹³	Among 96 non-acceptors, 49/96 (51.0%) were blind and 47/96 had visual impairment/severe visual loss. During 1-year follow-up, 37.5% experienced further visual deterioration. Functional limitations included bathing, toileting, eating, dressing, mobility, and work.
<i>Fletcher et al., 1999</i> ¹⁴	Among 552 non-attenders, 242/552 (43.8%) had low vision and 38/552 (6.9%) were bilaterally blind; 197/552 (35.8%) were recommended for surgery.
<i>Rabiu, 2001</i> ¹⁵	In the population survey, 120/1,461 (8.2%) were blind and 102/1,461 (6.9%) had low vision. Cataract accounted for bilateral blindness in 53/120 (44.2%) blind participants.
<i>Rotchford et al., 2002</i> ¹⁶	Among 20 non-attenders, 14/20 (70%) were blind and 6/20 (30%) had severe visual impairment.
<i>Chandrashekhar et al., 2007</i> ¹⁸	Cataract surgical coverage among people with VA <3/60 was 63% (95% CI 54–71) and among eyes 51% (95% CI 45–57). For VA <6/60, coverage was

	49% (95% CI 41–57) among people and 36% (95% CI 32–41) among eyes.
<i>Yin et al., 2009</i> ²³	67.8% of nonsurgical participants had VA $\leq$ 6/60 in at least one eye. Among surgical participants, approximately 26% remained blind in the operated eye according to the extracted postoperative assessment.
<i>Tanchangya et al., 2015</i> ³¹	Presenting visual acuity was severely reduced: HM 46.4%, 3/60 23.5%, and 6/60 30.0%. Women had poorer presenting VA.
<i>Sebabi et al., 2021</i> ³³	Among 82 delayed-uptake patients, 26/82 (32%) had right-eye VA $<$ 3/60, 38/82 (46%) had left-eye VA $<$ 3/60, and 11/82 (13%) had bilateral VA $<$ 3/60.
<i>Shakya et al., 2022</i> ³⁴	Delayed presentation was associated with mature/hypermature cataract and lens-induced glaucoma, including phacomorphic and phacolytic glaucoma.
<i>Other included studies</i>	Specific clinical consequences directly attributable to delayed cataract treatment were NR or not separately reported.

The studies describing delayed uptake or non-attendance demonstrated substantial visual disability. In Nepal, more than half of non-acceptors were blind and more than one-third experienced further visual deterioration during one year of follow-up.¹³ In rural South Africa, 70% of interviewed non-attenders were blind.¹⁶ Similarly, among non-attenders in rural India, 43.8% had low vision and 6.9% were bilaterally blind.¹⁴ In Uganda, delayed uptake was characterized by severe visual loss, with 13% of delayed-uptake patients having bilateral VA $<$ 3/60.³³

Advanced cataract and lens-related complications were also reported. Shakya et al. described mature or hypermature cataract with lens-induced glaucoma among patients presenting late.³⁴ These findings illustrate that delayed presentation may extend beyond visual impairment to more advanced ocular disease. However, these findings should be interpreted as reported clinical characteristics or consequences associated with delayed or untreated cataract, rather than evidence that delay itself caused each outcome, because most studies were observational.

Interventions and Strategies to Improve Cataract Surgical Uptake

The strategies reported across the included studies addressed several levels of the cataract-care pathway, particularly financial barriers, transportation, community outreach, counselling, health education, and decentralization of services. The strategies and available outcomes are summarized in **Table 4**.

