July 2026 Volume 15 No. 2

Journal of Ophthalmology of Eastern Central and Southern Africa

(Formerly East African Journal of Ophthalmology)

www.coecsa.org ISSN 2308-6327

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Dr Consity Mwale
Section Editor

Dr Consity Mwale is a consultant ophthalmologist based at Kitwe Teaching Eye Hospital and Phil Eye Hospital in Kitwe, Zambia. He is a specialist in glaucoma, global health, and public health, with extensive leadership and technical expertise across clinical, academic, and health systems domains. He has served as the Principal Investigator for Zambia's National Trachoma Elimination Programme since 2012, and for five years was the Principal Investigator for the CDC-funded Cooperative Agreement, providing strategic oversight for nationwide trachoma surveillance and elimination activities, and leading public health and health promotion interventions. From 2013 to 2023, Consity held the positions of Lusaka and Copperbelt Provincial Health Director, where he successfully managed large, complex public health programmes supported by multiple global and local partners. He is the immediate past Secretary General of the College of Ophthalmology of Eastern, Central and Southern Africa (COECSA) and also served as Senate and Executive Committee Chairperson of the East, Central and Southern Africa Health Community (ECSA-HC), contributing to regional policy, training, and health systems strengthening. Consity is a published researcher in reputable peer-reviewed journals and lectures at the Copperbelt University School of Medicine and Lusaka Apex Medical University, where he supports the training of the next generation of eye health and medical professionals.

Dr Lucy Njambi
Section Editor

Dr Lucy Njambi is a consultant paediatric ophthalmologist and a lecturer at the Department of Ophthalmology, University of Nairobi, Kenya since 2012. She holds the following qualifications;

- MBChB, MMed (Ophthalmology) (Nairobi)
- FCOphth (ECSA)- Fellow of COECSA and ICO Fellow
- Paediatric Ophthalmology and Strabismus Fellow (CCBRT)
- Retinoblastoma Fellow- SickKids Hospital (Toronto)

She has a passion in the promotion of patient care through research particularly in paediatric ophthalmology and retinoblastoma where she is leading a collaborative biomedical research towards discovery of the retinoblastoma genomics in the Kenyan population. She is keen to participate in the growth of JOECSA by promoting quality publications to match other high impact international journals. She has previously served COECSA in other capacities as a member of the Scientific and Research Committee and Training of Trainers programme.

Dr Simon Arunga
Section Editor

Dr Simon Arunga trained as an ophthalmologist in Uganda in 2014. He went on to do his PhD at the London School of Hygiene & Tropical Medicine, London, UK. His thesis was titled "Epidemiology of Microbial Keratitis in Southwestern Uganda". He works as a clinical lecturer and residency training coordinator at Mbarara University of Science and Technology, Uganda. He is also honorary visiting lecturer at the International Centre for Eye Health, London School of Hygiene & Tropical Medicine, London, UK. His research interest includes cornea, glaucoma, and community health with a particular interest on primary eye care. His current cornea research is on a series of Randomized Controlled Trials investigating prevention strategies and optimization of treatments for microbial Keratitis in Uganda. Dr Arunga also works as the Lions Clubs International Foundation Technical Advisor for Anglophone Africa.

Dr Anne Ampaire Musika
Section Editor

Dr Anne Ampaire Musika is an ophthalmologist since 2004, clinical epidemiologist/ biostatistician and lecturer since 2014 at Makerere University College of Health Sciences. She is an orbit and oculoplastics surgeon and ocular oncologist at Mulago National Referral Hospital. She is the coordinator for the ICO exams in Uganda and is a member of the School of Medicine Research Ethics Committee (Makerere University). Her research interests include orbital tumors, ocular TB and HIV, glaucoma, residency training curriculum, diabetic retinopathy, and ocular trauma. She has participated in clinical trials for ocular safety of therapy for multidrug resistance TB and is currently a co-investigator on ocular malignancies with Aids Malignancy Consortium.

Dr Egide Gisagara
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Dr Egide Gisagara is an ophthalmologist from Rwanda, trained in Uganda in 2015 and an MSc course addition from London School of Hygiene and Tropical Medicine (UK). He has worked under Ministry of Health and University of Rwanda, closely collaborated with Fred Hollows Foundation, Vision for A Nation and One Sight. Currently, he is a consultant ophthalmologist and lecturer/visiting faculty member at University Teaching Hospital of Kigali (CHUK) and University of Rwanda/Rwanda International Institute of Ophthalmology (RIIO) respectively. He has special interest in clinical work, research and teaching.

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Dr Sarah Sitati is a pediatric ophthalmologist and squint specialist working at the Kenyatta National Hospital. She completed her MMed training at the University of Nairobi, Kenya, followed by a Pediatric ophthalmology fellowship in the US. She is the Chair of the Retinopathy of Prematurity Working Group in Kenya, that published national guidelines for screening and management of ROP in Kenya. Dr Sitati has over ten years' experience in the management of pediatric and adult cataract, ocular trauma and squints. She has published research papers in local and regional journals and given several presentations in regional and international conferences. She is the current treasurer of COECSA.

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Dr Teddy Kwaga completed her training as an ophthalmologist in Uganda in 2021. She is currently working as an ophthalmologist at Ruharo Eye Centre, Uganda. Her interests include glaucoma, cornea and community health. Dr. Kwaga works also as a project coordinator for the Lions Comprehensive Eye Care Project for Kigezi in Uganda.

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Editorial - Glaucoma: Management and diagnostic challenges in Africa

Glaucoma remains one of the leading causes of irreversible blindness globally[1] and poses a significant public health challenge in Africa[2], with a reported prevalence of 4.4%[3]. The disease disproportionately affects populations of African ancestry, who are known to have higher prevalence, earlier onset, more aggressive disease progression, and poorer visual outcomes compared with other ethnic groups[3-5]. Despite advances in ophthalmic screening, diagnostic technology and therapeutic interventions worldwide, significant barriers continue to impede accessible, quality and cost-effective glaucoma services across the African continent. Common barriers include health system strengthening capacity, infrastructure and equipment gaps, direct and indirect costs, shortage of human resources for eye health, poor physical access and distance to services, diagnostic accuracy bias, lack of local guidelines, gender and socioeconomic inequities [6, 7]. These bottlenecks contribute to suboptimal glaucoma detection and management throughout the continent.

Primary Open-Angle Glaucoma (POAG) is the most common form of glaucoma in Africa[5, 8-10] and frequently presents at advanced stages[11]. Many patients remain asymptomatic and undiagnosed until substantial optic nerve damage and visual field loss have already occurred[10, 12]. The asymptomatic nature of early glaucoma, combined with limited public awareness and inadequate health promotion and screening programs, and poor socioeconomic status contributes to delayed presentation and irreversible blindness[13]. In many African communities, eye diseases are often only recognized when central vision and quality of life become severely impaired, by which time treatment options become less effective.

Diagnostic challenges remain profound. Comprehensive glaucoma evaluation requires specialized equipment such as slit lamps, gonioscopy and indirect lenses, pachymeters, Optical Coherence Tomography (OCT), and automated perimetry. However, many healthcare facilities in low-resource African settings lack access to such technologies[14]. Many studies have identified elevated IOP as a strong risk factor for POAG[15, 16]. In rural areas especially, diagnosis may rely largely on intraocular pressure measurements and direct ophthalmoscopy, both of which have limited sensitivity for early disease detection. Furthermore, normal-tension glaucoma cases may easily be missed when excessive emphasis is placed on elevated IOP[17]. In addition, fluctuations in Intraocular Pressure (IOP) may play an important role in the management and progression of glaucoma[18].

Visual field and Optical Coherence Tomography (OCT) testing, which are central to functional and structural glaucoma assessment, respectively, presents additional difficulties. This is because the diagnosis of glaucoma may have clinically significant depressive symptoms[19]. As a result, qualitative assessments of glaucoma visual field-testing challenges maybe related to sustained concentration, test-related anxiety, doubts about the testing process, and physical discomfort. Addressing patient concerns and anxiety related to visual field testing is essential, with particular emphasis on allowing patient-initiated breaks to mitigate concentration difficulties and physical discomfort during the procedure[20].

Moreover, OCT normative databases are predominantly derived from European, Asian, or North American populations, raising concerns about their applicability in African patients where neuroretina ring, retinal nerve fibre and ganglion cell inner retina layers characteristics may differ[21,22]. Monitoring structural and functional glaucoma progression is important for timely treatment in early disease[23].

Human resource for eye health limitations also contribute significantly to diagnostic delays. While the number of ophthalmologists has grown[24, 25], glaucoma subspecialists continue to be largely based in urban healthcare facilities, creating disparities in access to advanced glaucoma care for patients in rural and underserved areas[7, 26]. Despite carrying a substantial burden of eye disease, sub-Saharan Africa has three ophthalmologists per million population, highlighting a significant human resource gap[25]. In addition, the distribution of eye care personnel across sub-Saharan Africa remains inadequate for the growing burden of visual impairement[14,24]. Consequently, tertiary eye centres are often overwhelmed, while rural populations remain underserved.

Management of glaucoma in Africa is equally challenging. Medical therapy is frequently limited by poor affordability and accessibility, frequent drug stock outs, and inadequate insurance coverage. Prostaglandin analogues, although highly effective, are often too expensive for long-term use in low-income populations. In addition, Rho kinase (ROCK) inhibitors may not be readily available in many health facilities on the continent, necessitating alternative management. Poor adherence to therapy is common and may result from medication side effects, limited understanding of the chronic nature of glaucoma, and socioeconomic constraints[27-29]. Although laser therapy is available in certain centres, its adoption and utilization remain limited[30]. Furthermore, patients

may discontinue treatment once symptoms improve or when financial resources become strained. Given the high prevalence of glaucoma and the predominantly low-income populations across sub-Saharan Africa, optimal management strategies should emphasize early screening and timely detection, coupled with reliable, long-term treatment options that are minimally dependent on patient adherence and compliance[2].

Surgical intervention, particularly trabeculectomy, remains an important treatment modality in Africa because of poor adherence to chronic medical therapy. Evidence suggests that early surgical management of Primary Congenital Glaucoma, undertaken within the first days to weeks of life, substantially improves prognosis and reduces the risk of irreversible visual impairment[31]. However, surgical outcomes may be compromised by late presentation, aggressive wound healing responses, limited postoperative follow-up, and shortages of antifibrotic agents such as mitomycin-C. Fear of surgery and cultural misconceptions further reduce surgical acceptance in some communities[32]. Furthermore, the increasing introduction of Minimally Invasive Glaucoma Surgery (MIGS) offers promise but remains financially inaccessible in many low-resource environments[33, 34].

Childhood glaucoma poses unique diagnostic and management challenges, particularly in low-resource settings. Delayed presentation, limited access to specialized paediatric ophthalmology services, and the frequent need for examinations under anaesthesia contribute to difficulties in achieving timely diagnosis and effective treatment. Therefore, increasing disease awareness, promoting early diagnosis, and ensuring timely treatment are essential for reducing the risk of long-term visual impairment[35,36]. Furthermore, the lifelong nature of the disease necessitates sustained monitoring and repeated interventions[37,38], yet long-term follow-up is often compromised by healthcare access barriers and socioeconomic constraints. Consequently, affected children are at increased risk of irreversible visual impairment, which can adversely affect educational attainment, psychosocial development, and overall quality of life during critical developmental years[39].

Nevertheless, important opportunities exist to improve glaucoma care in Africa. Strengthening public awareness campaigns, integrating glaucoma screening into primary healthcare systems, and promoting opportunistic screening of people at risk could facilitate earlier diagnosis. Teleophthalmology and artificial intelligence-assisted diagnostics may help bridge gaps in specialist availability, especially in remote regions[40-42]. Furthermore, increasing local training opportunities for ophthalmologists, glaucoma specialists and midlevel cadres, and expanding access to affordable diagnostic technologies are essential steps towards sustainable and high impact glaucoma services.

Research focused specifically on African populations must also be prioritized. There remains a critical need for population-based epidemiological studies, genetic research[3,43], and normative imaging databases relevant to African eyes[21]. Locally generated evidence will be vital in developing context-appropriate diagnostic criteria and treatment strategies.

Glaucoma in Africa is not merely an ophthalmic condition; it is a significant public health challenge with substantial socioeconomic consequences. Blindness from glaucoma affects productivity, independence, and quality of life, often placing additional burdens on already strained healthcare systems and families. Childhood glaucoma represents a significant economic challenge, with costs peaking in the first year after presentation due to the need for comprehensive diagnostic assessments, surgical treatment, and close postoperative monitoring[44]. Reducing the burden of glaucoma blindness across Africa will require coordinated efforts involving governments, civil society, non-governmental organisations, healthcare and academic institutions, professional societies, researchers, and international partners.

Early detection, equitable access to affordable treatment, investment in healthcare infrastructure and equipment, and sustained research initiatives remain central to addressing the growing glaucoma burden in Africa. Without urgent and coordinated action, glaucoma will continue to contribute significantly to preventable irreversible blindness across the continent.

