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The outcomes of paediatric cataract surgery with intraocular lens insertion in sub-Saharan Africa: a systematic review

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Abstract

Importance Cataract is one of the leading causes of childhood blindness in Africa. The management of this condition requires timely surgical extraction of the cataractous lens with immediate optical correction and long-term follow-up to monitor visual improvement and manage complications that may arise. This review provides an opportunity to benchmark outcomes and to shed light on the reasons for those outcomes.

Objectives To review the published literature and report on the outcomes of paediatric cataract surgery with intraocular lens insertion in sub-Saharan Africa.

Data source The EMBASE, PubMed, Scopus, and Web of Science were searched for relevant articles.

Study selection We included all published primary studies from sub-Saharan Africa on cataract surgery outcomes in children aged 0–16 years with primary intraocular lens implantation conducted between 1990 and 2020. Eligible studies were those published in English or for which an English translation was available. In addition, reviewers screened the reference lists of all studies included in the full-text review for eligible studies. During the review, studies fitting the inclusion criteria above except for having been conducted in middle and high-income countries were tagged and placed in a comparison arm.

Data extraction and synthesis Study eligibility was determined by two independent reviewers, and data extraction was conducted by one reviewer with entries checked for accuracy by another reviewer. Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines for data synthesis were followed. The Joanna Briggs Institute (JBI) critical appraisal checklist was used for quality appraisal of the studies. The statistical software R was used in the analysis, and data were pooled using a random-effects model. Forest plots were generated using the R package 'metafor'.

Main outcomes and measures The primary outcome was visual acuity (VA) after cataract surgery and the proportions of eyes that achieved good, borderline, or poor visual outcome according to the World Health Organisation (WHO) categorisation of post-operative visual acuity. The secondary outcome measures reported included lag time to surgery, rates of follow-up, and rate of complications.

Results Eight out of 4763 studies were eligible for inclusion in this review, and seven were included in the quantitative analysis. There was a male preponderance in the study population, and the mean age at the time of cataract

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surgery ranged from 3.4 to 8.4 years. Visual outcomes were available for short-term visual outcomes (1 to 6 months) as the studies had a significant loss to follow-up. The pooled proportion of eyes that achieved a good visual acuity (i.e. equal to or greater than 6/18) in the short-term period was 31% (CI, 20–42). The comparative studies from middle and high-income countries reported proportions ranging from 41 to 91%, with higher thresholds for good visual acuity of 6/12 and 6/15.

Conclusion and relevance This review reports that there is a lower proportion of eyes with good outcomes after undergoing paediatric cataract surgery in sub-Saharan Africa than in middle- and high-income countries. Furthermore, this review states that there is a high proportion of patients lost to follow-up and suboptimal refractive correction and amblyopia treatment after paediatric cataract surgery.

Introduction

The management of paediatric cataracts, i.e. the opacification of the crystalline lens in children, involves timely diagnosis and surgical intervention as delays can lead to permanent suboptimal functional vision due to amblyopia. Previously, corneal disease was the predominant anatomic cause of childhood blindness [1]. However, in recent years, with improved childhood immunisation coverage and vitamin A supplementation, visual impairment from cataracts has become an important cause [2].

Over the years, the technique for paediatric cataract surgery has undergone changes in order to improve visual outcomes and lower the rate of post-operative complications [3]. Substantial debate still exists among paediatric ophthalmologists regarding the best practice of intraocular lens implantation in children [4]. These include primary versus secondary implantation, intraocular lens power calculations, intraocular lens material selection, and associated safety profiles [4]. However, the general consensus is that primary intraocular lens implantation is an appropriate standard of care for children above the age of 2 years [5], with much less consensus on the implantation in infants, especially under the age of 1 year [6].

After surgical removal of the cataract, immediate correction of any refractive error is required to maximise the visual acuity and prevent amblyopia [7]. In patients with primary intraocular lens implantation, this is usually achieved using prescription spectacles. For children who are left aphakic, this can be done using aphakic glasses or more preferably contact lenses [8]. Although refractive correction alone can significantly enhance visual acuity, treatment for amblyopia is sometimes necessary. This is done by increasing visual stimulation of the amblyopic eye by intermittent occlusion of the dominant eye, either by means of patching (occlusion therapy) or atropine and optical penalisation [9].

There is a lack of comprehensive prospective studies on the outcomes of paediatric cataract surgery in sub-Saharan Africa (SSA). A few isolated reports suggest that paediatric cataract surgical outcomes in SSA are not in keeping with outcomes from other parts of the world. For example, using the World Health Organisation's (WHO) visual acuity threshold of 6/18 for a good cataract surgical outcome, only 31.5% of eyes in a retrospective Nigerian study achieved a good visual outcome [10]. Another retrospective study conducted in Ethiopia reported an even lower proportion of 11% of the study eyes that achieved a good outcome.

Complications of paediatric cataract surgery are potentially visually significant, and they may be observed from the early post-operative period up to many years after the procedure [11]. The risk of post-operative complications is higher than in adult cataract surgery due to the more intense inflammatory response mounted by children after intraocular surgery [12]. Paediatric cataract management requires a multidisciplinary team that includes paediatric ophthalmologists, optometrists, and orthoptists to optimise outcomes [12]. Furthermore, it requires the dedication of the child's carer to the numerous visits required to monitor for short- and long-term post-operative complications.

Rationale

This review synthesised studies that reported the outcomes of paediatric cataract with a minimum follow-up of 4 weeks. The findings from this review may provide a baseline for tracking paediatric surgical outcomes in Africa. This review will be one of the first to report on the outcomes of paediatric cataract surgery in SSA. There have been some isolated reports in parts of Africa. However, there has not been a comprehensive analysis of these data to add to the body of knowledge and inform clinical practice on the surgical management of paediatric cataract in the SSA region.

Objective

This review aimed to answer the following question: what is the level of vision achieved in children who underwent cataract surgery with intraocular lens insertion in SSA?

Methods

This study protocol and review were reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P) guidelines [13]. The protocol was registered prospectively on PROSPERO (ID CRD42022309523).

Eligibility criteria

In 1990, the World Health Organisation (WHO) organised the inaugural meeting of experts on the prevention of blindness in children, where they estimated the global magnitude, classification, and causes of childhood blindness [14]. Following from this meeting, a new system for classifying the causes of blindness in children was developed [14]. We thus expected studies starting from 1990 onwards to be more likely to be relevant and comparable to contemporary healthcare practices in sub-Saharan Africa. We included all published primary studies on cataract surgery outcomes in children aged 0–16 years conducted in SSA between 1990 and 2020. Only studies with a minimum follow-up time of 4 weeks were included. Studies with mixed patient groups, for example, those with traumatic cataracts, were included if the data analysis regarding the visual outcomes of the aetiology was performed separately.