Table 4. Interventions and strategies to improve cataract surgical uptake

<i>Study</i>	<i>Strategy/intervention</i>	<i>Comparator/outcome</i>
<i>Brilliant et al., 1991¹¹</i>	Economic incentives, aphakic motivators, eye workers, screening vans, mass media; full incentive included free transport and food in addition to surgery and spectacles	Acceptance with full aphakic motivator/incentive 33.3% vs 13.6% in control; other intervention groups 18.3–28.0%
<i>Ellwein et al., 1991¹²</i>	Financial support, transport, case identification, motivation, health education and logistical support	Cost-effectiveness/intervention evaluation; individual uptake estimates NR
<i>Snellings et al., 1998¹³</i>	Repeated counselling	Only 13% of 96 previous non-acceptors accepted surgery after second counselling
<i>Fletcher et al., 1999¹⁴</i>	Counselling; reduction of indirect cost and distance; shorter stay/fewer visits; closer services	Recommendations/programme implications; no controlled intervention effect
<i>Rabiu, 2001¹⁵</i>	Community education, low-cost/free surgery, outreach camps, mobile services	Programme recommendations; no controlled intervention effect
<i>Rotchford et al., 2002¹⁶</i>	Education/counselling, community screening, aphakic motivators, addressing anxiety and perceived surgical quality	Qualitative evidence; no comparative intervention outcome

<i>Lewallen et al., 2005</i> ¹⁷	Outreach/community cataract services, referral, transport/access improvement, programme organization	Programme evaluation; no single controlled comparator
<i>Chandrashekhar et al., 2007</i> ¹⁸	Outreach camps, mobile/NGO services, awareness and low-cost/free surgery	Service coverage evidence; no controlled intervention effect
<i>Finger et al., 2007</i> ¹⁹	Outreach screening and counselling	Observational evidence; no controlled intervention estimate
<i>Gyasi et al., 2007</i> ²⁰	Outreach expansion, differential pricing, escort support	Recommendations; no controlled intervention outcome
<i>Kessy et al., 2007</i> ²¹	Outreach, transport, counselling, fee waiver	Among 157 citing inability to pay, 32 returned with money and 4 returned with a waiver
<i>Chibuga et al., 2008</i> ²²	Community programme, transport, counselling and high-quality surgery	Uptake remained limited; exact comparative effect NR
<i>Yin et al., 2009</i> ²³	Improve cataract knowledge and perceived surgical quality; transport/cost support	No controlled intervention estimate
<i>Zhang et al., 2010</i> ²⁴	Cataract screening outreach	Screening reached patients with different access/uptake characteristics; willingness and knowledge differed between groups
<i>Dean et al., 2011</i> ²⁵	Outreach addressing cost, awareness, fear, distance and service quality	Programme recommendations; no controlled intervention effect
<i>Finger et al., 2011</i> ²⁶	Regular same-location outreach by the same provider	Acceptance 94.6% vs 82.3%, $P < .001$

<i>Mehari et al., 2013</i> ²⁷	Outreach model addressing cost and distance	Recommendations; no controlled intervention estimate
<i>Nkumbe et al., 2013</i> ²⁸	Social marketing/community mobilisation using radio, churches and administrative authorities	Communication channels differed by sex; radio more effective among men and churches among women
<i>Li et al., 2014</i> ²⁹	Strategies addressing cost, service availability, knowledge, fear and escort barriers	No controlled intervention estimate
<i>Marmamula et al., 2014</i> ³⁰	Improved affordability, accessibility and accompaniment	General eye-care recommendations; not cataract-specific intervention
<i>Tanchangya et al., 2015</i> ³¹	Early identification and referral, particularly for women	No tested intervention
<i>Sangameswaran et al., 2016</i> ³²	Decentralized/mobile cataract surgical services	Service evaluation; no comparator
<i>Sebabi et al., 2021</i> ³³	Surgical outreach, health education, reduction of direct and indirect costs	Recommendations; no tested intervention
<i>Shakya et al., 2022</i> ³⁴	Earlier presentation, awareness, reduction of financial/distance/seasonal barriers	No tested intervention
<i>Ma et al., 2024</i> ³⁵	Free surgery/financial access component	77/99 accepted free surgery and 22/99 refused; no eligible comparative clinical effect estimate extracted
<i>Chatterjee et al., 2024</i> ³⁶	Strategies addressing escort, cost, awareness, fear, transport, outreach and work barriers	No controlled intervention outcome

Among the comparative or intervention-oriented studies, regular outreach showed one of the clearest differences in surgical acceptance. Finger et al. reported acceptance of 94.6% compared

with 82.3% with less regular outreach provision ($P<.001$).²⁶ Financial support was also evaluated through several approaches. In Tanzania, among 157 patients who initially reported inability to pay, 32 returned with money and four returned after receiving a fee waiver.²¹ In Nepal, however, repeated counselling resulted in surgery acceptance among only 13% of previously non-accepting patients, indicating that counselling alone did not address all barriers to uptake.¹³

