JURNAL KEDOKTERAN DIPONEGORO
(*DIPONEGORO MEDICAL JOURNAL*)
Online : http://ejournal3.undip.ac.id/index.php/medico
E-ISSN : 2540-8844
DOI : 10.14710/dmj.v15i2.55460
JKD (DMJ), Volume 15, Number 2, March 2026 : 174-182

PROFILE OF VISUAL FUNCTION AFTER PHACOEMULSIFICATION AT A SECONDARY HOSPITAL

Christina Aritonang[1,2*], Sarah Nia Amru[2]
[1]Department of Ophthalmology, Dr. Soetomo General Academic Hospital, Surabaya, Indonesia
[2]Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

Keywords:
Contrast sensitivity,
Phacoemulsification,
Visual acuity,
Visual function.

Received: 03 February 2026
Revised: 18 February 2026
Accepted: 18 February 2026
Available online: 01 March 2026

Corresponding Author:
E-mail: christina@fk.unair.ac.id

ABSTRACT

Background: Cataract is the leading cause of preventable blindness worldwide, with the highest burden in developing countries. In Indonesia, East Java has the highest incidence of cataract. **Objective:** To evaluate the visual function outcomes after phacoemulsification through a social service program at a secondary hospital in Gresik Regency, East Java, Indonesia. **Methods** This retrospective observational study included 40 patients undergoing phacoemulsification surgery (April 22 to May 15, 2025). Eligible patients were those with mature or immature cataracts, with preoperative vision ranging from mild impairment to blindness, according to WHO criteria. Postoperative evaluations were conducted on days 1 and 14. Data were obtained from medical records and analyzed with the Wilcoxon and Friedman tests using SPSS version 27**. Results:** Among 40 patients, 37.5% were severely visually impaired and 32.5% were blind preoperatively. Postoperatively, blindness declined to 11.5% on day 1 and 2.5% on day 14, with 45% achieving good vision. Visual acuity and contrast sensitivity showed significant improvement postoperatively (both $p < 0.001$). Surgical complications included iritis, Descemet's membrane detachment, elevated intraocular pressure, and one patient did not receive an implant due to a posterior capsular rupture during the surgery. **Conclusion:** Visual function demonstrates significant early improvements phacoemulsification through this social service program, highlighting the value of assessing multiple visual function parameters in routine postoperative evaluation.

BACKGROUND

The leading cause of preventable blindness worldwide is cataracts, with about 75% of cases occurring in developing countries. In 2013, more than 22 million people in the United States were affected by cataracts; this number increased to 30.1 million by 2020. Women are slightly more affected than men (26% vs. 22.6%), and the prevalence rises to 70.5% among individuals aged 75 and older. Age-related cataracts are often caused by lens oxidation; however, UV exposure, smoking, diabetes, corticosteroid use, and other oxidative stresses also contribute[1,2].

A survey from the Rapid Assessment of Avoidable Blindness (RAAB) across 15 provinces in Indonesia between 2014 and 2016 showed that cataract was responsible for approximately 81% of blindness in all 3% of individuals aged 50 years and older. East Java has the highest prevalence of cataract in Indonesia (4.4%)(3). The definitive treatment for cataracts is cataract surgery, which is widely performed worldwide and is highly effective[2].

Visual function is defined as the capability of the eye and visual system to detect target stimuli. Restoring visual function is the primary goal of cataract surgery, particularly through phacoemulsification, the current standard technique for cataract removal[4]. Visual acuity (VA) as well as contrast sensitivity (CS) are among the important aspects of visual function. VA is the most widely used measure of surgical success, with most patients achieving good-to-excellent corrected vision within weeks, often meeting World Health Organization

JURNAL KEDOKTERAN DIPONEGORO
(*DIPONEGORO MEDICAL JOURNAL*)
Online : http://ejournal3.undip.ac.id/index.php/medico
E-ISSN : 2540-8844
DOI : 10.14710/dmj.v15i2.55460
JKD (DMJ), Volume 15, Number 2, March 2026 : 174-182

benchmarks. However, CS is equally important, as it is defined as the ability to detect small changes in luminance between diffuse areas that are not separated by defined boundaries and is used to clearly and sharply see the outlines of small objects, as it reflects the ability to perform daily tasks under low-contrast conditions, such as driving at night or reading in dim light. But it is rarely assessed in routine eye exams. Improvements in VA and CS after surgery significantly affect patients' quality of life by restoring independence and functional vision[4]. Complications such as glaucoma, diabetic retinopathy, and surgical complications may decrease postoperative improvement. This underscores the importance of careful preoperative evaluation and optimal surgical technique[5].