Mwale C, Section Editor, JOECSA and Phil Eye Hospital, Kitwe and Lusaka Apex Medical University, Zambia. Email: consitymwale@gmail.com

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Study of the efficacy and safety of once and twice daily timolol (0.5% solution) treatment in controlling intraocular pressure

Kergeda MO, Alemu AM

Department of Ophthalmology, Faculty of School of Medicine, Addis Ababa University, College of Health Sciences, Addis Ababa, Ethiopia

Corresponding author: Dr. Muhidin Oumer Kergeda, Department of Ophthalmology, Faculty of School of Medicine, Addis Ababa University, College of Health Sciences, Addis Ababa, Ethiopia. Email: barcho7@gmail.com

ABSTRACT

Objective: To compare the efficacy and safety of once-daily versus twice-daily 0.5% timolol ophthalmic solution in reducing Intraocular Pressure (IOP) among patients with mild to moderate open-angle glaucoma or ocular hypertension.

Methods: A prospective comparative interventional study was conducted at a tertiary referral hospital from November 2022 to September 2023. Eighty-four patients were allocated to once-daily or twice-daily 0.5% timolol treatment using a quasi-randomization method (initial lottery followed by alternate allocation). Baseline IOP was measured at 8:00am, 12:00pm, and 4:00pm, together with pulse rate and blood pressure. Measurements were repeated after one month. Data were analyzed using SPSS version 26, with $p < 0.05$ considered statistically significant.

Results: Both groups demonstrated significant reductions in IOP from baseline (once daily: $p \leq 0.004$, 95% CI: 1.23–5.96 mmHg; twice daily: $p \leq 0.001$, 95% CI: 1.63–5.75 mmHg). However, there was no statistically significant difference in IOP reduction between the two groups. Systemic and ocular adverse effects were also comparable between the treatment groups.

Conclusion: The findings suggest that once-daily 0.5% timolol may be as effective and safe as twice-daily treatment for patients with mild to moderate open-angle glaucoma or ocular hypertension.

Key words: Timolol, Intraocular pressure, Glaucoma, Ocular hypertension, Beta-blocker, Eye drops, Dosing frequency, Adverse effects

INTRODUCTION

Glaucoma is a group of progressive optic neuropathies characterized by an excavated optic disc, loss of retinal ganglion cells, and corresponding visual field loss[1]. It is a leading cause of irreversible blindness worldwide, with elevated intraocular pressure as the main risk factor. Anti-glaucoma medications lower IOP by affecting aqueous humor dynamics, with nonselective β-blockers taken once or twice daily[1,2]. Timolol maleate reduces aqueous humor production by 20–50% and lowers IOP by 18–25%, but may cause ocular and systemic side effects, including bradycardia, hypotension, and bronchospasm[1,3].

Nighttime or anaesthesia reduces aqueous humor production by 50%, similar to daytime adrenergic blockers[1,2]. Timolol once or twice daily shows comparable efficacy and safety, this study evaluates 0.5% timolol dosing in Ethiopian patients[3].

Objective: In Ethiopia, ophthalmologists commonly prescribe 0.5% timolol twice daily for glaucoma management. However, evidence regarding whether once-daily administration provides comparable efficacy with fewer side effects in Ethiopian patients is limited. Since reduced dosing frequency may improve patient adherence, reduce systemic adverse effects, and lower treatment costs, this study was conducted to evaluate the efficacy and safety of 0.5% timolol when used twice daily versus once daily among Ethiopian patients.

Rationale: Using the minimum effective number of medications with the lowest effective dosing frequency may reduce patient burden, improve adherence, and consequently help control disease progression more effectively. Although timolol 0.5% is commonly prescribed either once or twice daily, there is limited local evidence comparing the efficacy of these two dosing regimens among Ethiopian patients. Therefore, this study was conducted to evaluate whether once-daily timolol provides a comparable intraocular pressure-lowering effect to twice-daily treatment. If similar efficacy is achieved with once-daily dosing, it may improve patient convenience, adherence, and overall quality of life.

Literature: Besides, many studies in the literature have shown that there is no significant difference in intraocular pressure reduction or tolerability of timolol when administered once daily versus twice daily in different

formulations. Similar findings have been reported in both parallel-group and crossover studies.[4–9].

MATERIALS AND METHODS

Study design: This study was a prospective comparative interventional study conducted to compare the efficacy and safety of once-daily versus twice-daily 0.5% timolol ophthalmic solution among patients with glaucoma and ocular hypertension. Participants were followed prospectively after initiation of treatment. An alternate assignment after an initial lottery method was used, in which the treatment assignment for the first participant was determined by lottery method, after which subsequent participants were assigned alternately to the two treatment groups until the required sample size was achieved. It was conducted at a tertiary referral hospital from November 2022 to September 2023.

Ethical considerations: Ethical approval for this study was obtained from the Institutional Review Board of a university in Ethiopia (Approval No: 089/22/Optha). Written informed consent was obtained from all participants before enrollment in the study, and the study adhered to the principles of the Declaration of Helsinki.

Masking: This study employed single masking at the outcome assessment level. The nurses who measured intraocular pressure were masked to participants' treatment allocation in order to minimize measurement bias. Participants received their assigned treatment regimen according to the study protocol, while the principal investigator and co-authors were not masked during study implementation and data collection. This has been acknowledged as a potential limitation of the study.

Sample size determination: Sample size was calculated using G*Power version 3.1.9.4 based on an independent t-test. The input parameters were: effect size (p) = 80%, alpha error probability = 5%, and power (1–β) = 95%, derived from similar literature. This yielded a sample size of 35 participants per group. After adding a 15% non-response rate, the final sample size was 42 per group, giving a total sample size of 84.

Inclusion criteria: Patients diagnosed with mild to moderate Open-Angle Glaucoma (OAG) or ocular hypertension, with IOP below 35mm Hg, who had not started any anti-glaucoma medication or had discontinued it for more than six weeks were included.

Exclusion criteria: On the contrary, excluded patients were those who had undergone ocular surgery, had angle-closure glaucoma, ocular trauma or inflammation, were taking systemic or local medications that could affect IOP like systemic B-blockers, cardiac patients taking medications, those on steroids, patients with bronchial asthma, those allergic to beta-blockers, patients with poor medication adherence, or those with corneal opacity affecting IOP measurement.

Participants: The diagnosis of glaucoma and its subtypes were confirmed. The diagnosis of these glaucoma types was made by ophthalmologists who were not part of the study authors after performing the necessary clinical evaluations and investigations required for diagnosis. The role of the study authors was to recruit patients after confirming that they fulfilled the inclusion and exclusion criteria of the study. A total of 84 patients meeting the inclusion criteria were recruited. Participant's flow chart is shown in results section.

Randomization: A quasi-randomization allocation method was used. The treatment group for the first participant was determined by lottery method, after which subsequent participants were assigned alternately to the once-daily timolol 0.5% group or the twice-daily group until the total sample size of 84 participants (42 in each group) was achieved. Participants excluded or lost due to poor adherence were replaced, and the alternate allocation sequence was continued.

Intervention: The study consisted of two groups: an intervention (once-daily timolol 0.5%) group and a comparison (twice-daily timolol 0.5%) group. The intervention was the administration of 0.5% timolol ophthalmic solution, with participants assigned to either once-daily or twice-daily dosing. Both groups received the same formulation, and the only difference between them was the frequency of administration.

Procedure: Baseline IOP, Blood Pressure (BP), and Pulse Rate (PR) measurements were recorded. The IOP measurements were taken on the same day at 8:00am, 12:00pm, and 4:00pm, while BP and PR were measured solely at 8am. The IOP measurements were consistently monitored throughout the study using the I-Care100-tonometer model TOA11**.** Trained glaucoma clinic nurses used the digital measuring device to measure BP and PR for all patients. All measurements were conducted with patients in a sitting position. Each patient and family member was explained the procedure for administering the eye drops. They were also instructed to adhere to the medication regimen strictly. Both groups received the same brand of timolol 0.5% solution from the principal investigator. The once-daily group was advised to apply their medication at 9:00 am, whereas the twice-daily group was instructed to apply the same medicine at 9:00am and 9:00pm.

If a patient was diagnosed with bilateral OAG or ocular hypertension, they were advised to use the medication for

both eyes. However, for the study purpose, the eye with the higher average IOP at the three baseline measurements was selected as the study eye.

Baseline measurements and examination were repeated after one-month treatment period, employing the same procedure. Ocular examination and systemic review for possible adverse effect evaluation was done by the principal investigator. The questionnaire was developed for this study and filled out by principal investigator for all patients

Adherence and monitoring: Adherence was actively monitored throughout the one-month treatment period using a patient-administered medication checklist. Each patient was instructed to record every instillation of the prescribed Timolol dose daily. At the end of the study period, patients returned their completed checklists for evaluation.

Adherence was assessed by calculating the percentage of missed doses using the formula: (number of missed doses ÷ total expected doses) × 100. Patients with more than 15% missed doses were considered non-adherent, excluded from the final analysis, and replaced to maintain the required sample size. Only adherent patients were included in the primary outcome analysis. This approach ensured objective monitoring of adherence and minimized bias in the evaluation of intraocular pressure outcomes.

Primary and secondary outcomes: The primary outcome of the study was to compare the mean difference in Intraocular Pressure (IOP) reduction and safety between the once-daily and twice-daily 0.5% Timolol groups after one month of treatment.

The secondary outcomes included the mean IOP reduction within each treatment group, treatment adherence, differences in IOP reduction among glaucoma subtypes. Adherence was assessed based on compliance with the prescribed dosing regimen, and safety was evaluated by the occurrence of ocular and systemic side effects associated with timolol use.

Statistical analysis

The data were checked for completeness and consistency and then entered into SPSS version 26. Normality of continuous variables was assessed using the Shapiro–Wilk test and Q–Q plots. The IOP measurement data were approximately normally distributed ($p > 0.05$), whereas the PR, SBP, and DBP data were not normally distributed ($P<0.05$)). Accordingly, parametric tests were applied where normality assumptions were met, and non-parametric tests were used when the assumptions were violated.

Descriptive statistics were used to summarize baseline characteristics and outcome variables. The primary analysis compared mean Intraocular Pressure (IOP) reduction and safety between the once-daily and twice-daily Timolol groups using an independent sample t-test and Chi-square test, respectively. The mean difference in IOP reduction between groups was reported with its 95% confidence interval as a measure of effect size.

Within-group comparisons of baseline and post-treatment IOP were performed using paired samples t-tests. A one-sample t-test was used to compare the mean IOP reduction in each study group with the expected average IOP reduction (18%–25%). One-way ANOVA was used to assess differences in IOP reduction among glaucoma subtypes.

The Wilcoxon signed-rank test was used to assess the effect of timolol treatment on Pulse Rate (PR), Systolic Blood Pressure (SBP), and Diastolic Blood Pressure (DBP), while the Mann–Whitney U test was used to determine differences between the two treatment groups with respect to PR, SBP, and DBP.

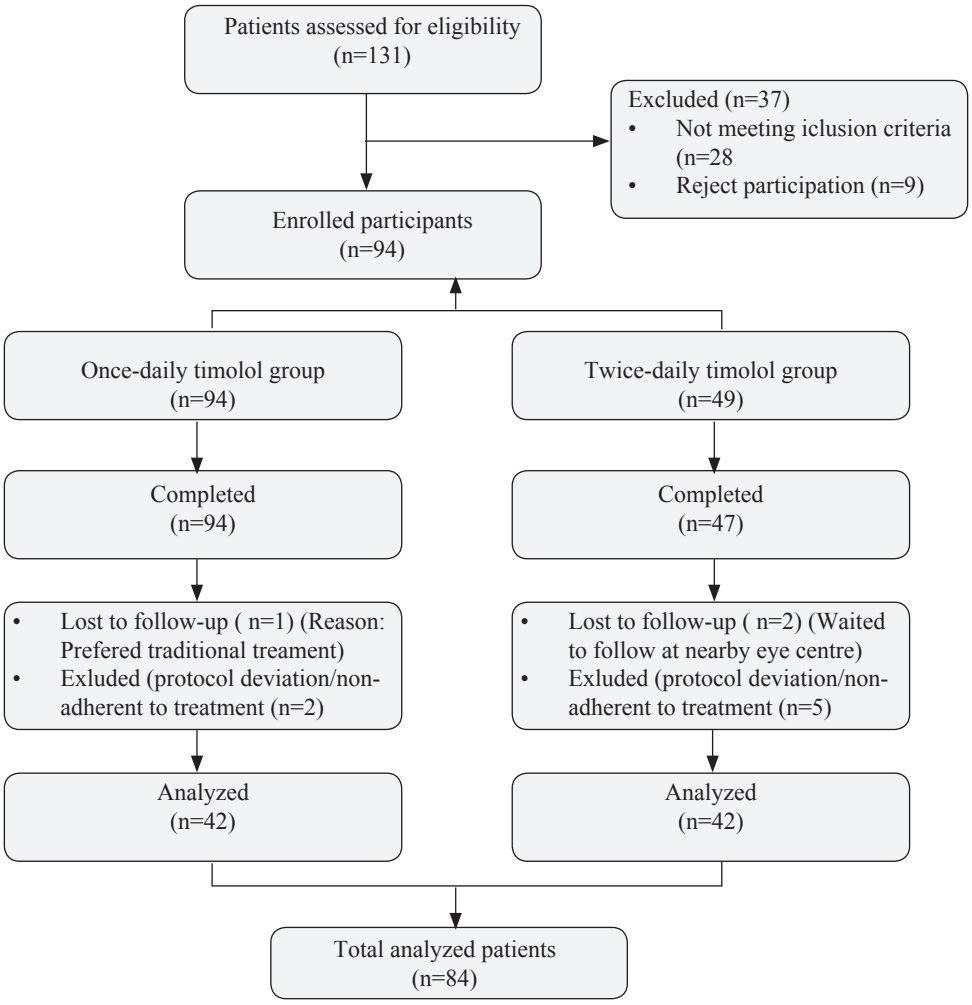
Chi-square test was used for categorical variables such as adherence and side effects. Risk ratios with 95% confidence intervals were calculated for categorical outcomes where appropriate. A p-value of less than 0.05 was considered statistically significant.