Articles were excluded from the analysis if the study design was a letter to the editor, a case report, or a systematic review. Studies that included children with pre-existing visually significant comorbidities such as glaucoma and retinal or corneal dystrophy were excluded. Furthermore, studies available only as conference abstracts or unpublished data and studies that were reported in languages other than English with no translation available were also excluded.

Information sources and search strategy

A search of PubMed (last searched on 21st March 2022), EMBASE (last searched on 28th March 2022), Scopus (last searched on 1st April 2022), and Web of Science (last searched on 10th April 2022) databases was done using a predefined search strategy. The full search strategy for PubMed (Additional file 1: Appendix 1) was modified as necessary for the other databases. The results from the four databases were uploaded to the online review management software Covidence [15]. Two independent reviewers (PPM and TLZ) performed the first and second rounds of article screening through this platform. The first round was the screening of titles and abstracts, and round two was full-text screening. The reference lists of full-text articles were also scrutinised for potentially eligible studies. All discrepancies in article selection were tagged by Covidence, and the conflicts were resolved within the software while the reviewers were blinded to each other's conflict-resolving vote. In scenarios where both reviewers had voted to exclude an article but disagreed on the reason for exclusion, a discussion was held to reach a consensus on the reason. A third reviewer (HIN) was available as an arbitrator in case the two reviewers could not resolve any conflicts; however, the need for this did not arise. During the review, studies fitting the inclusion criteria but conducted in middle and high-income countries were tagged and placed in a comparison arm.

Data extraction

Data were extracted from studies retained from round two of screening by one reviewer (PPM) and checked by a second reviewer (HIN) for accuracy. One reviewer (PPM) conducted the data extraction for all the included studies, and a second reviewer (HIN) rechecked the results against the papers for accuracy. Discrepancies were resolved through a review of the article in question and a discussion between the two reviewers.

The primary outcome was visual acuity after cataract surgery, which was reported using the WHO categorisation of visual acuity; those with a visual acuity of 6/18 or better were categorised as 'good outcome', those with a visual acuity of less than 6/18 but greater than 6/60 were categorised as borderline, and those with a visual acuity less than 6/60 were categorised as poor outcome [16]. Depending on the duration after surgery, these outcomes were described as short-term outcomes (1 to 6 months), medium-term (7 to 12 months), or long-term (longer than 12 months). Data on the secondary outcome of the rate of post-operative complications such as uveitis, glaucoma, retinal detachment, and visual axis or posterior capsular opacification were also collected if reported. Where available, other data collected included publication characteristics, preoperative visual acuity, whether or not amblyopia treatment was given, and lag time. Lag time was defined as the time taken from noticing the cataract to surgery and 'late presentation' was defined as a delay to cataract surgery of more than 12 months.

Risk of bias and quality assessment

We applied the Joanna Briggs Institute (JBI) critical appraisal checklist [17] to the eight studies included in this review. The checklist had 11 questions with the options 'yes', 'no', and 'unclear'. A response of 'yes' indicated that the study met that question's quality criterion. Two reviewers (PPM, HIN) performed the risk of bias assessment independently, and conflicts were resolved through discussion. An arbitrator (TLZ) was on standby for conflicts that could not be resolved through dialogue. For the risk of bias and quality assessment, all the studies were classified as case series because the study population consisted of only participants who were sampled based on the presence of a specific outcome [18], i.e. visual outcomes after cataract surgery. The studies included consecutive participants who satisfied the inclusion criteria over a given period of time. Furthermore, the absence of a control group of patients that prevented the estimation of relative risk (the odds ratio) for the outcome [18] was also considered a criterion for classification as a case series.

Statistical analysis

The statistical software R was used in the analysis [19]. Forest plots were generated using the R package 'metafor' [20]. We used a random-effects model to evaluate pooled effects due to the high likelihood of heterogeneity among the selected studies. Heterogeneity between studies was assessed using the I^2 statistic and the chi-squared test.

Differences between protocol and review

The age of inclusion in the review was adjusted from 0–15 to 0 to less than 16 years as some studies considered this range the paediatric population. We concluded that an additional 12 months would not significantly alter or adversely affect the results.

During the review process, similar studies from middle- and high-income countries were tagged and placed in a geographical comparison group. This was done in an attempt to contextualise the results on a global scale of paediatric cataract surgical outcomes.

Results

The search strategy extracted 6448 published articles of which 1685 were duplicates as described by the PRISMA flow chart (Additional file 1: Appendix 2). The full texts of 24 studies were evaluated, and 16 studies were excluded. A summary of excluded studies can be found in Additional file 1: Appendix 3. Eight studies were included in the quantitative analysis, seven of which were included in qualitative analysis. The study types that were included as reported by the authors were retrospective case series, retrospective chart review, prospective interventional, retrospective interventional case series, prospective longitudinal, hospital-based interventional study, prospective longitudinal hospital-based observational study, and retrospective survey. The PRISMA checklist for the review is available in Additional file 1: Appendix 4.

Clinical presentation

All the studies had a male preponderance in the patient population and the study durations ranged from 12 to 58 months. The mean age in the studies ranged from 3.4 to 8.4 years old. Only three of the studies provided the mean age along with the standard deviation. Therefore, combining the means of these studies alone, although considered, was deemed unlikely to yield meaningful results. Table 1 shows the characteristics of the included studies.

Six out of the eight studies documented the lag time of the study participants. For the studies that reported the lag time as mean, the longest mean delay was reported in Bowman et al. [22]: 44 months. Gogate et al. [25] and Mndeme et al. [28] reported similar mean delays in their study populations, 20.7 months (SD 18) and 21 months (SD 26.7), respectively. Furthermore, half of the study participants had a delay of more than 15 months in Gogate et al. [25] and more than 12 months in Mndeme et al. [28]. A larger proportion of patients with a long lag time were seen in Mboni et al. [26], with nearly two-thirds of the study population undergoing surgery after more than a 12-month delay.

Assessment and diagnosis

Six of the eight studies described the proportion of eyes that were blind prior to cataract surgery, that is, eyes with a visual acuity of less than 3/30. The remainder of the studies described the proportion of eyes that had a preoperative visual acuity of less than 6/60, and these were 98.7% and 88.4% in Mboni et al. [26] and Gogate et al. [25], respectively.