Cataract surgery in developing countries, such as Indonesia, continues to face numerous challenges. These challenges include low patient awareness, inadequate infrastructure in secondary-level health facilities, financial resource shortages, and a limited number of trained ophthalmologists. Social service programs that provide cataract surgery have proven valuable in improving access to care and reducing the overall burden of avoidable blindness among underserved populations[6]. Financial support remains necessary to sustain social service programs that provide access to cataract surgery. Not only to increase the availability of care, but it also plays a crucial role in improving visual function[7]. Therefore, this study aims to evaluate visual function outcomes after phacoemulsification at a secondary hospital in Gresik Regency, East Java, Indonesia.

METHODS

Study design

This was an observational study with a descriptive retrospective design. Medical records are used to obtain data. Forty participants who underwent cataract surgery at Eka Husada Secondary Hospital in Gresik Regency, East Java, Indonesia, between April 22 and May 15, 2025, were included. A retrospective design was chosen due to logistical considerations in a short-term social service cataract surgery program. Randomization or inclusion of an untreated control group was not possible due to ethical concerns and the limited number of participants.

Population and sample

All patients diagnosed with mature or immature cataracts from January to May 2025 were eligible. **The inclusion criteria** were adult patients aged >18 years with VA > 6/18 and a diagnosis of mature or immature cataract. **Exclusion criteria** included patients with negative light perception and those who declined to participate in the study.

Data collection

All data were retrieved from medical records in September 2025. Preoperative data, including patients' demographic and clinical information, were collected. We used a consecutive method for patient selection. To minimize selection bias, all consecutive patients who met the inclusion criteria during the study period were included. VA was assessed preoperatively and postoperatively using a standard protocol on days 1 and 14. These time points are consistent with the progressive improvement in VA after phacoemulsification reported in previous studies[8,9]. CS was evaluated on postoperative day 14, when early postoperative inflammation and corneal edema were expected to have stabilized[10]. All measurements were performed using validated instruments as follows:

Preoperatively, VA was assessed with uncorrected visual acuity (UCVA) with Huvitz Digital Chart. The Huvitz Digital Chart is a computerized system for visual acuity testing, positioned at a distance of 6 meters. During the test, patients are instructed to read optotypes displayed on the LCD screen, beginning with larger letters and progressing to smaller ones until they can no longer correctly identify the characters.

The Pelli–Robson chart was used to assess CS, with a distance of 1 meter between the patient and the chart. In the test, the chart presents letters in triplets of constant size with progressively decreasing contrast. Patients read the letters until they were unable to identify at least two in a triplet correctly, and the final log CS score was recorded based on the last correctly identified triplet[5].

Descemet's membrane detachment (DMD) and iritis were evaluated using slit-lamp examination (SLM-KD3, Ruiyu, Germany). Intraocular pressure (IOP) was measured using non-contact tonometry (TX-20P, Canon, Japan). Biometry was performed using Pac Scan 300 Plus (Sonomed Escalon, USA), and autorefractokeratometry was assessed using HRK-7000A (Huvitz, Korea). All surgeries were unilateral

JURNAL KEDOKTERAN DIPONEGORO
(*DIPONEGORO MEDICAL JOURNAL*)
Online : http://ejournal3.undip.ac.id/index.php/medico
E-ISSN : 2540-8844
DOI : 10.14710/dmj.v15i2.55460
JKD (DMJ), Volume 15, Number 2, March 2026 : 174-182

cataract procedures performed by two surgeons using phacoemulsification.

Data analysis

The Wilcoxon and Friedman tests of SPSS version 27 were used to analyze data obtained from medical records.

RESULTS

This study included 40 patients in total. Accounting 75% of patients were aged over 60 years old. Gender distribution between males and females was relatively balanced—the majority of cases presented with mature cataracts (76.1%). According to the LOCS II four-point grading system, the majority of mature cataracts were classified as NIII, CIV, and PIII. Regarding comorbidities, hypertension and diabetes mellitus were present in a minority of patients, while most patients (62.5%) had no systemic comorbidities. Postoperative complications occurred in several cases, with DMD identified as the most common complication. **Table 1** presents detailed patient characteristics and associated complications.