The intervention described by Brilliant et al. combined economic incentives with community-based case identification and motivational strategies. The full incentive intervention achieved acceptance of 33.3% compared with 13.6% in the control group.¹¹ Overall, the reported strategies were directed predominantly toward reducing financial and geographic barriers, improving awareness and perceived need, increasing community engagement, and bringing services closer to rural populations. However, the intervention evidence was heterogeneous, and many reported strategies represented programme approaches or author recommendations rather than controlled interventions.

DISCUSSION

Principal findings

This systematic review identified delayed cataract care as a multifactorial problem involving financial, geographic, informational, behavioral, social, and health-system factors. Across the included studies, delay occurred through several pathways, including delayed presentation, delayed uptake after cataract had been identified or surgery recommended, and prolonged non-utilization of available eye-care services. These pathways should be distinguished because their determinants and potential solutions may differ.^{13,14,23,31,33,34}

The most consistently reported barriers were financial constraints, geographic and transportation difficulties, lack of perceived need, inadequate knowledge, fear of surgery, and limited family or social support. However, the relative importance of individual barriers varied substantially between settings. For example, inability to afford surgery was reported by 60 of 66

non-acceptors (90.9%) in Ghana, 157 of 198 non-acceptors (79.0%) in Tanzania, and 94 of 154 respondents (61.0%) in northern Nigeria.^{15,20,21}

The review also found that delayed cataract care frequently occurred among patients with substantial visual impairment and, in some settings, advanced cataract or lens-related complications.^{13,14,16,23,33,34} However, because most included studies were observational, these findings should generally be interpreted as describing the clinical profile of patients experiencing delayed care rather than demonstrating a causal effect of delay on clinical outcomes.

Barriers to Cataract Surgical Uptake

Financial Barriers

Financial constraints were among the most consistently reported barriers to cataract surgical uptake across the included studies. In addition to the direct cost of surgery, several studies identified indirect costs related to transportation, accommodation, food, loss of income, and the need for an accompanying person.^{11,12,15,18,20,21,25,27,29,35,36} The magnitude of the reported financial barrier varied substantially between settings. In Ghana, 60 of 66 non-acceptors (90.9%) identified cost as a barrier.²⁰ In Tanzania, 157 of 198 non-acceptors (79.0%) reported inability to afford surgery, while in northern Nigeria, inability to afford treatment was reported by 94 of 154 respondents (61.0%).^{15,21} These findings indicate that financial barriers may extend beyond the nominal surgical fee and include the broader economic burden associated with accessing and completing cataract surgery.

Importantly, reducing the direct financial barrier alone did not necessarily result in universal surgical uptake. In Tanzania, 32 of 157 patients who initially reported inability to pay subsequently returned with sufficient funds, while four returned after receiving a fee waiver.²¹ This suggests that financial assistance may facilitate uptake but may need to be combined with interventions addressing other barriers.

Geographic and Transportation Barriers

Geographic accessibility and transportation were also frequently reported barriers. Distance from surgical facilities, limited transportation, lack of an accompanying person, and difficulties travelling to health facilities were reported across several

991

settings.^{11,13,14,18,20,21,26,27,32,34} In rural India, living within 3 km of the service location was associated with higher cataract surgical uptake (adjusted OR 4.54, 95% CI 1.67–12.50).¹⁴ In the South Indian study by Finger et al., distance was reported as a barrier by 41 of 158 non-acceptors (26.6%), while 2 patients (1.3%) reported lack of transportation.²⁶

These findings indicate that the availability of cataract surgery does not necessarily translate into access when patients face substantial geographic or transportation barriers. The location, regularity, and continuity of services may therefore be important components of cataract surgical uptake. In South India, regular outreach at the same location was associated with higher surgical acceptance, suggesting that continuity of service delivery may reduce logistical barriers.²⁶ Decentralized services, outreach, mobile services, and transportation support may therefore be relevant strategies for populations living far from conventional surgical facilities. However, several studies evaluating these approaches were programme evaluations without randomized or concurrent control groups, limiting causal interpretation.