Five out of eight and six out of eight studies reported the proportion of eyes with preoperative strabismus and nystagmus, respectively. One study, Mndeme et al. [28], gave the combined proportion of patients with both findings. Six of the eight studies reported collecting data on systemic comorbidities as part of their methodology; however, only three studies reported the results of these findings (Table 2).

Treatment

We did not specify a single surgical procedure for cataract extraction in the eligibility criteria and allowed for some variation in the surgical procedure. The reason was the consideration of the differences in the availability of resources in the various sub-Saharan countries like surgical equipment and consumables. For example, in Gogate et al. [25], the participants underwent phacoaspiration with primary posterior capsulotomy (PPC) and anterior vitrectomy (AV) performed in participants below 6 years of age. On the other hand, the cataract removal procedure performed included lens aspiration, PPC and AV in Bowman et al. [22], and extra-capsular cataract extraction (ECCE) in Onabolu and Iwuora [23] as shown in Table 1.

Table 1 Summary of included studies

Study reference	Study design	Country	Duration of Study (months)	Total number of eyes recruited	Mean age (years)	Sex distribution % (Male to female)	Biometry	Surgical method used	Amblyopia treatment	IOL types
Yorston et al. (2001) [21]	R	Kenya	58	118	3.5	69 to 31	Done in 2nd half of study (20 of 118 eyes)	Lens aspiration ± PPC and AV	Yes	Hydrogel PMMA
Bowman et al. (2007) [22]	R	Tanzania	36	232	5.6 (SD ± 4.7)	52 to 48	Done	Lens aspiration, PPC and AV	Yes	PMMA Hydrophobic acrylic
Onabolu and Iwuora (2010) [23]	P	The Gambia	12	32	8.4	60 to 40	Not done	ECCE	No	PMMA
Umar et al. (2015) [24]	R	Nigeria	12	181	6.9 (SD ± 7.97)	64 to 38	Done	MSICS, PPC (below 5 years) ± AV	Yes	PMMA
Gogate et al. (2016) [25]	P	Republic of South Africa	25	69	3.8 (SD ± 3.3)	52 to 48	Done	Phacoaspiration ± PPC and AV	Yes	Hydrophobic acrylic
Mboni et al. (2016) [26]	R	Zambia	12	102	NR	65.9 to 43.1	Done	Lens aspiration, PPC and AV	Not stated	'Foldable'"
Asferaw et al. (2019) [27]	R	Ethiopia	48	176	BC: 5.8 UC: 7.0	66.2 to 33.8	Done	Lens aspiration ± PPC and AV, Lensectomy	No	'Foldable' PMMA
Mndeme et al. (2021) [25]	P	Tanzania	12	405	3.4	61.8 to 38.2	Done	± PPC and AV (below 7 years)	Not stated	Hydrophobic acrylic

Note: *R* retrospective, *P* prospective, *BC* bilateral cataract, *UC* unilateral cataract, *PPC* primary posterior capsulotomy, *AV* anterior vitrectomy, *SD* standard deviation, *PMMA* polymethyl methacrylate, *ECCE* extra-capsular cataract extraction, *NR* not reported

Table 2 Preoperative assessment

Author	Eyes with nystagmus *n* (%)	Eyes with strabismus *n* (%)	Eyes blind before surgery (%)	Systemic examination and/or comorbidities	
				Data collected	Data reported
Yorston et al. [21] 2001	30 (42.3)	NR	74.6	No	No
Bowman et al. [22] 2007	60 (25)	27 (11)	50	Yes	Yes
Onabolu and Iwuora [23] 2010	3 (12)	2 (8)	100	Yes	No
Umar et al. [24] 2015	66 (36.5)	64 (35.4)	78.8	Yes	Yes
Gogate et al. [25] 2016	NR	NR	NR	No	No
Mboni et al. [26] 2016	NR	NR	NR	Yes	No
Asferaw et al. [27] 2019	24 (35)	13 (19)	BC—58 UC—75	Yes	No
Mndeme et al. [28] 2021	Reported as nystagmus/strabismus 105 (66.5)		BC—75 UC—90.2	Yes	Yes

Note: *NR* not reported, *BC* bilateral cataract, *UC* unilateral cataract

Visual outcomes

All the studies except Mndeme et al. [28] reported quantifiable visual outcomes using the conventional 6 m. Although Mndeme et al. reported visual acuity in LogMar, the same WHO cut-offs for good borderline and poor categories were used. For example, the 0.48 LogMar vision for a good outcome equates to 6/18. Good short-term visual outcomes were reported for all eight studies. However, borderline and poor short-term outcomes were not available for Mndeme et al. [28] and Bowman et al. [22], and poor short-term outcomes were not available for Yorston et al. [21] (Fig. 1).

The proportion of eyes that achieved a good visual outcome after cataract surgery ranged from 16.5 to 62.0%. On the other hand, the proportion of eyes which attained poor visual outcome ranged from 0 to 51%. Only one study, Yorston et al. [21], reported medium- and long-term visual outcomes. The proportions of eyes that achieved a good visual outcome were 39.1% and 50.8% in the medium and long term, respectively. In the long term, only 6.1% of eyes in Yorston et al. [21] had maintained a poor visual outcome. The pooled proportion of eyes that achieved a good visual acuity in the short-term period is 31% (CI, 20–42), as shown in Fig. 2.

Amblyopia treatment

Four out of the eight studies (Yorston et al. [21], Bowman et al. [22], Umar et al. [24], and Gogate) indicated that