Table 1. Patients' Characteristics

Variable	N(%)
Age	
<60	10 (25)
>60	30 (75)
Gender	
Male	21 (45.7)
Female	19 (41.3)
Cataract	
Mature	35 (76.1)
Immature	5 (10.9)
Comorbid	
HT	5 (12.5)
DM	4 (10)
HT + DM	6 (15)
None	25 (62.5)
Complication	
Iritis	4 (10)
DMD	20 (50)
Elevated IOP	4 (10)
PCR	1 (2.5)

DMD: Descemet's membrane detachment; DM: Diabetes Melitus; HT: Hypertension; IOP: Intraocular Pressure; PCR: Posterior Capsular Rupture

Visual acuity (VA) were classified according to the World Health Organization (WHO), as follows: VA of 6/6 - <6/12 is classified as good vision, VA of <6/12 - 6/18 as mild visual impairment, VA of <6/18 - 6/60 as moderate visual impairment, VA of <6/60 - 3/60 as severe visual impairment, and VA worse than 3/60 as blindness[11].

Preoperatively, most patients were severely visually impaired and blind according to WHO criteria. Postoperatively, the proportion of blindness decreased on day 1 and further declined by day 14, with nearly half of the patients achieving good vision. For statistical analysis, VA was converted to the logarithm of the minimum angle of resolution (logMAR) units. VA before and after phacoemulsification was statistically significant ($p < 0.001$). These results demonstrate early visual recovery after phacoemulsification, with continued improvement observed during the short-term follow-up period, as shown in **Table 2.**

Table 2. Visual Acuity Outcomes

Visual Acuity (log Mar)	Preoperative		Postoperative d-1		Postoperative d-14		χ^2 (Friedman), p
	n	%	n	%	n	%	53.77; <0.001
Good Vision	-	-	5	12.5	18	45.0	
Mild Visual Impairment	3	7.5	8	20.0	5	12.5	
Moderate Visual Impairment	9	22.5	9	22.5	9	22.5	
Severe Visual Impairment	15	37.5	11	27.5	7	17.5	
Blind	13	32.5	7	11.5	1	2.5	

Figure 1 demonstrates a boxplot of VA before and after phacoemulsification. The data indicate a distinct postoperative shift toward improved VA, with a narrower distribution by day 14 than at baseline. This pattern suggests more homogeneous visual outcomes. The limited number of outliers indicates that most patients experienced functional improvement, with many recovering from severe impairment to near-normal levels.

JURNAL KEDOKTERAN DIPONEGORO
(*DIPONEGORO MEDICAL JOURNAL*)
Online : http://ejournal3.undip.ac.id/index.php/medico
E-ISSN : 2540-8844
DOI : 10.14710/dmj.v15i2.55460
JKD (DMJ), Volume 15, Number 2, March 2026 : 174-182

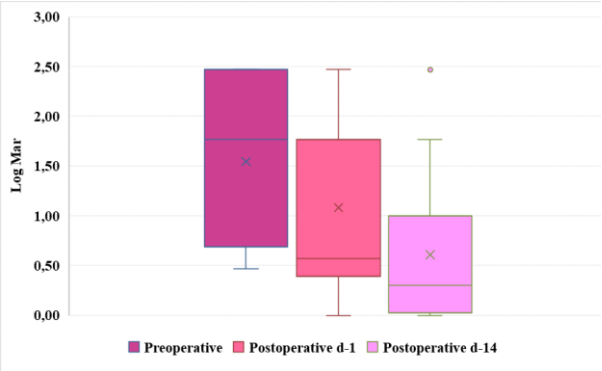

Figure 1. Boxplot of Visual Acuity Before and After Phacoemulsification

Contrast sensitivity (CS) is also an important indicator of visual function. This study quantified CS using log contrast sensitivity (log CS) scores, which were classified as follows: a Pelli–Robson log CS score of ≥2.0 indicates normal CS; a score of <2.0 indicates reduced CS; a score of <1.5 suggests visual impairment; and a score of <1.0 indicates visual disability. These thresholds align with established clinical classifications reported in the literature, which have been used to stratify CS loss and its impact on visual performance and quality of life[12].