Perceived Need for Surgery and Fellow-Eye Vision

A recurring barrier across the included studies was limited perceived need for surgery. Perceived need for surgery refers to whether patients recognize cataract surgery as necessary or sufficiently important to seek treatment. This perception may be influenced by residual vision in the fellow eye and the ability to maintain daily activities. Patients did not necessarily seek surgery simply because cataract caused measurable visual impairment. Adequate vision in the fellow eye, the belief that surgery was unnecessary, and the ability to continue daily activities were repeatedly reported as reasons for delayed uptake.^{13,15,16,18,24,27,33,34}

In Nepal, 13 of 96 non-acceptors (13.5%) reported adequate vision as a reason for not accepting surgery.¹³ In Uganda, ability to see with one eye was associated with lower odds of delayed uptake (aOR 0.026, 95% CI 0.002–0.432), whereas lack of perceived need was strongly associated with delayed uptake (aOR 19.713, 95% CI 1.640–237.000).³³ These findings suggest that measurable visual impairment does not necessarily translate into perceived need for cataract surgery. Counselling may therefore need to address not only the

presence of cataract but also the expected functional benefits of surgery and the potential consequences of continuing to defer treatment.

Knowledge, Fear, and Trust

Inadequate knowledge and fear of surgery were additional recurrent barriers to cataract surgical uptake. Fear of surgery was reported in studies from Nepal, South Africa, India, Ghana, and Ethiopia.^{13,16,18,20,26,27} Concerns regarding the quality of available surgical services were also identified in rural China, where cataract knowledge and perceived quality of local surgical services were associated with surgical uptake.²³ These findings suggest that barriers related to information and confidence may persist even when surgical services are available. Patients may be reluctant to undergo surgery because of fear of the procedure, insufficient understanding of cataract and its treatment, or concerns regarding the quality of care. Consequently, improving cataract surgical uptake may require interventions that address knowledge, expectations, and confidence in addition to increasing surgical capacity. Community education and counselling may be particularly relevant when fear or limited understanding contributes to non-acceptance.

Family and Social Support

Family and social support emerged as additional barriers to cataract surgical uptake. Lack of an escort or family assistance was reported in several studies, while family responsibilities were particularly prominent in the South Indian study by Finger et al., in which 116 of 158 non-acceptors (75.3%) reported family responsibilities as a reason for not undergoing surgery.²⁶ This finding is important because cataract surgery may require patients to temporarily interrupt household, agricultural, or occupational responsibilities. For older adults, dependence on family members for transportation, decision-making, financial support, or postoperative assistance may further influence surgical uptake.^{13,16,19,26,36} The social context of cataract surgical uptake therefore extends beyond the individual patient. Interventions focused solely on patient education may be less effective when family members who facilitate transportation, financial decisions, or caregiving are not involved.

Clinical Consequences of Delayed Cataract Care

The included studies provide evidence that delayed cataract care frequently occurs among patients with substantial visual impairment. However, because most studies were observational or descriptive, the review does not establish a causal relationship between the duration of delayed care and the degree of visual loss. In Nepal, among 96 non-acceptors, 49 were blind and 47 had visual impairment or severe visual loss; 37.5% experienced further deterioration during one year of follow-up.¹³ In rural South Africa, 14 of 20 non-attenders (70%) were blind and six (30%) had severe visual impairment.¹⁶ In rural India, Fletcher et al. reported low vision in 242 of 552 non-attenders (43.8%) and bilateral blindness in 38 (6.9%).¹⁴

Similar evidence was reported in rural China. Yin et al. found that 67.8% of nonsurgical participants had visual acuity $\leq 6/60$ in at least one eye.²³ These findings demonstrate substantial visual morbidity among populations experiencing delayed or non-uptake of cataract surgery, although the cross-sectional nature of much of the evidence limits causal interpretation. The relationship between delayed care and advanced cataract was particularly evident among patients presenting with lens-induced glaucoma. Shakya et al., reported prolonged waiting, adequate vision in the fellow eye, financial constraints, distance, and lack of a caretaker among factors associated with delayed presentation.³⁴

Overall, the evidence indicates that delayed cataract care frequently occurs in the presence of substantial visual morbidity and, in selected populations, advanced cataract or lens-related complications. However, these findings should be interpreted as clinical consequences observed among populations experiencing delayed care rather than as uniform or directly attributable outcomes of delay.