Operational definitions

(a) Open-angle glaucoma was defined as glaucomatous optic nerve damage with corresponding visual field defects and an open angle on gonioscopy.
(b) Ocular hypertension was defined as an intraocular pressure greater than 21 mmHg without glaucomatous optic nerve damage or visual field loss.
(c) Primary open-angle glaucoma was defined as the presence of glaucomatous optic neuropathy with corresponding visual field defects, open anterior chamber angles on gonioscopy, and elevated intraocular pressure and absence of secondary causes.
(d) Pseudoexfoliative glaucoma was defined as glaucoma associated with pseudoexfoliative material deposition on anterior segment structures in the presence of glaucomatous optic nerve damage and open angles.
(e) Normal-tension glaucoma was defined as glaucomatous optic nerve damage and corresponding visual field defects with intraocular pressure within the statistically normal range (<21 mmHg).
(f) The severity of glaucoma was classified based on the Vertical Cup-To-Disc Ratio (VCDR), where a VCDR of less than 0.65 was considered mild glaucoma, a VCDR between 0.65 and 0.85 was considered moderate glaucoma, and a VCDR greater than or equal to 0.85 was considered severe glaucoma.
(g) A participant was considered hypertensive if the systolic blood pressure was greater than or equal to 140 mmHg and/or the diastolic blood pressure was greater than or equal to 90 mmHg.

RESULTS

Participant flow chart



Most of the patients were males, accounting for more than 50% of the cases. The mean age was 68 and 56 in once daily and twice daily groups, respectively (Table 1).

Table 1: Background characteristics of the study participants.2023 (N=84)

Characteristics	Once daily group No. (%)	Twice daily group No. (%)
Number of patients	42	42
Sex		
Female	12 (28.6%)	18 (42.9%)
Male	30 (71.4%)	24 (57.1%)
Age group (years)	40-82	28-80
Mean age	68.3	56.5
Hypertensive patients	22 (52.4%)	18 (42.9%)
Baseline mean PR	81.5 (63-126)	80 (57-109)
Glaucoma type		
PXG	30 (71.4%)	15 (35.7%)

POAG	9 (21.4%)	14 (33.3%)
NTG	0	2 (4.8%)
OHT	3 (7.1%)	11 (26.2%)
Adherence	42/44*100 (93.33%)	42/47*100 (89.36%)

†PXG = Psudoexfoliative Glaucoma; POAG = Primary Open Angle Glaucoma; NTG = Normal Tension Glaucoma; OHT = Ocular Hypertension; PR = Pulse Rate

Table 2: Mean baseline intraocular pressure (IOP) measurements at 8:00am, 12:00pm, and 4:00pm

Report				
1. Twice daily group 2. Once daily group		Baseline IOP at 8:00am	Baseline IOP at 12:00pm	Baseline IOP at 4:00pm
1.00	Mean	23.2619	22.9048	23.0238
	N	42	42	42
	Std. Deviation	6.16465	4.87807	5.18200
2.00	Mean	20.2857	21.6190	20.2619
	N	42	42	42
	Std. Deviation	5.72238	6.30119	5.99618
Total	Mean	21.7738	22.2619	21.6429
	N	84	84	84
	Std. Deviation	6.09829	5.63791	5.74067

The average baseline IOP of all study participants at 8:00am, 12:00pm and 4:00pm was 21.7738 mmHg, 22.2619 mm Hg, and 21.6429 mm Hg, respectively.

Table 3: Post treatment mean IOP & mean IOP-deference measurements at 8:00am, 12:00pm, and 4:00pm

Report							
1. Twice daily group 2. Once daily group		Post treatment IOP at 8:00am	Post treatment IOP at 12:00pm	Post treatment IOP at 4:00pm	Mean IOP_ diff 8:00am	Mean IOP_ diff 12:00pm	Mean IOP diff. 4:00pm
1.00	Mean	19.5714	18.9524	19.2381	3.6905	3.9524	3.7857
	N	42	42	42	42	42	42
	Std. Deviation	5.72603	5.77612	5.19761	6.60188	5.56536	6.47899
2.00	Mean	17.0952	16.6905	16.6905	3.1905	4.9286	3.5714
	N	42	42	42	42	42	42
	Std. Deviation	7.36773	7.81646	6.61295	6.31390	6.05017	7.50331
Total	Mean	18.3333	17.8214	17.9643	3.4405	4.4405	3.6786
	N	84	84	84	84	84	84
	Std. Deviation	6.67550	6.92500	6.04889	6.42538	5.79853	6.96836

The average post treatment mean IOP of all study participants at 8:00am, 12:00pm, and 4:00pm was 18.3333 mmHg, 17.8214 mmHg, and 17.9643 mmHg, respectively.

Once- daily group

The mean baseline IOP in this group was 20.7222 mmHg. After one month of treatment, the mean IOP was reduced to 16.8254 mmHg. Pretreatment mean pulse, systolic, and diastolic BP values were 81.5714, 146.0476 mmHg, and 78.3810 mmHg, respectively. The post-treatment values were 79.8571, 145.3571 mmHg, and 80.2143 mmHg. The mean reduction of intraocular pressure with once-daily timolol was from 12.8985 to 22.5857%.

A one-sample t-test was conducted to compare the mean percentage reduction achieved with once-daily timolol treatment against the expected minimum percentage reduction of 18%. The analysis showed no statistically significant difference at any of the three time points. The p-values for the 8:00am, 12:00pm, and 4:00pm measurements were 0.377, 0.218, and 0.402, respectively.

Table 4: Intraocular pressure values of once- daily timolol treatment, 2023 (N=42)

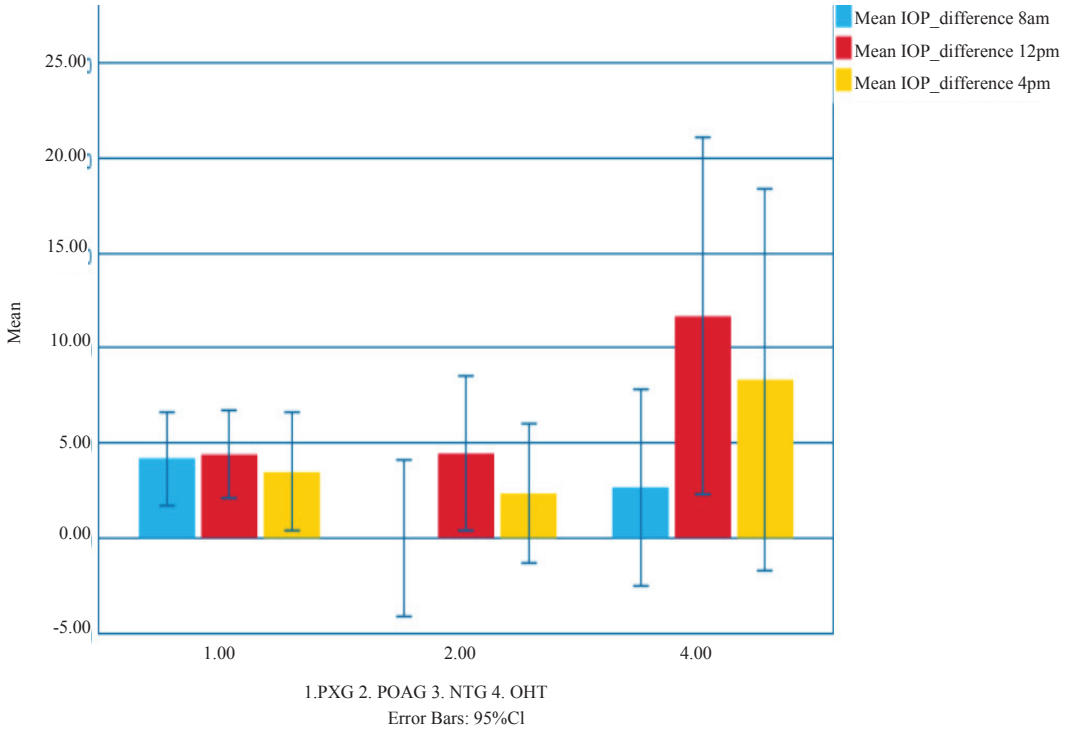
Paired Samples Test[a]

Mean		Paired Differences				t	df	Sig. (2-tailed)
		Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1	Baseline IOP at 8:00am – post treatment OP at 8:00am	3.19048	6.31390	.97426	1.22293	5.15802	3.275	41	.002
Pair 2	Baseline IOP at 12:00pm - post treatment IOP at 12:00pm	4.92857	6.05017	.93356	3.04321	6.81394	5.279	41	.000
Pair 3	Baseline IOP at4 pm - post treatment IOP at 4pm	3.57143	7.50331	1.15779	1.23323	5.90962	3.085	41	.004

a. 1. Twice daily group 2. Once daily group = 2.00

The effect of once daily timolol eye drop treatment in intraocular pressure lowering on subtypes of OAG or ocular hypertension was higher in ocular hypertension and lower in primary OAG patients, but this was not statistically significant (Figure 1 and Table 5).

Figure 1: Effect of once- daily timolol treatment on type of OAG and OHT at the three timings



**OHT = Ocular Hypertension; OAG = Open Angle Glaucoma; NTG = Normal Tension Glaucoma; PXG = Psudoexfoliative Glaucoma; POAG = Primary Open Angle Glaucoma; IOP = Intraocular Pressure

Table 5: Comparison of mean intraocular pressure reduction at 8:00am, 12:00pm, and 4:00pm among glaucoma subtypes

1. Twice daily 2 Once daily group = 2.00-ANONA-May 16,2026

ANOVA[a]

		Sum of Squares	df	Mean Square	F	Sig.
meanIOP_difference8am	Between Groups	123.010	2	61.505	1.587	.217
	Within Groups	1511.467	39	38.756		
	Total	1634.476	41			
meanIOP_difference12pm	Between Groups	146.697	2	73.348	2.113	.135
	Within Groups	1354.089	39	34.720		
	Total	1500.786	41			
meanIOP_difference4pm	Between Groups	82.152	2	41.076	.720	.493
	Within Groups	2226.133	39	57.080		
	Total	2308.286	41			

a. 1. twice daily group 2. once daily group = 2.00

††

The Wilcoxon signed-rank test showed no statistically significant difference in Pulse Rate (PR), Systolic Blood Pressure (SBP), or Diastolic Blood Pressure (DBP) after once daily timolol treatment, with p-values of 0.485, 0.891, and 0.129, respectively.

Twice- daily group

The mean baseline IOP in this group was 23.0635.9 mmHg. After one month of treatment, it decreased to 19.2540 mmHg. Pulse, systolic, and diastolic BP pretreatment values were 80.00, 139.9762 mmHg, and 81.7381 mmHg, respectively. The corresponding post-treatment measurements were 79.7143, 140.6429 mmHg, and 82.9524 mmHg which was not significant. The mean IOP reduction was from 11.5961 to 16.2018%.

A one-sample t-test was conducted to compare the mean percentage reduction achieved with twice-daily timolol treatment against the expected minimum percentage reduction of 18%. The analysis showed no statistically significant difference at any of the three time points. The p-values for the 8:00am, 12:00pm, and 4:00pm measurements were 0.220, 0.591, and 0.230, respectively.