Preoperatively, none of the patients had normal CS, and most presented with visual disability, visual impairment, and reduced CS. On postoperative day 14, a marked improvement was observed, with more than half of the patients achieving normal CS and the remainder exhibiting only reduced CS, as detailed in **Table 3**. The Wilcoxon signed-rank test demonstrated a statistically significant improvement in CS after phacoemulsification ($p < 0.001$), indicating enhanced functional visual performance beyond improvements in VA alone.

Table 3. Contrast Sensitivity Outcomes

Contrast Sensitivity (log CS)	Pre-Op		Post-Op		Z, p value
	n	%	n	%	-5.384, <0.001
Normal	-	-	22	55%	
Reduced sensitivity	2	5%	13	32.5%	
Visual Impairment	16	40%	4	10%	
Visual Disability	22	55%	1	2.5%	

Figure 2 presents a boxplot that illustrates a notable postoperative shift toward higher CS values. CS generally improved after phacoemulsification; however, several outliers persisted, including one patient who did not receive an intraocular lens implant due to posterior capsular rupture. The overall distribution shifted toward higher values, indicating an improvement in CS after surgery.

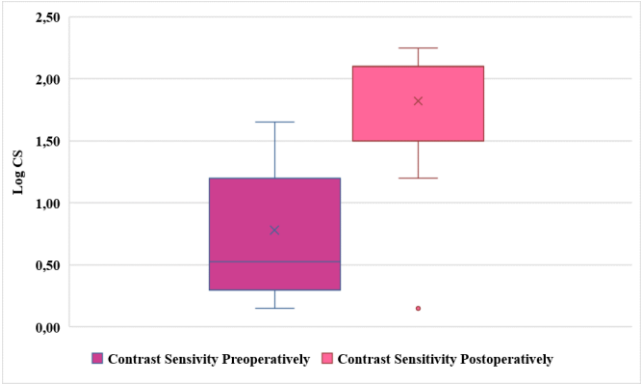

Figure 2. Boxplot of Contrast Sensitivity Before and After Phacoemulsification

DISCUSSION

Forty patients with cataract underwent cataract surgery through a social service program conducted at a secondary hospital in Gresik Regency, East Java, Indonesia. All patients underwent the phacoemulsification technique with a modified 2.7 mm horizontal incision chop. Phacoemulsification is a minimally invasive procedure that results in faster healing, less pain, and a lower risk of infection compared with traditional methods[13].

This study predominantly affects individuals aged 60 years and older, consistent with a meta-analysis reporting a global prevalence of cataract of approximately 54.38% in 2020 among individuals aged 60 years and older[14]. Aging induces changes in the lens, including denaturation and coagulation, which contribute to progressive lens opacity and visual impairment[15]. The high proportion of mature cataracts observed in this study likely reflects delayed access to cataract services, financial constraints, low awareness of the need for treatment, and a lack of early cataract diagnostic services, which are commonly reported barriers in developing regions[16]. Comorbidities such as hypertension and diabetes were present but not

JURNAL KEDOKTERAN DIPONEGORO
(*DIPONEGORO MEDICAL JOURNAL*)
Online : http://ejournal3.undip.ac.id/index.php/medico
E-ISSN : 2540-8844
DOI : 10.14710/dmj.v15i2.55460
JKD (DMJ), Volume 15, Number 2, March 2026 : 174-182

predominant, suggesting that age-related degeneration remains the main etiology in this population.

The nearly equal gender distribution is consistent with previous studies suggesting that males and females are equally susceptible to cataract development. However, some studies have reported a slightly higher prevalence among women due to hormonal and longevity factors[17].

Visual acuity (VA) improved significantly after day 14 postoperatively ($p < 0.001$). These results are consistent with several previous studies reporting significant differences in VA as early as postoperative day 1 and sustained recovery within the first few months after surgery[15]. The selection of postoperative days 1 and 14 as evaluation time points was based on evidence from previous studies on visual and refractive stabilization after phacoemulsification. Lokarjana et al. reported that only 16% of eyes achieved good VA (≥ 6/18) on postoperative day 1[8]. A marked improvement was observed after the first postoperative week, indicating progressive visual recovery. Consistent with this, a previous study by Feriza et al. found that most patients had good VA by postoperative day 14[9]. Refractive stabilization has also been shown to progress during this period, with McNamara et al. reporting stabilization in 59% of eyes at two weeks[19]. Therefore, these time points were selected to capture both immediate postoperative outcomes and early functional visual recovery.