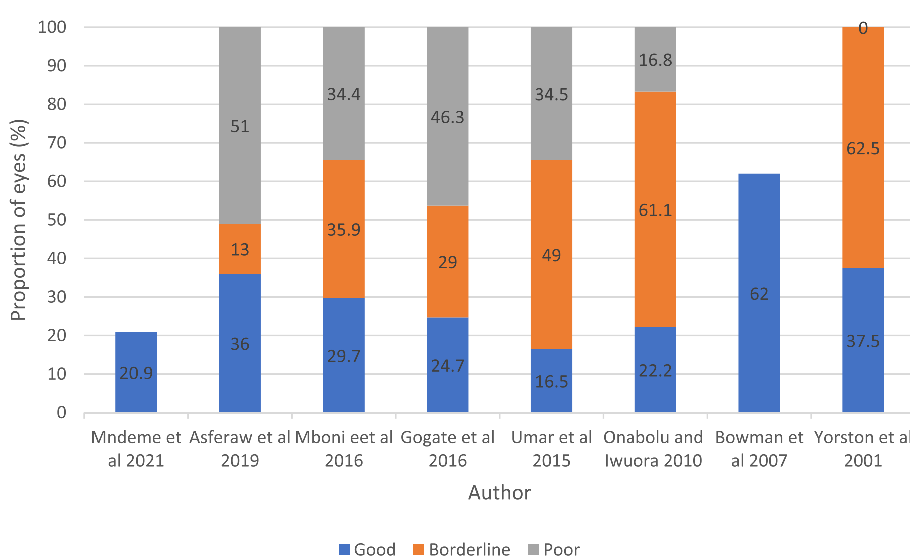

Fig. 1 Short-term visual outcomes of paediatric cataract surgery

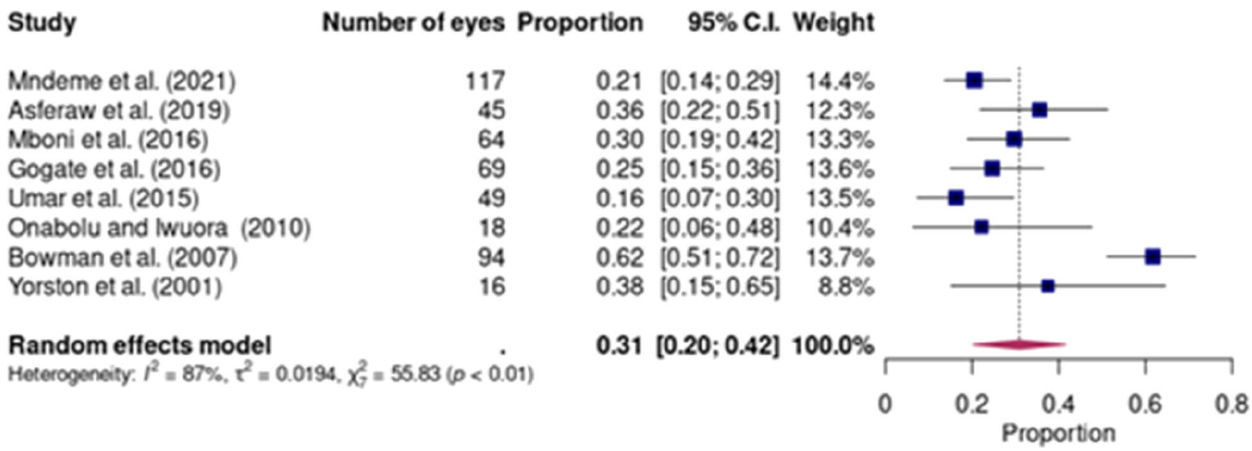

Fig. 2 Observational forrest plot showing the pooled proportion of eyes with short-term visual outcomes

they had instituted amblyopia treatment during the post-operative period. The method of amblyopia treatment in these studies was patching of the better eye for a specified duration according to the severity of the amblyopia. A comparison of visual acuity before and after amblyopia treatment was not reported.

Post-operative complications

Five out of the eight studies reported that some eyes developed acute fibrinous uveitis. The proportion of eyes that developed this complication ranged from 1.3 to 30.5% (Fig. 3). Analysis yielded I^2 statistic of 96% (p-value < 0.01). This indicated the presence of large and significant heterogeneity in the effect sizes. Pooling the data yielded a proportion of 12% (CI, 2–21) with uveitis.

Six of the eight studies reported on the development of posterior capsular or visual axis opacification within 6 months post-surgery (Fig. 4). Analysis for those who developed PCO yielded I^2 statistic of 93% (p-value < 0.01). This indicated the presence of large and significant heterogeneity in the effect sizes. Pooling the proportions yielded a proportion of 13% (CI, 5–22). Only one study, Onabolu and Iwuora [23], reported the complication of post-operative retinal detachment. No study observed the development of post-operative endophthalmitis in the participants' eyes. The rest of the post-operative complications are depicted in Additional file 1: Appendix 5.

Post-operative follow-up

Only three of the eight studies reported a statistically quantifiable follow-up time for the study eyes. Asferaw et al. [27] reported a median follow-up time of 2.8 months (range, 1–33). Bowman et al. [22] reported a mean follow-up time of 6 months (SD 9 months), with only 54% of participants seen after 3 months. On the other hand, Yorston et al. [21] reported both mean and median follow-up times of 15 and 17 months, respectively.