Table 6: Intraocular pressure values of twice-daily timolol treatment, 2023 (N=42)

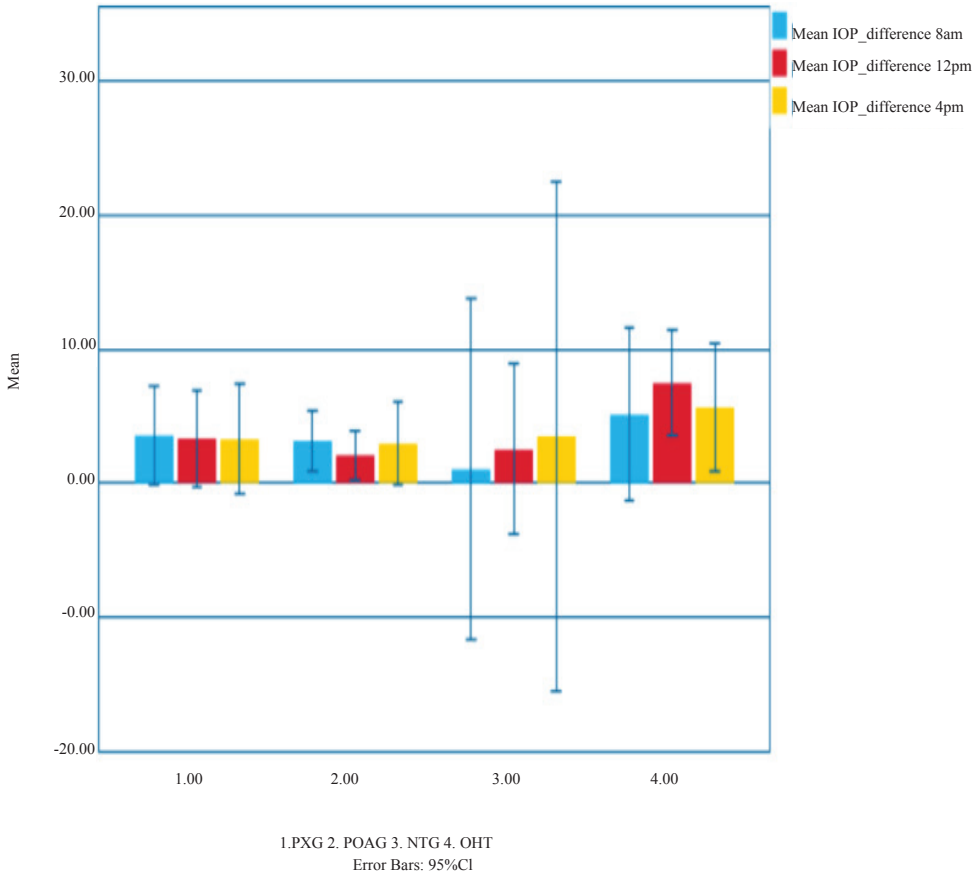
Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
				95% Confidence Interval of the Difference					
Mean		Std. Deviation	Std. Error Mean	Lower	Upper				
Pair 1	Baseline IOP at 8:00am - posttreatment IOP at 8:00am	3.69048	6.60188	1.01869	1.63319	5.74777	3.623	41	.001
Pair 2	Baseline IOP at 12:00pm - posttreatment IOP at 12:00pm	3.95238	5.56536	.85875	2.21809	5.68667	4.602	41	000
Pair 3	Baseline IOP at 4:00pm - posttreatment IOP at 4:00pm	3.78571	6.47899	.99973	1.76672	5.80471	3.787	41	.000

a. 1. twice daily group 2. once daily group = 1.00

The IOP lowering effect of twice daily timolol eye drop treatment on sub-types of OAG or ocular hypertension was higher in ocular hypertension and lower in primary OAG patients & NTG, but this was not statistically significant (Figure 2 and Table 7).

Figure 2: Effect of twice- daily timolol treatment on type of OAG and OHT at the three timings



OAG = Open Angle Glaucoma; OHT= Ocular Hypertension; IOP = Intraocular Pressure; PXG = Psudoexfoliative Glaucoma; POAG = Primary Open Angle Glaucoma, *, †, ‡, §, ||,¶ , **, ††, ‡‡

Table 7: Comparison of mean intraocular pressure reduction at 8:00am, 12:00pm, and 4:00pm among glaucoma subtypes

1. Twice daily 2 Once daily group = 1.00-ANONA-May 16,2026

ANOVA[a]

		Sum of Squares	df	Mean Square	F	Sig.
meanIOP_difference8am	Between Groups	40.619	3	13.540	.295	.829
	Within Groups	1746.357	38	45.957		
	Total	1786.976	41			
meanIOP_difference12pm	Between Groups	194.416	3	64.805	2.290	.094
	Within Groups	1075.489	38	28.302		
	Total	1269.905	41			
meanIOP_difference4pm	Between Groups	52.164	3	17.388	.396	.757
	Within Groups	1668.907	38	43.919		
	Total	1721.071	41			

a. 1. twice daily group 2. once daily group = 1.00

The Wilcoxon signed-rank test showed no statistically significant difference in Pulse Rate (PR), Systolic Blood Pressure (SBP), or Diastolic Blood Pressure (DBP) after treatment, with p-values of 0.705, 0.098, and 0.217, respectively.

Inter-group comparison

There was no statistically significant difference in lowering IOP whether timolol treatment was used once or twice daily. This is shown in Table 8.

Table 8: Comparison of reduction in intraocular pressure between the two groups (N=84)

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
meanIOP_difference8am	Equal variances assumed	.009	.926	.355	82	.724	.50000	1.40958	-2.30410	3.30410
	Equal variances not assumed			.355	81.837	.724	.50000	1.40958	-2.30418	3.30418
meanIOP_difference12pm	Equal variances assumed	.012	.915	-.770	82	.444	-.97619	1.26846	-3.49957	1.54718
	Equal variances not assumed			-.770	81.435	.444	-.97619	1.26846	-3.49983	1.54745
meanIOP_difference4pm	Equal variances assumed	.042	.839	.140	82	.889	.21429	1.52968	-2.82874	3.25731
	Equal variances not assumed			.140	80.295	.889	.21429	1.52968	-2.82971	3.25828

The Mann–Whitney U test showed no statistically significant difference between the once-daily and twice-daily treatment groups in Pulse Rate (PR) and Diastolic Blood Pressure (DBP), with p-values of 0.545 and 0.865, respectively. However, there was a statistically significant difference in Systolic Blood Pressure (SBP) between the two groups (p = 0.045). No significant ocular and systemic adverse effects were reported or observed in either group (Tables 9 – 11).

Table 9: Distribution of reported side effects among the once-daily and twice-daily timolol group

.00		None 1.Ocular irritation 2 .Bluring of vision 3. Allergic conjunctivitis 4. Bradicardia 5. Angina 6. Fatigability 7. Asthmatic attacks 8..Sexual disturbances 9. Depression 10. Fainting episodes 11. Others			Total
		1.00	3.00		
Twice daily group Once daily group	1.00	39	1	2	42
	2.00	40	2	0	42
Total		79	3	2	84

Table 10: Association between timolol dosing frequency and occurrence of side effects using Chi-square test

Chi-Square Tests					
	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.213a	1	.645		
Continuity Correction	.000	1	1.000		
Likelihood Ratio	.214	1	.644		
Fisher's Exact Test				1.000	.500
Linear-by-Linear Association	.210	1	.647		
N of valid cases	84				

Table 11: Risk estimate of side effects between the once-daily and twice-daily timolol groups

	Risk estimate		
	Value	95% Confidence Interval	
		Lower	Upper
Odds Ratio for 1. Twice daily group 2. Once daily group (1.00 / 2.00)	.650	.103	4.104
For cohort 1. No 2.Yes = 1.00	.975	.875	1.086
For cohort 1. No 2.Yes = 2.00	1.500	.264	8.523
N of valid cases	84		

Among the 91 patients who completed the one-month treatment period, seven patients were found to be non-adherent based on evaluation using the self-administered adherence checklist. Of these, two patients were from the once-daily treatment group, while five patients were from the twice-daily treatment group. Therefore, only the 84 adherent patients were included in the outcome analysis of the study.

DISCUSSION

In both groups, timolol treatment resulted in a statistically significant reduction in Intraocular Pressure (IOP). Although the observed percentage reduction appeared clinically lower than the expected minimum reduction of 18%, the difference was not statistically significant in either group.

The average reduction in IOP with timolol treatment was not found to be statistically different from the expected reduction (18% to 25%). However, it is essential to note that the mean decrease in IOP observed at three different time points was insignificant but lower than the expected reduction in both regiments. This finding contrasts with the results of other studies, which reported more significant reductions in IOP (meeting or exceeding the expected decrease of IOP)[4 - 12]. Several factors could explain this discrepancy. Firstly, the study's small sample size might have limited its ability to detect significant differences. Additionally, the short duration of the treatment period could have influenced the observed results. The inappropriate application of eye drops or poor adherence to the treatment regimen could also have contributed to the lower reduction in IOP. Moreover, it is worth mentioning that adherence in this study was evaluated based on patient reports, which might not always accurately reflect the accurate adherence level. The other reason could be the poor preparation of the timolol solution drop used for this study. It is essential to consider these limitations when interpreting the findings of this study and to investigate further the potential reasons behind the observed differences in IOP reduction compared to other studies.

This study has compared the effectiveness of timolol in treating different types of OAG and ocular hypertension. The result indicated that there was no specific type of glaucoma or ocular hypertension in which one treatment regimen was more effective than the other. Both regimens were found to lower IOP to a similar extent across all types of OAG and ocular hypertension. Although a slightly more significant reduction was observed in both groups for ocular hypertension and a lesser effect for primary OAG, this difference was not statistically significant. Similar findings were reported in other studies[5,13]. This could be explained by physiological reduction of aqueous humor production at night time. However, it is essential to note that the number of patients, age, and sex were not matched for the sub-types of glaucoma in this analysis. Therefore, further study is recommended to confirm.

There was no statistically significant difference in the systemic effects on Blood Pressure (BP) and Pulse Rate (PR) measurements, and no notable adverse effects were observed when evaluating each treatment group individually. However, comparison between once-daily and twice-daily use of timolol 0.5% solution showed a slight effect on systolic blood pressure in the twice-daily group. Comparative analysis using the Mann–Whitney U test demonstrated marginal statistical significance, with a p-value of 0.045. This marginal effect was not observed in the individual group analyses and may be attributable to the small sample size and short duration of treatment. This finding is consistent with several previous studies[4-12].

There was no statistically significant difference in reducing IOP when 0.5% timolol solution was used once or twice daily during the three time periods that were measured. Similarly, multiple studies have compared the effectiveness of timolol gel formulation administered once daily versus twice daily aqueous timolol solution[4,5-8]. As well as few studies comparing once daily aqueous timolol solution with twice daily timolol aqueous solution have consistently shown similar efficacy in lowering IOP[9,10,12,15]. Some studies comparing the formulation of timolol when used once or twice daily found no statistical difference in lowering IOP[14].

There was no significant difference in ocular or systemic side effects between once-daily and twice-daily use of timolol 0.5% solution. This finding is consistent with results reported in several previous studies[4 – 15].

To minimize the effect of non-adherence on the study outcome, participants' self-administered checklists were reviewed at the end of the one-month treatment period for missed doses. Participants who missed more than 15% of the prescribed doses were replaced by other patients. Accordingly, two patients in the once-daily group and five patients in the twice-daily group were replaced. Therefore, the 84 patients included in the final analysis were considered adherent based on their self-administered checklists. However, this assessment had a limitation, as actual administration of every eye drop dose was not directly observed and adherence relied solely on patient self-report.

Study limitations

This study has limitations. Participant allocation was based on a quasi-randomization method, with the first participant assigned by lottery followed by alternate allocation, which may have introduced selection bias. Baseline differences in age and glaucoma type were present between the groups, and no statistical adjustment for these imbalances was performed. The investigators were not masked. In addition, the one-month follow-up and relatively small sample size may limit the assessment of long-term safety and the generalizability of the findings.

CONCLUSION

The findings of this study suggest that once-daily 0.5% timolol ophthalmic solution may provide intraocular pressure reduction and a safety profile comparable to twice-daily treatment in patients with mild to moderate open-angle glaucoma or ocular hypertension. However, these findings should be interpreted with caution in light of the study limitations.

ACKNOWLEDGMENT

We extend our heartfelt gratitude to glaucoma clinic nurses for their invaluable assistance in measuring participants' IOP and vital signs. Medicare Ethiopia Pharmaceuticals PLC, for generously providing us with timolol eye drops (Gemolol). Lastly, we express our sincere appreciation and thanks to all study participants and Professor Negussie Deyessa for reviewing the manuscript

Funding: This study was supported by Addis Ababa University (AAU).

Consent for publication: All authors have given their consent for publication.

Availability of data and materials: All data and materials of the study are available.

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

Authors' contributions: Dr. Muhidin Oumer Kergeda was involved in data collection, data analysis, manuscript writing. Dr. Abiye Mulugeta Alemu did the study conception, supervision and critical review of the manuscript.