According to World Health Organization (WHO) recommendations, at least 80% of eyes achieve a good outcome (6/6–6/18) following cataract surgery[20]. In this study, the proportion of good outcomes (57.5%) did not meet this benchmark. This discrepancy may be attributed to the short two-week follow-up period and the relatively small sample size. Comparable results have been reported by Pramita and Suniarsih, even at six weeks postoperatively[21]. Additional factors, including comorbidities, poor preoperative VA, and intraoperative complications, may also contribute to suboptimal outcomes[22]. Despite not meeting WHO recommendations, a statistically significant improvement in VA was observed after phacoemulsification, with postoperative data in a boxplot indicating a more homogeneous distribution toward near-normal levels.

Contrast sensitivity (CS) also showed a significant improvement postoperatively after day 14 ($p < 0.001$). Unlike the Snellen visual acuity test, CS evaluates the ability to detect objects under varying luminance[23]. These findings are consistent with several previous studies. A study using a contrast sensitivity acuity tester reported a statistically significant improvement in CS at three months postoperatively[24], while Mukkamala et al. demonstrated significant postoperative improvement in CS regardless of the intraocular lens material used[25].

Assessing CS on postoperative day 14 allows a more reliable evaluation, as postoperative inflammation, corneal edema, and refractive fluctuations are reduced[19]. These findings support the role of CS as a critical parameter for assessing postoperative visual function after phacoemulsification.

Although VA remains the most frequently used measure of postoperative outcome after cataract surgery, it does not fully capture functional vision in daily tasks. CS plays an equally important role, complements VA by reflecting the ability to detect objects under different lighting conditions and may remain impaired in certain patients despite satisfactory VA[5]. Therefore, combining VA and CS offers a more comprehensive assessment of postoperative visual function and more accurately reflects real-world visual performance after phacoemulsification, underscoring the importance of CS testing in routine postoperative evaluations.

In our study, several complications were observed, including DMD, iritis, and elevated IOP, and one patient did not receive an implant due to a PCR during the surgery. DMD was the most common complication observed on postoperative day 1 (50%), consistent with previous studies by Dai et al., which identified early postoperative DMD as a common, often transient event after phacoemulsification[26]. Studies have shown that incision size and surgical technique may influence the incidence of DMD. The study reported a significantly reduced incidence of DMD on day 1 postoperatively with larger 3 mm incisions, whereas Sharma et al. reported spontaneous resolution in most cases[27]. All DMD cases in this study resolved spontaneously without surgical intervention, suggesting that these events were transient. Further research with larger sample sizes and comparative

JURNAL KEDOKTERAN DIPONEGORO
(*DIPONEGORO MEDICAL JOURNAL*)
Online : http://ejournal3.undip.ac.id/index.php/medico
E-ISSN : 2540-8844
DOI : 10.14710/dmj.v15i2.55460
JKD (DMJ), Volume 15, Number 2, March 2026 : 174-182

study designs is necessary to clarify the relationship between incision size and postoperative DMD.

Iritis occurred in 4 patients (2.5%) and was successfully treated with topical corticosteroids within 2 weeks. Elevated IOP was observed in four patients (10%) on postoperative day 1, with IOP ranging from 22 to 25 mmHg; it decreased after two weeks. Elevated IOP can occur as a complication after cataract surgery. The IOP typically rises transiently, peaking within the first day after phacoemulsification, followed by a gradual return to baseline over several weeks. Elevated IOP is often attributable to postoperative inflammation, retained viscoelastic material, and impaired aqueous outflow[28].

One patient did not receive an intraocular lens (IOL) and was left aphakic due to PCR during the surgery. However, the patients were followed up on days 1 and 14 postoperatively and were scheduled for implantation of a high-power lens to prevent anisometropia once the eye was stable. Previous studies indicate that most PCR cases (approximately 41-60%) occur during the phacoemulsification phase of a cataract surgery. The risk increases if the lens is removed too deeply or during the final stage of cataract removal. Accidental contact between surgical instruments and the lens capsule can cause tearing and potential rupture[29,30]. These findings underscore the need for precise surgical technique during phacoemulsification.

A high proportion of mature cataracts and late presentation in this population likely contributed to postoperative complications and delayed visual recovery. These findings underscore the need for early detection and timely intervention to reduce surgical complexity and enhance patient outcomes.