Strategies to Improve Cataract Surgical Uptake

The strategies identified in this review largely targeted the barriers described above and included financial assistance, transportation support, counselling, community education, outreach, and decentralized service delivery.^{11,12,17,21,26,28,32} In South India, regular same-location outreach was associated with higher surgical acceptance, with acceptance increasing from 82.3% to 94.6% ($P < 0.001$).²⁶ This finding suggests that continuity and accessibility of outreach services may contribute to improved surgical uptake. Counselling also appeared to influence uptake in some

settings. In Nepal, repeated counselling resulted in 13% of the 96 initially non-accepting patients subsequently accepting surgery.¹³ These findings suggest that some patients may reconsider surgery when concerns regarding the procedure, perceived need, or expectations are addressed.

Financial assistance was similarly associated with subsequent return for surgery in some programme settings. In Tanzania, 32 of 157 patients who initially reported inability to afford surgery subsequently returned with sufficient funds, while four returned following a fee waiver.²¹ Community-level approaches were also reported, including community education and mobilisation through local communication channels and community structures. These approaches may be particularly relevant when inadequate knowledge, limited perceived need, or fear contributes to delayed uptake.

The findings also suggest that improving cataract surgical uptake requires attention to different stages of the care pathway. Patients who have not yet presented for eye care may require community awareness and early case identification, whereas patients who have already been diagnosed and recommended for surgery may require counselling, financial support, transportation assistance, or family engagement.^{13,28,31,34} Increasing surgical capacity alone may therefore be insufficient if patients cannot afford surgery, cannot reach the surgical facility, do not perceive a need for surgery, or lack family support.

Service-delivery models should consider not only the availability of surgery but also the accessibility and continuity of services. Outreach programmes, decentralized services, transportation support, and repeated services at consistent locations may help address barriers occurring after cataract has been identified.^{17,26,32} Monitoring cataract programmes using surgical volume alone may also overlook where patients are lost within the care pathway. Measures such as surgical acceptance after referral, reasons for non-acceptance, and loss to follow-up may provide additional information for identifying barriers to cataract surgical uptake.

Overall, the available evidence suggests that strategies addressing multiple barriers simultaneously may be more appropriate than interventions targeting a single factor. However, the intervention evidence was heterogeneous, and several studies represented programme evaluations or

author recommendations rather than controlled intervention studies. Therefore, the independent contribution of individual strategies remains uncertain.

CONCLUSIONS

Delayed cataract surgery in rural and underserved populations is a multidimensional access problem rather than a consequence of a single barrier. Financial constraints, geographic and transportation difficulties, limited perceived need for surgery, inadequate knowledge, fear, and limited family or social support repeatedly appeared across the literature, although their relative importance differed between settings.^{13,16-18,23-26,27-33,36}

Delayed cataract care was frequently observed among patients with substantial visual impairment and, in some populations, advanced cataract and lens-related complications.^{13,14,16,23,33,34} However, these findings should be interpreted cautiously because the included studies were heterogeneous in design, population, definitions of delayed care, and outcome measurement. Many studies relied on self-reported barriers, while several intervention studies lacked randomized or concurrent control groups. The available evidence was also insufficiently standardized for quantitative pooling, and the predominantly observational nature of the literature limits conclusions regarding causality.

Strategies to improve cataract surgical uptake should address multiple barriers across the care pathway, including community awareness, counselling, financial assistance, transportation support, and accessible and continuous outreach services.^{11,12,17,26,28,32} Further prospective studies using standardized definitions of delayed cataract care and stronger evaluations of intervention effectiveness are needed to identify the most effective approaches for improving cataract surgical uptake in rural and underserved populations.

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