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Prevalence of visual impairments and refractive errors in school-aged children in Mogadishu, Somalia

Mohamud LH[1], Mohamed MA[1], Khan AS[1], Mohamud IH[2]

[1]Al Ihsan Specialist Hospital, Mogadishu, Somalia
[2]Jazeera University, Mogadishu, Somalia

Corresponding author: Dr. Liban Hassan Mohamud, Al Ihsan Specialist Hospital, Mogadishu, Somalia. Email: libaanx@gmail.com

ABSTRACT

Objective: To determine the prevalence and causes of Visual Impairment (VI) and Refractive Errors (RE) among school-aged children in Mogadishu, Somalia.
Study design: Cross-sectional, school-based study.
Methods: Children aged 6–15 years were recruited from five schools using a modified Refractive Error Study in Children (RESC) protocol. Visual Acuity (VA) was measured with the Snellen Tumbling E-chart. Children with uncorrected VA ≤6/12 underwent pinhole testing, non-cycloplegic retinoscopy, and refraction. REs were defined as myopia (≥−0.5 diopters [D]), hypermetropia (≥+2.0 D), or astigmatism (≥0.75 D).
Results: Of 1,540 children, 1,516 participated (response rate 98.4%). Mean age was 7.44±1.58 years; 57.3% were female. VI in the better eye was detected in 19.4% (95% Confidence Interval (CI): 17.4–21.4%), yet only 19.7% used spectacles. VI was higher in females (21.9%) than males (16.0%) (P<0.001). REs accounted for 93.8% of VI, with an overall prevalence of 24.9% (myopia 10.5%, astigmatism 8.4%, hypermetropia 6.1%). RE prevalence was higher in females (29.1%) than males (19.2%) (P<0.001). Posterior segment abnormalities occurred in 1.8%.
Conclusions: Childhood VI in Mogadishu is common, largely driven by uncorrected REs. Low spectacle coverage underscores the need for school-based vision screening.

Key words: Visual impairment, Refractive errors, Myopia, Hypermetropia, Astigmatism, Schoolchildren, Somalia

INTRODUCTION

Refractive errors disrupt light focusing on the retina, causing blurred vision. In children, uncorrected refractive errors impact visual development and academic performance. Conditions like myopia, hypermetropia, and astigmatism can impede a child's ability to read and participate in educational activities[1].

Refractive errors are the primary cause of Visual Impairment (VI), affecting 101.2 million people worldwide. Furthermore, when left uncorrected, these refractive errors rank as the second leading cause of blindness, affecting 6.8 million people worldwide[2]. Refractive errors represent a substantial global health issue, impacting populations worldwide with varying prevalence rates across regions. Globally, uncorrected refractive errors are the primary cause of visual impairment, affecting approximately 19 million children[3]. The prevalence of myopia has been increasing rapidly, with projections suggesting that nearly half of the world's population may be myopic by 2050. The prevalence of refractive errors varies by region. In Asia, particularly in East Asian countries, the prevalence is the highest[4]. In certain urban areas of China, South Korea, and Japan, the incidence of myopia among young adults can surpass 87.7%[5]. In contrast, Europe and North America reported a myopia incidence with adult prevalence rates of 7%. Although these rates are generally lower than those in other regions, there is a clear upward trend in their prevalence[4].

In East Africa, data on refractive error is scarce. Studies indicate lower prevalence than global averages, though increasing in urban areas. Myopia is most common, followed by astigmatism and hypermetropia. Studies from Ethiopia and Kenya show 5-10% myopia prevalence in school children[6]. In Somalia, the lack of comprehensive data on the prevalence of Refractive Errors (RE) is largely due to limited eye care infrastructure and ongoing socioeconomic challenges[7]. Population-based studies are needed to assess refractive errors in Somalia, with higher urban prevalence and limited rural eye care access. Research must examine socioeconomic, environmental and genetic causes. Improved screening and infrastructure should address this issue in underserved areas. Developed countries have seen an increase in myopia, particularly in East Asia, while hyperopia remains prevalent in Western populations[8]. However, data on refractive errors in children from many developing countries, including Somalia, are lacking. This gap limits our understanding of the global burden and hinders targeted interventions for affected populations.

MATERIALS AND METHODS

Study population and study site: The study included children aged 6–15 years from Al Najah, Al Haramain, KPP Sheikh Ali Sufi, Ma'hadu Sunnah, and Moasser schools in Mogadishu, Somalia.

Study design: This cross-sectional study used the modified Refractive Error Study in Children (RESC) protocol to evaluate Visual Impairment (VI) and Refractive Errors (RE) in children. Non-cycloplegic refraction was used to determine RE prevalence, defined as (a) myopia of ≥ −0.5 diopters (D) in one or both eyes, (b) hypermetropia of ≥ 2.0 D, and (c) astigmatism of ≥ 0.75 D cylindrical refraction[3].

Inclusion and exclusion criteria: Children aged 6-15 years present at school on examination days with parental consent were included in the study. Children without parental consent were excluded.

Study sample: A two-stage sampling method was employed. First, five schools were randomly selected from the registry of primary schools in Mogadishu. Second, within these selected schools, eligible children present on the examination days were consecutively examined using convenience sampling. We assumed an RE prevalence of 15.7% based on childhood rates in Hargeisa, Somaliland, Somalia[7]. The sample size was calculated using a 97% CI and 3% sampling error. With a design effect of 2, the final sample size was 1540.

$n = (Z^2pq)/d^2 = (2.172 \times 0.157 \times 0.843)/ 0.032 = 692.48 \approx 693$

The initial sample size was 693 participants. To account for the design effect of 2, this was multiplied by 1386. With a 10% non-response rate, the final sample size was adjusted to 1540 schoolchildren. Five randomly selected schools were selected for this study.

Clinical investigation: Clinical assessments followed the modified RESC protocol. Distance Visual Acuity (VA) was assessed using the Snellen Tumbling E-chart at 6 m. Participants with VA ≤ 6/12 underwent a pinhole test; if vision improved, they had retinoscopy and subjective refraction. Children were examined for anterior segment abnormalities using a penlight and hand magnifier. A cover test detected heterophoria or heterotropia, measured through corneal light reflex and Prism Cover Test. Ocular motility testing evaluated eye muscle function. For children with pinhole-improved vision, subjective refraction determined optimal correction. Those with VA ≤ 6/12 and no pinhole improvement underwent fundus examination, with abnormalities recorded as potential VI causes.

Data analysis: A descriptive analysis of the participant data was conducted using Standard Deviation (SD) and percentages facilitated by the Statistical Package for the Social Sciences (SPSS) version 26. The relationships between variables were assessed using correlation, cross-tabulation and $\chi 2$ analysis. A significance level of P = 0.05 was applied to all the statistical tests.

Ethical considerations: Ethical approval for this study was obtained from the Jazeera University Research Ethics Review Committee (JU24/08). This study was conducted in accordance with the Declaration of Helsinki. Informed consent was obtained from all participants. To protect patient confidentiality, physical data collection sheets containing personal identifiers were securely shredded after data entry. The anonymized master database and copies of the signed consent forms are securely retained at Jazeera University in accordance with institutional ethics committee mandates.

RESULTS

From a cohort of 1,540 children, 1,516 (98.4%) were enrolled in the study.

Demographic characteristics of participants: Table 1 shows the demographic characteristics of the participants. The study included 1,516 children aged 6-15 years (mean age 7.44 years, SD = 1.58). The cohort comprised 872 females (57.3%) and 644 males (42.5%) participants. Seven-year-olds constituted 42.8%, while 6-year-olds made up 25.1%. Ages 14-15 years had lowest representation (0.3-0.8%). A significant age difference existed between males and females (analysis of variance [ANOVA]: F = 7.197, P < 0.001).

Table 1: Sociodemographic characteristics

Variable	Categories	Frequency	(%)
Age of children (years)	6	380	25.1
	7	649	42.8
	8	279	18.4
	9	79	5.2
	10	46	3.0
	11	13	0.9
	12	29	1.9
	13	24	1.6
	14	12	0.8
	15	5	0.3
	Total	1516	100.0
Gender	Female	872	57.5
	Male	644	42.5
	Total	1516	100.0

Distribution of signs and symptoms among school-aged children: Among school-aged children surveyed, 1,138 (75.1%) reported no ocular symptoms, while 227 (15.0%) had blurred vision, 129 (8.5%) experienced itching and redness, and 22 (1.5%) had pain and photophobia.

Visual acuity: Table 2 shows the distribution of uncorrected visual acuity. Among the children, 1,172 (77.3%; 95% CI: 75.2–79.4) had normal uncorrected Visual Acuity (VA) of 6/6 in the right eye, while 1,166 (76.9%; 95% CI: 74.7–79.0) had normal VA in their left eye. For better eyes, 1,169 (77.1%; 95% CI: 75.0–79.2) had VA of 6/6. Visual impairment (VA ≤6/12) was identified in 283 children (18.7%; 95% CI: 16.7–20.6) in the right eye, 304 (20.1%; 95% CI: 18.0–22.1) in the left eye, and 294 (19.4%; 95% CI: 17.4–21.4) in their better eye. After best-corrected refraction, VA ≤6/12 decreased to 24 children (1.58%; 95% CI: 0.95–2.21).

Table 2: Distribution of uncorrected visual acuity for right – left and better eye by percentage

UVA	Right Eye		Left Eye		Better Eye		Best-Corrected VA	
	N	% (95% CI)	N	% (95% CI)	N	% (95% CI)	N	% (95% CI)
6/6	1172	77.3% (75.2% - 79.4%)	1166	76.9%(74.7% - 79.0%)	1169	77.1% (75.0%-79.2%)	1480	97.63% (96.7% - 98.4%)
6/9	61	4.0% (3.0% - 5.0%)	46	3.0%(2.1% - 3.9%)	53	3.5% (2.6% -4.5%)	12	0.79% (0.4% - 1.2%)
6/12	108	7.1% (5.8% - 8.4%)	109	7.2%(5.8% - 8.4%)	109	7.2% (5.9% - 8.5%)	6	0.40% (0.1% - 0.7%)
6/18	91	6.0% (4.8% - 7.2%)	95	6.3%(5.0% - 7.4%)	93	6.1% (4.9% - 7.3%)	5	0.33% (0.04% - 0.6%)
6/24	29	1.9% (1.2% - 2.6%)	46	3.0%(2.1% - 3.9%)	37	2.5% (1.7% - 3.3%)	3	0.20% (-0.03% - 0.4%)
6/36	17	1.1% (0.5% - 1.6%)	14	0.9%(0.4% - 1.4%)	16	1.0% (0.5% - 1.5%)	5	0.33% (0.04% - 0.6%)
6/60	13	0.9% (0.3% - 1.3%)	17	1.1%(0.5% - 1.6%)	15	1.0% (0.5% - 1.5%)	2	0.13% (-0.05% - 0.31%)
CF	23	1.5% (0.9% - 2.1%)	21	1.4%(0.80% - 1.9%)	22	1.5% (0.9% - 2.1%)	1	0.07% (-0.06% - 0.20%)
HM	2	0.1% (-0.0% - 0.3%)	2	0.2%(0.0% - 0.2%)	2	0.1% (0.1% - 0.4%)	2	0.13% (-0.05% - 0.31%)
Total	1516	100.0%	1516	100.0%	1516	100.0%	1516	100.0%
VA ≥ 6/12					294	19.4% (17.4% - 21.4%)	24	1.58% (0.95% - 2.21%)

CF = Count Fingers; CI = Confidence Interval; HM = Hand Movement; UVA = Uncorrected Visual Acuity; VA = Visual Acuity.

Prevalence of visual impairment: Table 3 analyzes Visual Impairment (VI) data from 1,516 school-aged children in the Mogadishu, Somalia. VI prevalence, measured by uncorrected visual acuity in the better eye, was 19.4% (294 cases; 95% CI: 17.4%-21.4%), with only 19.7% of VI cases wearing spectacles. VI prevalence showed significant association with age (P<0.001) and sex (P = .004), being higher in girls (21.9%; 95% CI, 19.1%–24.7%) than boys (16.0%; 95% CI, 13.0%-19.0%). Children aged 6-7 years showed lower VI prevalence (15.8%; 95% CI, 13.6%-18.1%), while the 10-11 age group had the highest (49.2%; 95% CI, 36.5%–62.0%).

Table 3: Prevalence of visual impairment among school-aged children by age groups and gender

Variable		Categories	Frequency	Percentage with 95% CI
Better eye VA		6/6	1169	77.1% (75.0-79.2%)
		6/9	53	3.5% (2.6 -4.5%)
		6/12	109	7.2% (5.9% - 8.5%)
		6/18	93	6.1% (4.9% - 7.3%)
		6/24	37	2.5% (1.7% - 3.3%)
		6/36	16	1.0% (0.5% - 1.5%)
		6/60	15	1.0% (0.5% - 1.5%)
		CF	22	1.5% (0.9% - 2.1%)
		HM	2	0.1% (0.1% - 0.4%)
		Total	1516	100.0%
Visual Impairment		Children without visual impairment	1222	80.6%
		Children with visual impairment (VA ≤ 6/12 in Better Eye)	294	19.4%
		Total	1516	100.0
		Children without visual impairment	Children with visual impairment	Total
Gender P=0.004	Male	541	103	644
	Female	681	191	872
Total		1222	294	1516
Age (years) P=0.000	6	336	44	380
	7	530	119	649
	8	229	50	279
	9	57	22	79
	10	21	25	46
	11	9	4	13
	12	18	11	29
	13	13	11	24
	14	6	6	12
	15	3	2	5
Total		1222	294	1516

CI = Confidence Interval; VA = Visual Acuity

Binocular anomalies: In a study involving children, 28 participants (1.9% of the total) were diagnosed with tropia. Of these, 12 were identified as esotropia and 16 as exotropias.