Several limitations of this study should be acknowledged. The retrospective observational design, relatively small sample size, and single-center setting may limit the generalizability of the findings. The lack of a control or comparison group precludes definitive conclusions regarding the effectiveness of phacoemulsification. Additionally, the short study period, due in part to financial constraints, limited the ability to evaluate additional visual function parameters, such as best-corrected near visual acuity and may not have been sufficient to capture long-term visual function outcomes or delayed postoperative complications.

Despite these limitations, this study demonstrates significant early improvements in VA and CS after phacoemulsification in a secondary hospital setting, highlighting the value of assessing multiple visual function parameters in routine postoperative evaluation.

CONCLUSION

Visual function improved significantly after phacoemulsification compared with preoperative values in this study. Although postoperative visual acuity did not fully meet the WHO recommendations for cataract surgery outcomes, both visual acuity and contrast sensitivity improved during the short follow-up period. These results suggest that evaluating both parameters provides complementary information on early postoperative visual function. Further studies with larger sample sizes, extended follow-up periods, and multicenter designs are necessary to validate these findings and further elucidate visual function outcomes after phacoemulsification.

ETHICAL APPROVAL

Ethical approval has been obtained from the Faculty of Medicine, Airlangga University, under ethical approval number 300/EC/KEPK/FKUA/2025.

CONFLICTS OF INTEREST

All authors declare that there is no conflict of interest

FUNDING

This study received no external funding.

AUTHOR CONTRIBUTIONS

Conceptualization, CAT; methodology, CAT; software, CAT, SNA; validation, CAT, SNA; formal analysis, CAT, SNA; investigation, CAT, SNA; resources, CAT, SNA; data curation, CAT, SNA; writing—original draft preparation, CAT, SNA; writing—review and editing, SNA; visualization, SNA; supervision, CAT; project administration, CAT, SNA; funding acquisition, CAT.

ACKNOWLEDGMENTS

The authors would like to thank the patient, Eka Husada Hospital, and the Faculty of Medicine, Universitas Airlangga, for their contributions to this study.

JURNAL KEDOKTERAN DIPONEGORO
(*DIPONEGORO MEDICAL JOURNAL*)
Online : http://ejournal3.undip.ac.id/index.php/medico
E-ISSN : 2540-8844
DOI : 10.14710/dmj.v15i2.55460
JKD (DMJ), Volume 15, Number 2, March 2026 : 174-182