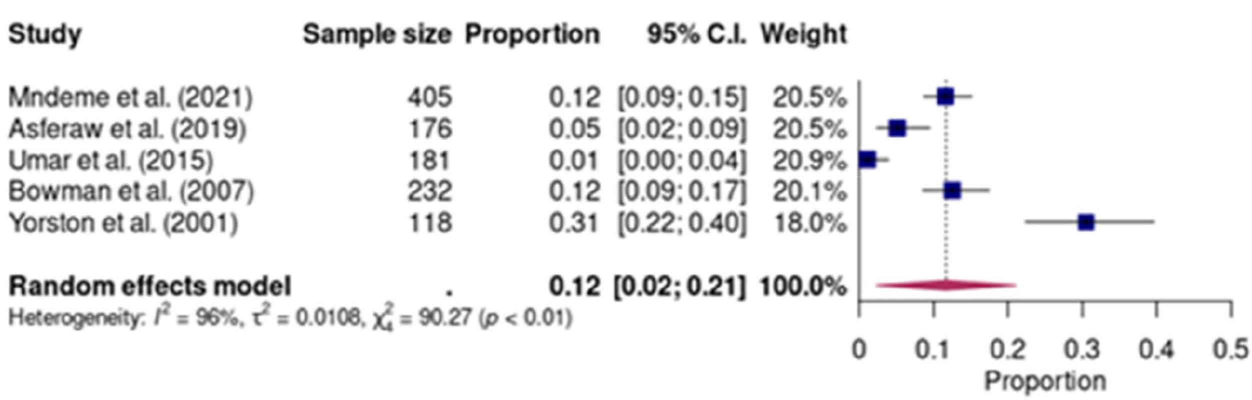

Fig. 3 Eyes that developed uveitis

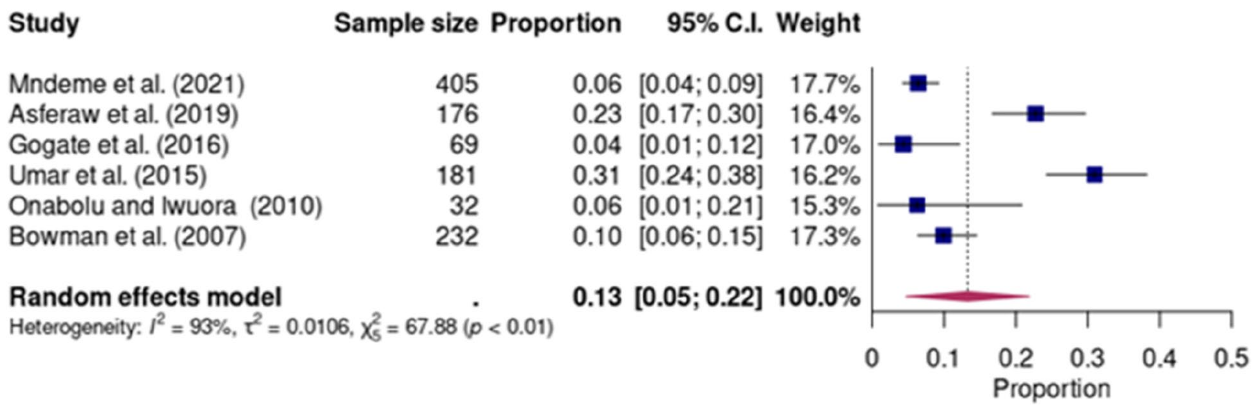

Fig. 4 Eyes that developed posterior capsular or visual axis opacification

Quality of the evidence and subgroup analysis

The results of the quality assessment are presented in Additional file 1: Appendix 6. Analysis output for good visual acuity reveals that Q-statistic is 22.3225 with *p*-value equal to 0.002, and I^2 statistic is 67.74% (CI, 23.0–91.5). This suggests the presence of heterogeneity in the effect sizes. The heterogeneity is between low to large. The heterogeneity in the effect sizes is uncertain.

An in-depth analysis of visual outcomes based on age was not possible due to the lack of homogeneity of age categories in the studies (Fig. 5). For example, Bowman et al. [22] did not report visual outcomes disaggregated by age, Yorston et al. [21] grouped the eyes in the categories 0–1, 2–5, and 6–10 years, and Umar grouped them 0–1, > 1–3, and > 8.

However, after stratifying the studies based on the average age of the participants, large and significant heterogeneity in the effect sizes was observed among the studies with mean age of participants of less than 6 (I^2 statistic was 94% and *p*-value < 0.01), while among the studies that had a mean age of participants of greater than 6, heterogeneity was medium and not significant (I^2 statistic was 57% and *p*-value = 0.10). Although the outcomes for those under the average age of 6 shown better visual outcomes, analysis did not yield a significant difference between the proportions (for good visual acuity) of those that were under the age of six (CI, 16–55) and those whose age was more than six (CI, 12–37).

Subgroup analysis based on whether biometry was done or not yielded an I^2 statistic of 40% (*p*-value = 0.15) for the studies in which biometry was done indicating that heterogeneity in the effect sizes was low and not significant (Fig. 6). For studies in which biometry was done, the analysis yielded a proportion of good visual acuity