Anterior-segment examination: In this study, 1,416 children (93.4%, 95% Confidence Interval (CI) (92.2%, 94.7%)) had no right eye abnormalities, while 1,417 children (93.5%, 95% CI (92.2%, 94.7%)) had no left eye abnormalities. Conjunctivitis, including bacterial, viral, and allergic types, was observed in 30 children (2.0%) in the right eye [95% CI, 1.3%–2.7%] and 30 children (2.0%) in the left eye [95% CI, 1.3%–2.7%]. Vernal Keratoconjunctivitis (VKC) affected 26 children (1.7%) in the right eye [95% Confidence Interval (CI), 1.1%–2.4%] and 26 children (1.7%) in the left eye [95% CI, 1.1%–2.4%]. Cataracts appeared in seven children (0.5%) in the right eye [95% CI, 0.1%–0.8%] and in three children (0.2%) in the left eye [95% CI, 0.0%–0.4%]. A corneal scar was observed in one child (0.1%) in the right eye [95% CI, 0.0%–0.2%] and in one child (0.1%) in the left eye [95% CI, 0.0%–0.2%].

Prevalence of refractive error: Table 4 shows the prevalence of refractive error. The prevalence of Refractive Errors (RE) among schoolchildren was 24.9% (95% CI, 22.8–27.1), with 75.1% being emmetropic. Myopia was the most common RE, affecting 10.5%, followed by astigmatism (8.4%) and hypermetropia (6.1%). RE prevalence was significantly linked to sex (P = 0.001) and age (P = 0.001), with higher rates in girls (29.1%) than boys (19.2%). Myopia was more prevalent in girls (12.4%) than boys (7.9%), hypermetropia in girls (7.5%) than boys (4.2%), and astigmatism in girls (9.3%) than boys (7.1%). RE prevalence rose with age, with myopia peaking at 58.6% among 12-year-olds. Hypermetropia was most common in 7-year-olds (6.8%) and absent in 13- and 15-year-olds. Astigmatism was highest in 7-year-olds (9.4%) and declined with age.

Table 4: The prevalence of refractive error in one or both eyes by age and gender

Age (years) (P=0.001)	Emmetropia		Myopia		Hypermetropia		Astigmatism		Total	
	N	% (95% CI)	N	% (95% CI)	N	% (95% CI)	N	% (95% CI)	N	% (95% CI)
6	323	85.0% 81.4%, 88.6%)	23	6.1% (3.7%, 8.5%)	19	5.0% (2.8%, 7.2%)	15	3.9% (2.0%, 5.9%)	380	25.1% (22.9% - 27.3%)
7	489	75.3% (72.0%, 78.7%)	55	8.5% (6.3%, 10.6%)	44	6.8% (4.8%, 8.7%)	61	9.4% (7.2%, 11.6%)	649	42.8% (40.3% - 45.3%)
8	206	73.8% (68.7%, 79.0%)	24	8.6% (5.3%, 11.9%)	18	6.5% (3.6%, 9.3%)	31	11.1% (7.4%, 14.8%)	279	18.4% (16.5% - 20.4%)
9	64	81.0% (72.4%, 89.7%)	7	8.9% (2.6%, 15.1%)	2	2.5% (-0.9%, 6.0%)	6	7.6% (1.8%, 13.4%)	79	5.2% (4.2% - 6.4%)
10	31	67.4% (53.8%, 80.9%)	2	4.3% (-1.5%, 10.2%)	6	13.0% (3.3%, 22.8%)	7	15.2% (4.8%, 25.6%)	46	3.0% (2.3% - 4.1%)
11	4	30.8% (5.7%, 55.9%)	7	53.8% (26.7%, 80.9%)	1	7.7% (-6.8%, 22.2%)	1	7.7% (-6.8%, 22.2%)	13	0.9% (0.5% - 1.5%)
12	9	31.0% (14.2%, 47.9%)	17	58.6% (40.7%, 76.5%)	1	3.4% (-3.2%, 10.1%)	2	6.9% (-2.3%, 16.1%)	29	1.9% (1.3% - 2.8%)
13	8	33.3% (14.5%, 52.2%)	15	62.5% (43.1%, 81.9%)	0	0.0% (0.0%, 0.0%)	1	4.2% (-3.8%, 12.2%)	24	1.6% (1.1% - 2.4%)
14	2	16.7% (-4.4%, 37.8%)	8	66.7% (40.0%, 93.3%)	1	8.3% (-7.3%, 24.0%)	1	8.3% (-7.3%, 24.0%)	12	0.8% (0.4% - 1.4%)
15s	2	40.0% (-2.9%, 82.9%)	1	20.0% (-15.1%, 55.1%)	0	0.0% (0.0%, 0.0%)	2	40.0% (-2.9%, 82.9%)	5	0.3% (0.1% - 0.8%)
Total	1138	100.0%	159	100.0%	92	100.0%	127	100.0%	1516	100.0%
Gender (P=0.001)	N	% (95% CI)	N	% (95% CI)	N	% (95% CI)	N	% (95% CI)	N	%
Male	520	80.7% (77.7%, 83.8%)	51	7.9% (5.8%, 10.0%)	27	4.2% (2.6%, 5.7%)	46	7.1% (5.2%, 9.1%)	644	42.5% (40.0% - 45.0%)
Female	618	70.9% (67.9%, 73.9%)	108	12.4% (10.2%, 14.6%)	65	7.5% (5.7%, 9.2%)	81	9.3% (7.4%, 11.2%)	872	57.5% (55.0% - 60.0%)
Total	1138	75.1% (72.8% - 77.2%)	159	10.5% (9.0% - 12.1%)	92	6.1% (5.0% - 7.4%)	127	8.4% (7.1% - 9.9%)	1516	100.0%

CI = Confidence Interval

Posterior-segment examination: A comprehensive examination of the posterior segment revealed that 1,488 children (98.2% [95% CI, 97.4–98.8%]) had no abnormalities. In contrast, abnormalities in the posterior segment were detected in 28 children (1.8% [95% CI, 1.2–2.6%]). Among these cases, myopic degeneration was the most frequent, affecting 17 children (1.1% [95% CI, 0.6–1.7%]). Additional abnormalities included optic atrophy in three children (0.2% [95% CI, 0.04–0.6%]), macular dystrophy in three children (0.2% [95% CI, 0.04–0.6%]), glaucoma in two children (0.1% [95% CI, 0.01–0.4%]), diabetic retinopathy in two children (0.1% [95% CI, 0.01–0.4%]), and toxoplasmosis in one child (0.1% [95% CI, 0.002–0.3%]).

The principal causes of visual impairment: Table 5 shows the causes of Uncorrected Visual Acuity (UVA) of 6/12 or worse in at least one eye. Refractive Error (RE) was the main cause of Visual Impairment (VI) in 364 children (93.81%; 95% CI, 91.42%–96.21%), with a population prevalence of 24.01% (95% CI, 21.86%–26.16%). Cataract was observed in 10 children (2.58%; 95% CI, 1.00%–4.15%), with a population prevalence of 0.66% (95% CI, 0.25%–1.07%), and amblyopia in 9 children (2.32%; 95% CI, 0.82%–3.82%), with a population prevalence of 0.59% (95% CI, 0.21%–0.98%). Retinal disease affected three children (0.77%; 95% CI, 0.00% to 1.64%) and corneal opacity 2 children (0.52%; 95% CI, 0.00% to 1.23%), with population prevalence rates of 0.20% (95% CI, 0.00%–0.42%) and 0.13% (95% CI, 0.00%–0.31%), respectively.

Table 5: Causes of uncorrected visual acuity 6/12 or worse

Causes	Children with VA 6/12 or worse in one or both eyes		Prevalence in the population in one or both eyes, % (95% CI)
	N	% (95% CI)	
Amblyopia	9	2.32% (0.82% - 3.82%)	0.59% (0.21% - 0.98%)
Refractive error	364	93.81% (91.42% - 96.21%)	24.01% (21.86% - 26.16%)
Cataract	10	2.58% (1.00% - 4.15%)	0.66% (0.25% - 1.07%)
Corneal opacity	2	0.52% (-0.20% - 1.23%)	0.13% (0.00% - 0.31%)
Retinal disease	3	0.77% (-0.10% - 1.64%)	0.20% (0.00% - 0.42%)
Total	388	100.0%	100.0%

CI = Confidence Interval

Schoolchildren who received spectacles, eye drops or were referred: Of the study cohort, 1,066 children (70.3%; 95% CI, 68.1–72.5%) had normal ocular findings. Three hundred and sixty four children (24.0%, 95% CI, 21.9–26.2%) received corrective lenses, while 62 children (4.1%; 95% CI, 3.1–5.1%) received ophthalmic medications. Twenty four children (1.6%; 95% CI, 1.0–2.3%) were referred to Al Ihsan Specialist Hospital for specialized management.

DISCUSSION

Refractive errors show significant regional variations worldwide. Due to the lack of standardized assessment methods, the "Refractive Error Study in Children" protocol was developed and implemented across multiple countries[2]. Understanding the prevalence of refractive errors and visual impairment among school-aged children is crucial for planning eye care services. This study aimed to assess these conditions in Mogadishu for the first time.

In this study, non-cycloplegic refraction was used to assess Refractive Errors (REs), consistent with research conducted on school-aged children in USA[9] and Somaliland, Somalia[7]. Non-cycloplegic refraction was selected to prevent interference with the children's academic activities.

The prevalence of presenting VI (uncorrected VA ≤6/12 in the better eye) was 19.4%, with refractive error causing 93.81% of cases, highlighting the need for vision screening in school children.

Our study revealed that the prevalence of Visual Impairment (VI) surpassed the rates documented in similar studies conducted in Nigeria (3.4%)[10], Sudan (1.75%)[3], Ethiopia (5.8%)[11], Somalia (7.6%)[7], and China (7.70%)[12]. However, this remains below the prevalence reported in western Saudi Arabia (34.9%)[13]. These

findings highlight the need for interventions targeting VI in school-aged children. The primary contributors to VI prevalence in this demographic are inadequate primary eye care services and a lack of health education programs to increase community awareness of the implications of VI in childhood.

Our analysis revealed a significant correlation between the prevalence of Visual Impairment (VI) and sex, with a notably higher prevalence among girls (21.9%) than among boys (16.0%) (P=.004). This observation is consistent with the findings from studies in Somalia, which reported a slightly higher prevalence in girls (4.6% vs. 2.6%)[7], and Ethiopia (3.2% vs. 2.6%)[6]. However, this finding differs from those of studies that found no significant sex differences. This variation may be due to socioeconomic factors, which give boys better access to healthcare in certain cultures. Furthermore, we identified a statistically significant relationship between VI prevalence and age (P<0.001), with VI being less common in younger children (6-7 years) and peaking in the 10 -11 year age group (49.2%). This pattern likely reflects the progression of refractive errors, particularly myopia, as children age.

The overall prevalence of Refractive Errors (RE) in our study was 24.9%, surpassing the 15.7% reported in a previous study conducted in Somaliland, Somalia[7], South Africa (20.7%)[15], and South India (1.44%)[16] but lower than that in Sudan (27%)[3] and Ghana (25.6%)[14]. The variation in RE prevalence across studies may be attributed to the sampling method, population size, and geographic location. We identified a significant association between RE prevalence and sex (P=0.001) and age (P=0.001). Consistent with our findings on Visual Impairment (VI), RE was more prevalent among girls (29.1%) than among boys (19.2%).

Myopia was identified as the most prevalent Refractive Error (RE), affecting 10.5% of children. This prevalence is higher than that reported in a previous study conducted in Ethiopia (6.0%)[6] and South India (1.38%)[16] but lower than the rates observed in Ghana (14.1%)[17] and Vietnam (20.4%)[17]. The age-related increase in myopia prevalence, which peaked at 58.6% among 12-year-olds, was consistent with findings from similar studies conducted in China, where the prevalence was 73.12% among 15-year-olds[18], Vietnam[17] and Ghana[14]. These findings underscore the importance of outdoor activities in preventing myopia in school-aged children.