REFERENCES

1. Shaw E, Patel BC. Complicated Cataract. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 [cited 2025 Sep 30]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK572139/
2. Moshirfar M, Milner D, Patel BC. Cataract Surgery [Internet]. StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023. Available from: https://www.ncbi.nlm.nih.gov/books/NBK559253/.
3. Kementrian Kesehatan Republik Indonesia. Buku Peta Jalan Penanggulangan Gangguan Penglihatan Di Indonesia Tahun 2017 2030 [Internet]. 2018 [cited 2025 Sep 30]. Available from: https://id.scribd.com/document/414155631/Buku-Peta-Jalan-Penanggulangan-Gangguan-Penglihatan-Di-Indonesia-Tahun-2017-2030.
4. Kyei S, Amponsah BK, Asiedu K, Akoto YO. Visual function, spectacle independence, and patients' satisfaction after cataract surgery- a study in the Central Region of Ghana. Afr Health Sci [Internet]. 2021 Mar [cited 2025 Sep 30];21(1):445–56. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC8356608/.
5. Kaur K, Gurnani B. Contrast Sensitivity [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 [cited 2025 Sep 23]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK580542/
6. Mbwogge M, Nkumbe HE. Exploring the Reasons for Low Cataract Surgery Uptake Among Patients Detected in a Community Outreach Program in Cameroon: Focused Ethnographic Mixed Methods Study. JMIRx Med [Internet]. 2022 Jun 9 [cited 2025 Oct 3];3(2):e35044. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC10414320/.
7. Flessa S. Cataract Surgery in Low-Income Countries: A Good Deal! Healthcare (Basel) [Internet]. 2022 Dec 19 [cited 2025 Sep 30];10(12):2580. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC9778186/.
8. Lokarjana L, Atsari AG, Bahtiar NI. Comparison of Visual Outcomes Post Small Incision Cataract Surgery With Phacoemulsification At Dustira Hospital 2017-2022. Jurnal EduHealth [Internet]. 2025 Jan 13 [cited 2026 Feb 9];16(01):47–54. Available from: https://ejournal.seaninstitute.or.id/index.php/healt/article/view/6166.
9. Feriza A, Nurwasis N, Sukoto S. Visual Outcome of Phacoemulsification at Griya Husada Eye Center, Madiun, Indonesia. Vision Science and Eye Health Journal [Internet]. 2022 Nov 30 [cited 2026 Feb 9];2(1):24–8. Available from: https://e-journal.unair.ac.id/VSEHJ/article/view/33838.
10. Sharifi A, Dehghani-Meibodi D, Zand A. Refractive Error Stabilization Following Phacoemulsification Cataract Surgery and Its Associated Preoperative Factors. JOVR [Internet]. 2025 Sep 2 [cited 2026 Feb 9];20:1–7. Available from: https://knepublishing.com/index.php/JOVR/article/view/15132.
11. Bennett CR, Bex PJ, Bauer CM, Merabet LB. The Assessment of Visual Function and Functional Vision. Seminars in Pediatric Neurology [Internet]. 2019 Oct [cited 2025 Sep 23];31:30–40. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1071909119300427.
12. Saeed R. Evaluation of color vision and contrast sensitivity in diabetic patients without retinopathy. AOVS [Internet]. 2019 May 17 [cited 2025 Sep 24];9(3):71–6. Available from: https://medcraveonline.com/AOVS/AOVS-09-00349.php.
13. Upasani D, Daigavane S. Phacoemulsification Techniques and Their Effects on Corneal Endothelial Cells and Visual Acuity: A Review of "Direct-Chop" and "Stop-and-Chop" Approaches Under Topical Anesthesia. Cureus [Internet]. 2024 Aug 10 [cited 2025 Sep 24]; Available from: https://www.cureus.com/articles/282183-phacoemulsification-techniques-and-their-effects-on-corneal-endothelial-cells-and-visual-acuity-a-review-of-direct-chop-and-stop-and-chop-approaches-under-topical-anesthesia.
14. Hashemi H, Pakzad R, Yekta A, Aghamirsalim M, Pakbin M, Ramin S, et al. Global and regional prevalence of age-related cataract: a comprehensive systematic review and meta-analysis. Eye [Internet]. 2020 Aug [cited 2025 Sep

JURNAL KEDOKTERAN DIPONEGORO
(*DIPONEGORO MEDICAL JOURNAL*)
Online : http://ejournal3.undip.ac.id/index.php/medico
E-ISSN : 2540-8844
DOI : 10.14710/dmj.v15i2.55460
JKD (DMJ), Volume 15, Number 2, March 2026 : 174-182

25];34(8):1357–70. Available from: https://www.nature.com/articles/s41433-020-0806-3.