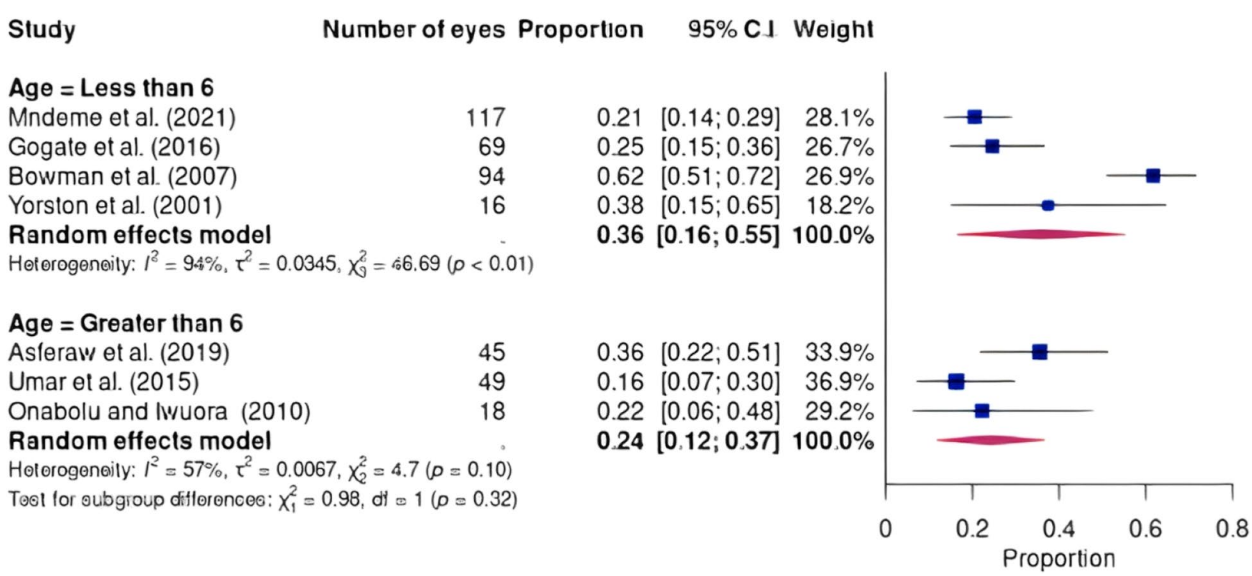

Fig. 5 Subgroup analysis based on age

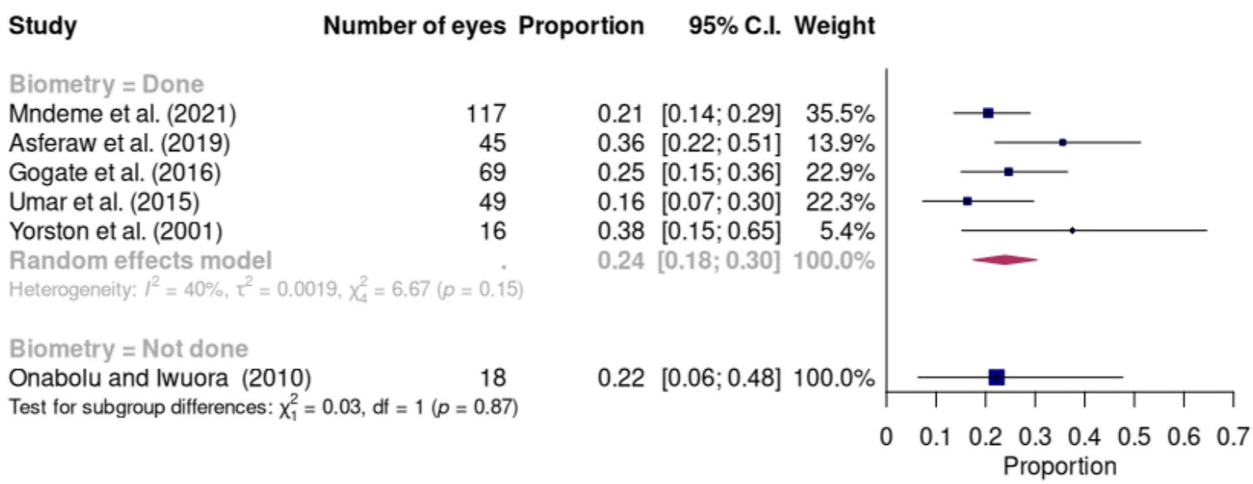

Fig. 6 Subgroup analysis based on biometry done or not done

of 24% (CI, 18–30). There was one study, Onabolu and Iwuora [23], which indicated that biometry was not done, and the proportion of good visual acuity was 22%(CI, 6–48).

Subgroup analysis was also performed based on whether single IOL or multiple IOLs types were used (Fig. 7). For studies that used single IOL, heterogeneity might be due to sampling error (I^2 statistic was 0% with p-value = 0.5), while among studies that used multiple IOL, it was large and significant (I^2 statistic was 81% with p-value < 0.01). The analysis yielded a proportion of 22% (CI, 18–27) for good visual acuity for studies that used single IOL, and a proportion of 46% (CI, 28–64) for those that used multiple IOLs. The proportion of good visual acuity for those who used multiple IOLs was significantly higher than that of those who used single IOL.

Discussion

In this review, we synthesised the available primary studies on the outcomes of paediatric cataract surgery with intraocular lens implantation in SSA.

Patient characteristics and presentation

All the studies in this review had a male preponderance of participants even though there is no biological evidence to support a sex-specific male predisposition in

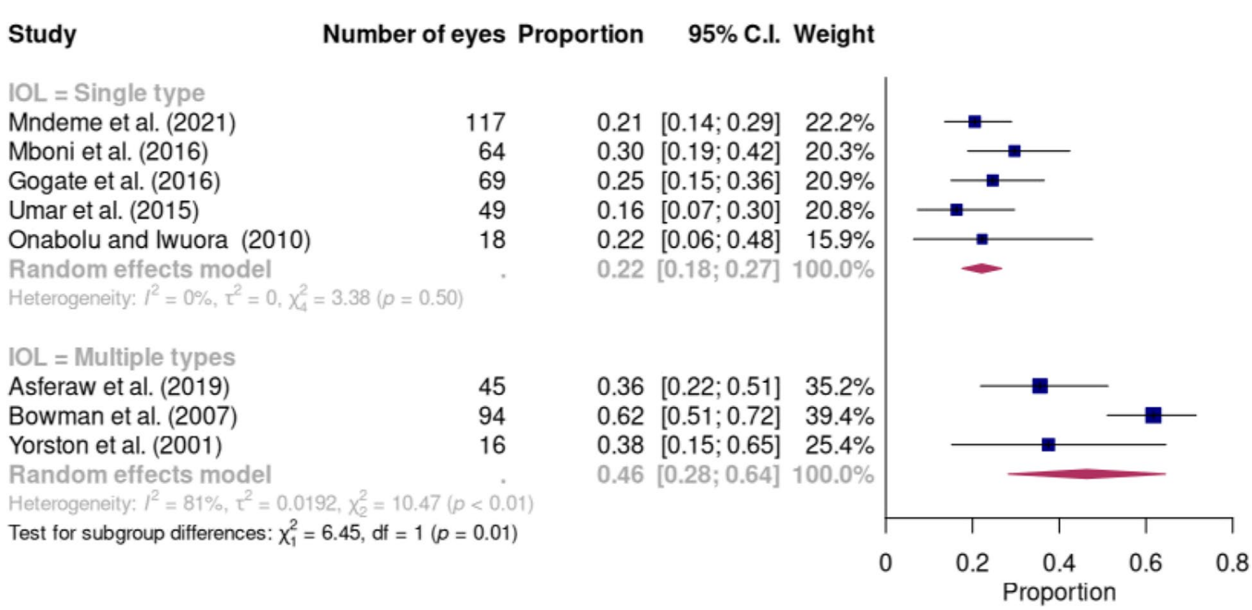

Fig. 7 Subgroup analysis based on single or multiple IOL types used

the prevalence of congenital or non-traumatic developmental cataracts [29]. Some studies [21, 24] reported one reason is that in a lot of African communities, boys are awarded a higher societal value than girls. Other studies on paediatric cataract surgery from Africa have reported the similar findings of gender discrepancy with similar explanations [30, 31]. These findings suggest a need to improve equitable access to paediatric cataract surgery in SSA.

The majority of the participants in the studies experienced a long preoperative delay which is not uncommon in SSA [25]. African studies that investigated the reasons for lag time and its association with visual outcomes defined delay as 'more than 12 months' before receiving a cataract operation [25, 26, 32]. This is likely due to pragmatic reasons, as it is a routine occurrence to have children with cataracts present late to the hospitals. In principle, for congenital and infantile cataracts, by the time the children are delayed for 12 months, the optimum time for surgery has passed [33, 34].

Mwende et al. [32] reported on the causes of delayed presentation for non-traumatic cataracts in Tanzania. They found that a longer distance from the eye care facility significantly increased the delay in presentation. Furthermore, there was a positive correlation between rising maternal socio-educational status and a reduction in delay in presentation. This is because these mothers are more likely to have some knowledge of the problem and the treatment that exists. They are also more likely to have the financial means to access eye care services and accept the surgical services offered.

The lag time from the studies in this review was not qualified; it is unclear the extent of delay that resulted from late recognition of the cataract by the children's caregivers, delay in accessing eye care services, and the delay that resulted from waiting for surgery after presentation to an eye care facility. This information would be crucial in formulating an approach to dealing with the primary barriers that exist at the community level. One study from Southwest Nigeria that investigated the factors associated with early versus late presentation to tertiary eye care facility found that children whose cataract was detected by their mothers were more likely to present to the eye care facility within 3 months of detection [35]. In addition, these children were also more likely to present at a younger age than cataracts detected by other caregivers [35]. This suggests that educating and empowering mothers about cataract in children may be a tool in the arsenal of tackling blindness from childhood cataracts.