Hypermetropia accounted for 6.1% of cases, which is lower than the 26.4% reported in Ethiopia[6]. However, this rate is higher than that documented in Somaliland, Somalia (2.7%)[7], and China (5.2%)[19]. The trend of decreasing hypermetropia prevalence with age, with a peak of 6.8% in 7-year-olds and no cases in the 13-15 age group, is consistent with the natural emmetropization process, where the eye's refractive state shifts towards emmetropia as children grow. It is crucial to acknowledge that our use of non-cycloplegic refraction may have resulted in an underestimation of the prevalence of hypermetropia. Studies comparing cycloplegic and non-cycloplegic refraction in similar age groups suggest that hypermetropia prevalence may be underestimated by approximately 2% to 5% when cycloplegia is not used due to active accommodation. Therefore, the true burden of hypermetropia in our cohort might be slightly higher than reported. Astigmatism was detected in 8.4% of the children, a figure that surpasses the rates reported in Somaliland, Somalia (3.9%)[7] but was lower than the prevalence found in the Islamic Republic of Iran (11.5%)[8], Sudan (14%)[3] and China (18.3%)[20]. The prevalence of manifest strabismus (tropia) was 1.9%, with exotropia being more common than esotropia. This is higher than the rates reported in Tanzania (0.5%)[21] but comparable to that of Iranian children (1.2%)[8]

In our study, uncorrected refractive error emerged as the predominant cause of Visual Impairment (VI), accounting for 93.81% of the cases. This finding aligns with the results of other studies employing similar methodologies, such as those conducted in Ethiopia (77.3%)[6], and Western China (86.08%)[12]. Cataracts were the second most prevalent cause of VI (2.58%), followed by amblyopia (2.32%). Retinal diseases, corneal opacities, and other causes contribute minimally to the overall burden. A critical public health concern is the low rate of spectacle use, with only 19.7% of children with VI using spectacles. This underscores a significant barrier to effective vision correction, which can be attributed to factors such as insufficient parental awareness, the financial burden of spectacles, and social stigma or peer pressure.

Limitations

Our study had limitations. The cross-sectional design limited causal inferences. Non-cycloplegic refraction may have underestimated hypermetropia. The exclusion of certain schools and non-enrolled children due to economic hardship affects generalizability. Using Snellen E-charts and basic examination tools instead of advanced equipment may have reduced diagnostic precision. Additionally, non-school-attending children, who may have higher rates of uncorrected visual impairment, were not included. Furthermore, the age distribution of our sample was markedly skewed towards younger children (6 -7 years), resulting in very small sample sizes for older age groups (11-15 years). Consequently, age-specific prevalence estimates and confidence intervals for older children are wide and should be interpreted with caution.

CONCLUSIONS

The prevalence of Visual Impairment (VI) among school-aged children in Mogadishu, Somalia, is notably high, with uncorrected Refractive Errors (REs) being the most prevalent cause. This underscores the urgent need for a comprehensive childhood eye care strategy aimed at delivering essential eye care services to this age group. Such a strategy should be formulated through a collaborative effort involving government entities, the private sector, stakeholders, and non-governmental organizations dedicated to the prevention of avoidable childhood blindness and VI. Furthermore, these findings emphasize the importance of instituting regular vision screening programs to mitigate the preventable causes of vision impairment.

ACKNOWLEDGEMENTS

The authors express their gratitude to Dr. Ifrah Hassan Mohamud, Jazeera University, for her valuable assistance and support in conducting this study.

Declarations

Consent for publication: All participants provided consent for publication, and any personal information was anonymized to protect their identities.

Conflicts of interest: Non to declare.

Funding: This research did not receive any specific grants from funding agencies in the public, commercial, or not-for-profit sectors.

Authors' contributions: All authors contributed to the conception and design of this study. Dr. Liban, Dr. Mohamoud, Dr Ifrah and Dr. Abdul Salam conducted the material preparation, data collection, and analysis. The initial draft of the manuscript was prepared by Dr. Liban, and all authors provided feedback on previous versions of the manuscript. All authors have read and approved the final manuscript.

Availability of data and materials: The datasets utilized and analyzed in the current study are available from the authors upon reasonable request.

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Prevalence and factors associated with refractive errors among healthcare workers at Mbarara Regional Referral Hospital

Birungi AM[1], Tusingwire DP[3,4], Namwase S[5], Ebong A[1], Arunga S[1,2], Onyango J[1]

[1]Department of Ophthalmology, Mbarara University of Science and Technology, Mbarara, Uganda
[2]International Centre for Eye Health, London School of Hygiene and Tropical Medicine, London, UK
[3]Department of Ophthalmology, Kabale University, Kampala, Uganda
[4]Department of Ophthalmology, Ruharo Mission Hospital, Mbarara, Uganda
[5]Department of Ophthalmology, Lira Regional Referral Hospital, Lira, Uganda

Corresponding author: Dr. Angela Meric Birungi, Department of Ophthalmology, Mbarara University of Science and Technology, Mbarara, Uganda. Email: angelameric9@gmail.com

ABSTRACT

Objective: To determine the prevalence of refractive errors and associated factors among healthcare workers at Mbarara Regional Referral Hospital (MRRH).

Methods: A cross-sectional study at Mbarara Regional Referral Hospital in Uganda. Healthcare workers were selected through multistage stratified random sampling using staff lists. Each participant completed a questionnaire, underwent refraction, and near vision testing for those 35 years and above. Descriptive statistics, chi-square and logistic regression analyses were conducted. Frequencies, percentages, odds ratios, 95% confidence intervals and p values are reported. All analyses were performed using Stata 17.

Results: Of the 422 participants included in the study, the overall prevalence of refractive errors was 30.1% while the age specific prevalence of presbyopia was 32.1%. A total of 110 participants (26.1%) had only distance refractive errors, 34 (8.1%) had presbyopia only, and 17 participants had both distance errors and presbyopia. Astigmatism was the leading distance refractive error. Age 40 years and above (Adjusted Odds Ratio (AOR): 3.5, 95% CI: 2.0–6.0, $p < 0.001$), education level above certificate (AOR: 2.1, 95% CI: 1.0–4.4, $p = 0.050$), and family history of refractive errors (AOR: 2.1, 95% CI: 1.0–4.4, $p = 0.050$) were statistically associated with refractive errors.

Conclusion: The prevalence of refractive errors among healthcare workers at MRRH was 38.1%. Age 40 years and above, higher education level and family history were associated with refractive errors. Key stakeholders should sensitize and implement routine eye screening for refractive errors among healthcare workers and provide timely interventions.

Key words: Astigmatism, Healthcare workers, Hyperopia, Myopia, Presbyopia, Refractive errors

INTRODUCTION

A refractive error is a condition in which light does not fall on the retina due to either abnormal shape or length of the eye ball hence resulting in blurry vision. The types include; myopia (short-sightedness), hyperopia (long sightedness) astigmatism (irregular surface of the cornea or lens)[1] and presbyopia, an age related loss of accommodation that ultimately leads to change in the refractive power of the lens[2].

Refractive errors are still the leading cause of visual impairment globally, and approximately 2.2 billion people are living with near or distance visual impairment, with the majority living in low- and middle income countries[3]. Community based studies among adults in African countries have reported different prevalences ranging from 12.3% in Ethiopia[4], 33.8% in Nigeria[5] and 57.3% in South Africa[6].

Published data about refractive errors among healthcare workers globally is very limited, with a few published studies within the region. Ophthalmic screening healthcare workers in India found that refractive errors followed by presbyopia were the leading cause of visual impairment among this population[7]. A study conducted among staff members of a medical university in Iran revealed that the prevalence of refractive errors was 15.7%[8]. Myopia has also been reported to be common among medical doctors in India, with a prevalence of 57%[9]. In Nigeria, Saka *et al*.[10] reported a prevalence of 22.3% among staff of a tertiary health facility, with myopia being the most prevalent at 14.0% followed by hyperopia while another study among healthcare workers reported a prevalence of presbyopia of 42.1%[11]. In Uganda, there is paucity of published data about refractive errors among healthcare workers. Refractive errors have various symptoms, ranging from headache

to blurry vision, eyestrain, headache, decreased vision, itching and haloes[4]. They are associated with age, sex, near work, positive family history, and ocular diseases such as cataracts [14–16]. Uncorrected refractive errors lead to difficulty in performing visual tasks such as reading and writing[17] and may also lead to economic losses to the individual and the nation at large[18,19].

Healthcare workers execute delicate and critical tasks that require perfect vision. They are also explicitly predisposed to refractive errors, especially myopia, due to their excessive near work[9] and presbyopia that develops with age[20]. Visual disturbances due to uncorrected refractive errors result in reduced productivity at work [17], which may affect the execution of expected tasks but also predispose healthcare workers to work-related accidents. Unfortunately, there is no routine vision screening performed for healthcare workers before the start of medical practice or even as a requirement to renew practicing licenses in Uganda. There is also a paucity of data concerning the prevalence and factors associated with refractive errors among healthcare workers in Uganda. This study, therefore, aimed to determine the prevalence and factors associated with refractive errors among healthcare workers at Mbarara Regional Referral Hospital in Uganda.

MATERIALS AND METHODS

This was a cross-sectional study conducted at Mbarara Regional Referral Hospital (MRRH), between May 2024 to June 2024. MRRH is a tertiary-level public hospital located in Mbarara city, southwestern Uganda. The hospital houses teaching facilities for undergraduate and postgraduate students at Mbarara University of Science and Technology and it is also an internship center for doctors, nurses, midwives, and pharmacists. The hospital has staff from both the university and the Ministry of Health. Healthcare workers at MRRH include clinical officers, intern doctors, intern nurses, intern midwives, intern pharmacists, medical officers, nurses, midwives, postgraduate students (pharmacists, doctors, nurses and laboratory technologists), pharmacists, laboratory technicians, physiotherapists, radiographers, orthopaedic technicians, radiographers, anaesthetists, pharmacy technicians, theatre assistants, dental officers and clinical specialists.

Inclusion criteria

Hospital and university staff doing clinical work at MRRH. These were full-time employees of either the hospital or university as listed by the human resource departments of each of the institutions.

Clinical postgraduate students at Mbarara University of Science and Technology working at MRRH. These were primarily healthcare workers and form a big part of the bulk of healthcare workforce in the hospital.

Exclusion criteria

History of corneal refractive surgeries. Dense media opacities that obstruct clear visualization of the red reflex, which is required for good retinoscopy.

Sample size calculation

The sample size was calculated using the formula for estimation of a single proportion by Kelsey *et al*. (1996): $n = Z^2 * P (1 - P)/d^2$. where Z = 1.96 and d = the margin error of estimation, which is assumed to be 5% (0.05). A prevalence of 50% was assumed. This was because there was no published study with a representative population closest to our study population.

$$n=\frac{1.96^2\ X0.50(1-0.50)}{0.05^2}$$

$$n=384$$

Taking into consideration the predicted 10% nonresponse rate, Final sample size =**422**.

Sampling procedure

The different healthcare professions were regarded as strata, and a stratified multistage sampling technique was used. In the first stage, the entire study population was categorized into four major groups: doctors, nurses/ midwives, pharmacists and allied healthcare professionals. In the second stage, each of the professional groups was further split into smaller subgroups to enable proportionate and representative sampling. Under the category of doctors, the strata included interns, medical officers, postgraduate student doctors, dentists and clinical specialists. The category of nurses included intern nurses, intern midwives, nursing assistants, enrolled nurses, registered nurses, nursing officers and clinical postgraduate nurses. The category of pharmacists included intern pharmacists, clinical pharmacy postgraduate students and pharmacists, whereas the category of allied healthcare professionals included clinical officers, radiographers, physiotherapists, laboratory technicians / technologists, laboratory technology postgraduate students, anaesthetists, dental officers, orthopaedic officers, occupational therapists and pharmacy technicians. The number (P) of staff recruited from each stratum was calculated as follows: P= number of staff in specific strata/total number of HCWs (627) * 422

Recruitment of participants

An updated list of all healthcare workers categorized by cadre was obtained from the hospital and the university

human resource department. A list of all clinical postgraduate students was obtained from the Faculty of Medicine. The names of the staff/postgraduate students from the different strata to be recruited were selected through random sampling using Microsoft Excel. The individual was then approached at his or her workstation as indicated on the staff list. Those who agreed to participate in the study were requested to fill in a written informed consent form, whereas for those who did not give consent or who postponed appointments more than four times, the immediate next person on the list who had not been initially selected by random sampling was considered.

Data collection procedure

Data collection was performed over two months, from May 2024 to June 2024. The data collection tools used included a questionnaire, a Keeler 3.6 V professional streak retinoscope, a torch, a refraction set, a trial frame, a pinhole, an occluder, a Keeler direct ophthalmoscope (UK make), a 6-meter Snellen visual acuity chart, a focimeter (GDJ-1 Manual Lens meter) and an N-notation near visual acuity chart. Screening for eligibility was performed by a research assistant who inquired about the history of corneal refractive surgeries and examined the eyes with a torch and a direct ophthalmoscope to look for any dense media opacities and a red reflex, after which visual acuity was assessed in a well-lit area close to the individual's workstation.