15. Nizami AA, Gurnani B, Gulani AC. Cataract. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 [cited 2026 Feb 10]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK539699/
16. Wan Z, Bai J, Wang W, Peng Q. Global, regional, and national burden of cataract among older adults from 1990 to 2021: a comprehensive analysis based on the global burden of disease study 2021. Front Med [Internet]. 2025 Sep 4 [cited 2025 Oct 3];12. Available from: https://www.frontiersin.org/journals/medicine/articles/10.3389/fmed.2025.1679828/full.
17. Suryathi NMA, Juliari IGAM, Andayani A, Jayanegara IWG, Ratnasari N, Putrawati Triningrat AAM. Barriers of Cataract Surgery in South Timor Tengah, East Nusa Tenggara-Indonesia. TOPHJ [Internet]. 2019 Jan 31 [cited 2025 Sep 23];12(1):7–10. Available from: https://openpublichealthjournal.com/VOLUME/12/PAGE/7/.
18. Takarai S, Jayanegara IWG, Triningrat AAMP, Suryathi NMA, Handayani AT, Djelantik AAAS, et al. Visual Acuity Improvement of Cataract Patients After Cataract Surgery at Sumbawa Hospital in 2018. Jurnal Pengabdian kepada Masyarakat (Indonesian Journal of Community Engagement) [Internet]. 2022 Dec 30 [cited 2025 Sep 24];8(4):211. Available from: https://jurnal.ugm.ac.id/jpkm/article/view/72478.
19. McNamara P, Hutchinson I, Thornell E, Batterham M, Iloski V, Agarwal S. Refractive stability following uncomplicated cataract surgery. Clin Exp Optom. 2019 Mar;102(2):154–9.
20. World Health Organization. Informal Consultation on Analysis of Blindness Prevention Outcomes. Geneva: World Health Organization (WHO/PBL/9868). 1998 Feb 16;
21. Pramita RD, Sunariasih NN. Visual Outcomes After Phacoemulsification in Sanjiwani Hospital Gianyar, Bali, Indonesia. EJMED [Internet]. 2021 Feb 22 [cited 2026 Feb 10];3(1):194–6. Available from: https://www.ejmed.org/index.php/ejmed/article/view/721.
22. Liu Y, Sugrim S, Persaud S, Reid C, Persaud T, Mingo C. Risk factors for suboptimal visual outcomes after cataract surgery: A retrospective study in Guyana. Medicine (Baltimore) [Internet]. 2025 Oct 17 [cited 2026 Feb 10];104(42):e45163. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC12537215/.
23. Tidbury LP, Czanner G, Newsham D. Fiat Lux: the effect of illuminance on acuity testing. Graefes Arch Clin Exp Ophthalmol [Internet]. 2016 Jun [cited 2025 Sep 23];254(6):1091–7. Available from: http://link.springer.com/10.1007/s00417-016-3329-7.
24. Miura G, Baba T, Tatsumi T, Yokouchi H, Yamamoto S. The Impact of Cataract Surgery on Contrast Visual Acuity and Retinal Sensitivity in Patients with Retinitis Pigmentosa. Lim SH, editor. Journal of Ophthalmology [Internet]. 2021 Nov 15 [cited 2025 Sep 24];2021:1–6. Available from: https://www.hindawi.com/journals/joph/2021/2281834/.
25. Mukkamala NRVL, Mathukumalli SSK, Undrakonda V, Pakalapati P. A study of contrast sensitivity in eyes with hydrophobic and hydrophilic acrylic foldable posterior chamber intraocular lens. IJCEO [Internet]. 2024 Jul 28 [cited 2025 Sep 24];10(2):275–80. Available from: https://ijceo.org/article-details/22168.
26. Dai Y, Liu Z, Wang W, Han X, Jin L, Chen X, Jin G, Wang L, Zhang E, Qu B, Liu J, Congdon N, He M, Luo L, Liu Y. Incidence of Incision-Related Descemet Membrane Detachment Using Phacoemulsification With Trapezoid vs Conventional 2.2-mm Clear Corneal Incision: A Randomized Clinical Trial. AMA Ophthalmol [Internet]. 2021;1;139(11):1228-1234. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC8600385/.
27. Sharma N, Bandivadekar P, Agarwal T, Shah R, Titiyal JS. Incision-Site Descemet Membrane Detachment During and After Phacoemulsification: Risk Factors and Management. Eye Contact Lens. 2015 Sep;41(5):273–6.
28. Zeppieri M, Tripathy K. Pigment Dispersion Glaucoma. In: StatPearls [Internet] [Internet]. StatPearls Publishing; 2023 [cited 2025 Sep 25].

JURNAL KEDOKTERAN DIPONEGORO
(*DIPONEGORO MEDICAL JOURNAL*)
Online : http://ejournal3.undip.ac.id/index.php/medico
E-ISSN : 2540-8844
DOI : 10.14710/dmj.v15i2.55460
JKD (DMJ), Volume 15, Number 2, March 2026 : 174-182

Available from: https://www.ncbi.nlm.nih.gov/sites/books/NBK580495/.

29. Koser E, Atik BK, Emul M, Ahmet S, Besek NK, Cubuk MO, et al. Clinical features, management, and outcomes of posterior capsule rupture during phacoemulsification surgery. ABO [Internet]. 2025 [cited 2025 Sep 25];88(5):1–8. Available from: https://www.scielo.br/j/abo/a/XjjcZZZXSGwwnPbhSnvKD5M/?lang=en.
30. Jeang LJ, Liechty JJ, Powell A, Schwartz C, DiSclafani M, Drucker MD, et al. Rate of Posterior Capsule Rupture in Phacoemulsification Cataract Surgery by Residents with Institution of a Wet Laboratory Course. Journal of Academic Ophthalmology [Internet]. 2022 Jan [cited 2025 Sep 25];14(01):e70–3. Available from: https://www.aupojournal.org/jao/vol14/iss1/1.