Preoperative assessment

This review found that the proportion of blind eyes preoperatively in all the studies ranged from 50 to 100%. Preoperative findings are essential in prognosticating the outcome of surgery. The presence of strabismus and/or nystagmus can adversely affect outcomes, and their prevalence varies widely among studies [36]. Strabismus prevents the development of binocular vision, and the amblyopia it causes can have adverse aesthetic and psychological effects on the child [36]. Moreover, the presence of nystagmus and strabismus are indications that substantial visual deprivation has occurred [24]. Other studies have reported an association between poor preoperative vision and limited improvement in post-operative visual acuity [22, 25, 28, 37].

Visual outcomes

During our literature review, we did not find standardised benchmark indicators for outcomes of paediatric cataract surgery comparable to the WHO guidelines established for adult cataract outcomes. Similarly, in their work on outcome indicators in paediatric cataract surgery, Nihalani et al. [38] did not identify any publication focused on benchmark indicators in paediatric cataract surgery. As such, the WHO categorisation was used in this review. The pooled proportion of eyes that achieved a good visual acuity in the short-term period was 31% (CI, 20–42). Although we did not find studies from high-income countries that defined the cut-off for 'good visual outcomes' as 6/18 like in the studies in our review to offer a direct comparison, there were several studies that used the cut-offs of 6/12 and 6/15 (Additional file 1: Appendix 7) The American studies Peterseim et al. [39], Wilson et al. [40], and Struck et al. [41] reported that 27 (91%) (CI, 80–97), 48 (72%) (CI, 59–82), and 13 (85.7%) (CI, 66–100) of eyes achieved a visual acuity of 6/12 or better good visual outcome at the last follow-up visit, respectively. In the UK, a study by Cassidy et al. [42], 25 (73.5%) (CI, 51–80) children achieved a visual acuity of 6/12 or better. Furthermore, the European study Ambroz et al. reported that 34 (54.0%) (CI, 41–67) of eyes achieved a post-operative acuity equivalent to 6/15 of better. Although these studies are not a direct comparison, the cut-offs of 6/15 and 6/12 are a higher standard of visual acuity. It thus suggests that outcomes that are achieved in middle- and high-income countries are superior to those from SSA.

It has been proposed that during visual development, there is a short, well-defined period in early life where the neuronal pathways are robustly restructured in response to sensory input [43, 44]. Years after this 'critical period' the same stimuli have less influence on visual development. What follows from these findings is that the occlusion of one eye during this critical period in early life results in the development of a suboptimal visual acuity in the deprived eye that persists into adulthood if left uncorrected [45]. Our expectation would be that children with developmental cataract would obtain better visual outcome because during the critical period, there was no sensory deprivation, and thus, they attained optimum vision prior to the cataract.

It should be noted that the visual outcomes in SSA may be better than those reported in this review. This is because of the lack of long-term follow-up for visual rehabilitation and maturation [25], especially in younger children. Moreover, the visual function is not limited to visual acuity and other factors such as contrast sensitivity and stereopsis need to be considered. However, no study in this review reported on post-operative contrast sensitivity testing, and only one study, Gogate et al. [25], measured stereopsis preoperatively and on follow-up visits. The majority of eyes had poor stereopsis, with only 9 (18%) children achieving better than or equal to 400 s of arc.

Post-operative follow-up

A comparison of the follow-up times from the studies in this review to those from studies in high-income countries revealed that the latter have longer follow-up times for patients. For example, in the American study Ledoux et al. [46], the median follow-up time was 3.65 years. Similarly, Repka et al. [47], in their multicentre study of 994 children, retained 88.4 and 66% of participants at 1 and 5 years. Follow-up in Africa is usually challenging for various reasons, such as the long distance from the tertiary eye care facility, which is coupled with poor road infrastructure, financial constraints, and lack of awareness of the importance of long-term follow-up [48]. Unfortunately, without appropriate post-operative follow-up, paediatric cataract surgery alone produces limited results [49]. The value of long-term follow-up visits can be evident if the child receives the appropriate care at each visit. In many parts of SSA, post-operative services from allied personnel such as orthoptists, refractionists, and low visual aid service providers are lacking [50]; thus, the care received is likely to be suboptimal.

Post-operative complications

Acute uveitis is more common in children as they mount a greater inflammatory reaction following intraocular surgery due to an immature blood-aqueous barrier [51]. Patients are typically prescribed topical steroid eye drops and cycloplegics post-operatively [51]. These were prescribed in all the studies included in this review. Literature shows a variable incidence of uveitis after paediatric cataract surgery. The proportion of eyes with acute uveitis in this review varied from zero in Gogate et al. [25] to 30.5% in Yorston et al. [21]. This is comparable to isolated studies from the west. In the American study by Ledoux et al. [46], no eyes in their series of 139 children had post-operative uveitis, whereas in the UK study by Cassidy et al. [42], uveitis occurred in 28.2% of eyes. However, the pooled proportion of uveitis in our study was found as 12% (CI, 2–21).

Glaucoma is a significant risk in paediatric cataract surgery. Recent multicentre prospective studies in high-income countries reported the incidence of glaucoma after paediatric cataract surgery to be 10% in the first year of follow-up, with the condition occurring in both aphakic and pseudophakic eyes [52, 53]. The highest proportion of eyes with elevated intraocular pressure was 2.9% in Mndeme et al. [28]. Glaucoma after paediatric cataract surgery is typically late-onset open-angle glaucoma [11], although it can be observed within the first few months following surgery. Most early-onset glaucoma is due to vitreous pupillary block or inflammation. But with advances in technology, changes in surgical techniques and the appropriate use of anti-inflammatory medication post-operatively, early-onset glaucoma is much more uncommon [54]. The low number of eyes that developed glaucoma in our review can be explained by the short follow-up time. Therefore, it can be anticipated that if there were a longer follow-up, there would be a larger proportion of eyes seen with glaucoma.

Eyes that have undergone cataract extraction are at an increased risk of retinal detachment. Like aphakic or pseudophakic glaucoma, retinal detachment is also a long-term complication. In Denmark, a study of 1043 eyes of children aged 0 to 17 years by Haargaard et al. [55] reported that 25 eyes developed retinal detachment after a mean duration of 9.1 years after surgery. They further reported an overall 20-year risk of retinal detachment of 7%. This highlights the need for lifelong monitoring in these patients. Our review has low numbers of eyes that developed retinal detachment for the same reason as the low number of glaucoma, which is the short follow-up time.

Heterogeneity in the effect sizes

Analysis output for good visual acuity revealed that Q-statistic was 55.83 with p-value less than 0.0001, and I^2 statistic was 87% (CI, 78–93). This indicated the presence of large heterogeneity in the effect sizes. This may result from the clinical and methodological differences across studies in this review. As previously outlined, there were variations in how the surgical procedures were conducted. Furthermore, in some studies, there was one surgeon who performed paediatric cataract surgeries, whereas some studies had multiple surgeons. In addition, the small number of studies included in the review may be the reason heterogeneity in the effect sizes is uncertain. Subgroup analysis based on whether biometry was done or not, and whether single IOL or multiple IOL types were used revealed small heterogeneity which was not significant in any of the strata. This indicates that in addition to the small number of studies considered, heterogeneity in the effect sizes was largely due to variations in the methodological designs of the studies.

Challenges that result in inferior outcomes in sub-Saharan Africa

Early surgical intervention is recommended for bilateral congenital cataracts to improve visual outcomes [33], and for unilateral cataracts, this intervention is recommended even earlier [34]. As seen from this review, the majority of patients had a lag time of more than 12 months and, in some cases, more than 36 months. In high-income countries, there are surveillance programs for routine screening of neonates for early recognition of any lens opacity and thus provide timely surgical intervention [56]. On the other hand, in low-income countries, research suggests that long lag times are multifactorial, ranging from sociocultural barriers at the community level to logistical and organisational barriers within the health care system [57]. In some cases, the late presentation is due to poor health-seeking habits of the child's guardians, as illustrated in Gogate et al. [25], where a quarter of guardians stated the reason for the delay in seeking help as 'did not see the need to come to hospital.' In situations where the symptoms are painless and not considered life-threatening, there may be a delay in presentation to tertiary eye facility for treatment [58].

Another reason for poor outcomes is the shortage of specialised paediatric ophthalmologists in SSA to cater to the immense burden of paediatric cataracts. Accessing sub-specialty training for paediatric ophthalmology is difficult, especially in Francophone Africa; thus, there is a continued lack of skilled eye care providers needed in tertiary hospitals [59]. In addition, there is a lack of visual rehabilitation facilities in SSA, especially for very young children. The standard of practice for managing these children is to prescribe contact lenses in lieu of intraocular lens implantation due to the increased risk of post-operative complications and higher reoperation rates in this patient group [60–62]. However, their use in SSA is impractical [21]. The majority reside in rural areas where clean running water is scarce, making personal and ocular hygiene a challenge [63]. This is further compounded by the high cost of the lenses and lens cleaning solutions. Other associated problems such as the risk of microbial keratitis and lens loss also limit the use of these methods [8]. There is a paucity of research on the safety and effectiveness of these interventions in the African context. With all the problems surrounding contact lens usage and the rise of published case series reporting promising results with intraocular lens implantation in younger children [39, 64–66], some paediatric surgeons are now moving to primary intraocular lens implantation in younger children.

Whether children are left aphakic or have intraocular lens implantation, they still require optical correction to maximise visual outcomes [67]. Although glasses are more appropriate for the African setting, there are few children who get the glasses even after being refracted. For instance, the Madagascan study Randrianotahina et al. [68], in their series of 86 children, found that despite three-quarters of patients having refraction performed, only 3.5% received glasses. Furthermore, the glasses may break or get lost [21], after which they may not be replaced. Other challenges in prescribing glasses to children include difficulties obtaining accurate refraction and the availability of suitable frames for very young children [21].

Strengths and limitations

This review has scope for novelty in adding to the knowledge gap regarding paediatric cataract surgery. To our knowledge, this is the first review focusing on collating outcomes of visual outcomes of paediatric cataract surgery across sub-Saharan Africa. The inclusion of primary research studies combined with rigorous article screening and quality assessment provides a comprehensive evaluation of the available evidence.

A limitation of this review is the presence of significant heterogeneity within the included studies. Given the context of the SSA setting, the nature of the study population, and intervention under investigation, identifying controlled trials for more accurate and reliable estimates proved challenging. Nevertheless, it is important to note that this review emphasised narrative synthesis of the results over quantitative analysis, aiming to highlight the underlying reasons behind the observed findings.

Caution is advised when interpreting our pooled estimate of good outcomes, as not all factors influencing post-operative visual acuity were systematically analysed. For example, the primary studies lacked information on the measures employed for visual rehabilitation in patients. Moreover, for those implementing amblyopia treatment, details on treatment compliance and the ultimate visual outcomes post-treatment were not reported. There was also no information provided on optical correction compliance for those who received glasses. Lastly, the follow-up period for most of the studies was very short; thus, visual acuity conducted on the young infants may not be reliable. A longer follow-up of patients is needed to further discuss the surgical outcomes of cataracts in SSA.

Conclusion

This review showed that paediatric cataract surgery outcomes in sub-Saharan Africa are lower compared to reports from high-income countries. We reported that the proportion of eyes that achieve a vision of 6/18 or better within 6 months of cataract surgery is 31%. All comparative studies from middle- and high-income countries reported proportions ranging from 41 to 91%, with a higher visual acuity cut-offs of 6/12 and 6/15. Furthermore, there are low rates of follow-up and suboptimal refractive correction and amblyopia treatment after surgery within the studies.

Recommendations

In order to improve outcomes, there is a need to focus on visual rehabilitation after paediatric cataract surgery. Therefore, we recommend cost-effectiveness studies to establish the best models that could be adopted for a sustainable provision of refractive services to children after undergoing cataract surgery in sub-Saharan Africa.

Furthermore, we propose that stakeholders and policymakers in international eye health should come up with guidelines and recommendations for the outcomes of paediatric cataract surgeries for benchmarking, ensuring quality, consistency, and continuous improvement in patient care.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13643-024-02607-z.

Additional file 1: Appendix 1. Search strategy. Appendix 2. PRISMA flow chart. Appendix 3. Summary of excluded studies [69–74]. Appendix 4. PRISMA checklists. Appendix 5. Post-operative complications. Appendix 6. Risk of bias assessment. Appendix 7. Summary of characteristics for comparative studies.

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Authors' contributions
Dr Mhango contributed to the review process and manuscript writing. Drs Zungu and Nkume contributed to the review process. Mr Musopole contributed to the statistical analysis of the data. Dr Mdala contributed to the manuscript writing and supervised the work on the project. All authors were involved in editing and approved the final version of the manuscript.

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Declarations

Competing interests
The authors declare that they have no competing interests.

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