Uncorrected visual acuity of each eye was measured using a 6-meter Snellen visual acuity chart with the participant standing at a distance of 6 meters from the chart. The visual acuity of individuals with spectacles was tested with and without spectacles. Spectacle users who achieved visual acuity of 6/6 with their current correction, and did not also report any visual symptoms were not subjected to refraction, but we determined the type of lens in their current spectacles using a lens meter. Both spectacle and non spectacle users with visual acuity worse than 6/6 were subjected to a pinhole test. Those whose visual acuity improved with pinhole by at least one line were requested to move to the designated place within the hospital for objective refraction using a retinoscope in a dark room and then subjective refraction to achieve the best corrected visual acuity. Refraction was performed by the principal investigator and confirmed by an experienced optometrist. Individuals with visual acuity of 6/6 or better but with symptoms of refractive errors such as blurry vision, frequent headaches, difficulty reading at far or near, abnormal tearing or itching were also subjected to both objective and subjective refraction. Both values of objective and subjective refraction were recorded, but the latter were considered for analysis. Individuals with visual acuity worse than 6/6 who did not improve with pinhole were advised to seek care at the University Tertiary Eye Centre for detailed assessment.

All participants aged 35 years and above had their near vision tested binocularly at 40 cm using an N-notation near visual acuity chart[11] . The distance from the patient's eyes to the near vision acuity chart was measured using a tape measure. Individuals with near vision correction spectacles (readers) were tested while they were wearing them. Individuals who achieved vision of N8 or better were allowed to continue with their routine activities. Participants whose near vision was worse than N8 underwent subjective refraction using convex lenses to achieve the best corrected binocular near visual acuity.

A refractive error was diagnosed when one or more of the following was present in one or both eyes[10]:

a) *Myopia*: If the spherical error was at least -0.5 diopters (D).
b) *Hyperopia*: If the spherical error was at least +0.5 dioptres (D).
c) *Astigmatism*: If the cylindrical error was at least 0.50 D
d) *Presbyopia*: W as present if near vision at 40 cm was worse than N8, that improves with convex lens addition[11].

Data entry and analysis

The data were entered into Epi info version 7, data cleaning was performed, and the data were then imported into STATA version 17.0. During the analysis, the pharmacists were categorized as allied healthcare workers since they were few in number.

The overall prevalence of refractive errors was determined as the number of individuals (participant level) with refractive errors out of the total number of participants screened and expressed as a percentage. An individual was considered to have a refractive error if one or both eyes had any of the above mentioned spherical, cylindrical or near vision errors.

To determine the percentage of each specific refractive error, we used the number of eyes with a specific refractive error out of the total number of eyes with refractive errors. Frequencies were also presented.

Factors associated with refractive errors were analysed with chi square tests and then logistic regression. Factors with $p < 0.1$ were further analysed using multivariable univariate analyses. Factors that were significant with a p value ≤ 0.05 were considered to be independently associated with refractive errors. Frequencies, percentages, Unadjusted Odd Ratios (UORs), 95% CIs, Adjusted Odd Ratios (AORs) and corresponding p values are presented.

The study obtained clearance from the Department of Ophthalmology of Mbarara University of Science and Technology (MUST), the Faculty Research Committee (FRC) at Faculty of Medicine, and ethical approval from the Research Ethics Committee (REC) of Mbarara University of Science and Technology (REC Number MUST-2024-1441). Administrative clearance

was sought from Mbarara Regional Referral Hospital. Heads of different departments at MRRH were notified about the study. Informed consent was also obtained from all participants.

RESULTS

Participant characteristics

Table 1: Sociodemographic characteristics of the patients (N=422)

Characteristics	Category	Frequency	
		No.	(%)
Gender	Male	230	54.5
	Female	192	45.5
Age (years) M =	<40	326	77.3
34.6, SD = 8.2	40+	96	22.7
Education level	Certificate	49	11.6
	Diploma	80	19.0
	Bachelors	222	52.6
	≥Masters	71	16.8
Designation	Doctor*	196	46.4
	Nurse/Midwife	144	34.1
	Allied health workers	82	19.4
Daily tasks	Far	160	37.9
	Near	262	62.1
Leisure activities	≤3 hours indoor/outdoor	66	15.6
	>3 hours outdoor only	73	17.3
	>3 hours indoor only	172	40.8
	Both	111	26.3
Use of electronic	None	20	4.7
gadgets	Phone	31	7.3
	Computer	65	15.4
	Both	306	72.5

Table 2: Medical and ophthalmic characteristics (N = 422)

		Frequency	
Characteristics	Category	No.	(%)
Family history of refractive errors	None	194	46.0
	One parent	91	21.6
	Both parents	50	11.8
	Siblings	48	11.4
	Parent (s) and siblings	39	9.2
Diabetes mellitus	No	419	99.3
	Yes	3	0.7
Cataract	No	411	97.4
	Yes	11	2.6

Visual impairment according to better eye	Normal (6/6-6/12)	387	91.7
	Mild (<6/12 -6/18)	23	5.4
	Moderate (<6/18-6/60)	12	2.8
	Severe (<6/60-3/60)	0	0
Spectacle use	No	370	87.7
	Yes	52	12.3

Prevalence of refractive errors among healthcare workers at Mbarara Regional Referral Hospital: Among the 422 healthcare workers at Mbarara Regional Referral Hospital, the overall prevalence of distance refractive errors was 137 (30.1%) while overall prevalence of presbyopia was 51 (12.1%). A total of 110 (26.1%) participants had only distance refractive errors, 34 (8.0%) had presbyopia only, and 17 (4.0%) had both distance errors and presbyopia. Age specific prevalence of presbyopia among individuals aged 35 years and above was 32.9% (51/155).

Types of refractive errors among healthcare workers at Mbarara Regional Referral Hospital: Among the 844 eyes of the 422 healthcare workers, 235 had at least one distance refractive error.

Table 3: Types of refractive errors among healthcare workers at Mbarara Regional Referral Hospital

Refractive errors	Types	Frequency	(%)
Distance refractive error (n=235 eyes)			
	Myopia	96	40.9
	Hyperopia	30	12.8
	Astigmatism	109	46.4
Near vision (n=155 participants)	Presbyopia	51	32.9

** The denominator for presbyopia are individuals aged 35 years and above.

Of the 161 healthcare workers with refractive errors, 38 (23.6%) were using medically prescribed spectacles while 76.4% were not. Eight (5%) of healthcare workers with refractive errors were using spectacles with incorrect power.

Factors associated with refractive errors among healthcare workers at Mbarara Regional Referral Hospital

Table 4: Bivariable analysis of factors associated with refractive errors among health workers at Mbarara Regional Referral Hospital (N=422)

Factors		Emmetropia N=261	Ametropia N=161	UOR (95%CI)	P
Gender	Male	148 (56.7)	82 (50.9)	1	
	Female	113 (43.3)	79 (49.1)	1.3 (0.9-1.9)	0.248
Age (years)	<40	228 (87.4)	98 (60.9)	1	
	≥40	33 (12.6)	63 (39.1)	4.4 (2.7-7.2)	<0.001*
Education level	Certificate	35 (13.4)	14 (8.7)	1	
	Diploma	47 (18.0)	33 (20.5)	1.8 (0.8-3.8)	0.100
	Bachelors	143 (54.8)	79 (49.1)	1.4 (0.7-2.7)	0.400
	≥Masters	36 (13.8)	35 (21.7)	2.4 (1.1-5.3)	<0.001*

Designation	Doctor	122 (46.7)	74 (46.0)	1	
	Nurse/Midwife	93 (35.6)	51 (31.7)	0.9 (0.6-1.4)	0.659
	Allied healthcare workers	46 (17.6)	36 (22.4)	1.3 (0.8-2.2)	0.340
Daily tasks	Far	99 (37.9)	61 (37.9)	1	
	Near	162 (62.1)	100 (62.1)	1.0 (0.7-1.5)	0.993
Leisure	≤3 hrs indoor/outdoor	36 (13.8)	30 (18.6)	1	
	>3 hours outdoor only	48 (18.4)	25 (15.5)	0.6 (0.3-1.2)	0.178
	>3 hours indoor only	112 (42.9)	60 (37.3)	0.6 (0.4-1.1)	0.133
	Both	65 (24.9)	46 (28.6)	0.8 (0.5-1.6)	0.602
Use of electronic gadgets	None	7 (2.7)	13 (8.1)	1	
	Phone	23 (8.8)	8 (5.0)	0.3 (0.1-0.7)	0.007*
	Computer	28 (10.7)	37 (23.0)	0.7 (0.3-2.0)	0.522
	Both	203 (77.8)	103 (64.0)	0.3 (0.1-0.7)	0.007*
Family history of refractive errors	None	128 (49.0)	66 (41.0)	1	
	One parent	58 (22.2)	33 (20.5)	1.1 (0.7-1.9)	0.711
	Both parents	27 (10.3)	23 (14.3)	1.7 (0.9-3.1)	0.119
	Siblings	29 (11.1)	19 (11.8)	1.3 (0.7-2.4)	0.470
	Parent/Siblings	19 (7.3%)	20 (12.4%)	2.0 (1.0-4.1)	0.044*
Diabetes	No	259 (99.2)	160 (99.4)	1	
	Yes	2(0.8)	1(0.6)	0.8 (0.1-9.0)	0.863
Cataract	No	260 (99.6)	151 (93.8)	1	
	Yes	1 (0.4)	10 (6.2)	17.2 (2.2- 135.8)	0.007*

Table 5: Multivariable regression analysis results of factors associated with refractive errors among healthcare workers at Mbarara Regional Referral Hospital

Factors		AOR (95% CI)	P-value
Age (years)	< 40	1	
	≥40	3.5 (2.0-6.0)	<0.001*
Education level	Certificate	1	
	Diploma	2.7 (1.1-6.5)	0.034*
	Bachelor's	2.4 (1.0-5.7)	0.044*
	≥Masters	3.2 (1.2-8.4)	0.017*
Family history of refractive errors	None	1	
	One parent	1.1 (0.6-2.0)	0.675
	Both parents	1.9 (0.9-3.7)	0.077
	Siblings	1.2 (0.6-2.4)	0.698
	Parent (s) and siblings	2.1 (1.0-4.4)	0.050*

*p≤0.05

Age, education level, use of electronic devices, family history of spectacle use, and cataract diagnosis were significantly associated with refractive errors ($p \leq 0.05$). These variables were considered in the multivariable logistic regression analyses.

DISCUSSION

This cross-sectional study at Mbarara Regional Referral Hospital reported a 30.1% prevalence of distance refractive errors among healthcare workers. The prevalence of 30.1% is comparable to that reported in a cross-sectional study among university staff in Nigeria, which reported a prevalence of 32.9%[21]. Several studies also reported a prevalence that was much lower than that reported in our study. A study among employees of Tehran Medical University in Iran revealed a prevalence of 15.7%[8] while another in Nigeria reported a prevalence of 22.3%[10]. There is no published local study among healthcare workers to compare this prevalence. Therefore, this higher prevalence of refractive errors compared to that reported in a similar population calls for urgent attention, routine screening and treatment where needed.

Unfortunately, spectacle use among individuals with refractive errors was very low at 23.6%. This is much lower than the global target of effective refractive error coverage of 65%[22]. Multiple other studies have reported low levels of spectacle use with a number of reasons listed such as lack of awareness[23,24], no felt need for spectacles[25]. A self-reported study assessing knowledge about refractive errors among physicians also found that a number did not have knowledge about refractive errors or even their correction[26]. It is therefore important to sensitise health care workers about refractive errors and the need to have correct spectacles. In this study, astigmatism was the most common distance refractive error at 46.4%. In a study conducted among university staff in Nigeria aged 18-82 years, astigmatism was the most common refractive error, followed by hyperopia. On the contrary, a study among healthcare workers reported astigmatism as the less common error representing 3.6% of the population. In our study, myopia was the second most common distance refractive error, contributing to 40.9% of distance refractive errors, more among individuals less than 40 years of age, and among individuals who reported having a bachelor's degree as the highest level of education. The latter population was mostly composed of postgraduate doctors, nurses, and pharmacists who are currently in their active phase of study. A study among medical doctors in India reported that Myopia was diagnosed among more than half (57.2%) of the participants, and this was associated with near work (reading, writing). Similarly, 62% of our study participants reported that they carried out near work for most of the day and this could possibly explain the presence of myopia among this population though in our study, near work was not a statistically significant factor, possibly due to reporting inconsistencies.

The age- specific prevalence of presbyopia among individuals aged 35 years and above was 32.9% (51/155). A study conducted among healthcare workers in a tertiary hospital in north western Nigeria among individuals aged 35--57 years reported a prevalence of 42.1%. A local population-based study conducted in Kamuli district in Uganda by Nsubuga *et al.*[24] reported a higher prevalence of 50.3% among individuals aged 35 years and above. The lower prevalence of presbyopia among healthcare workers than among the general population could be explained by differences in population characteristics, such as occupational exposure like near work, which may affect the manifestation of presbyopia.

This study revealed that healthcare workers aged 40 years and above, those with education beyond the certificate level, and individuals with a family history of refractive errors had increased odds of being diagnosed with refractive errors.

Age greater than 40 years was significantly associated with refractive errors with a p-value of less than 0.001. Similarly, in a cross-sectional population-based study carried out in individuals older than 15 years in Tanzania, refractive errors were found to be more common among individuals older than 40 years (OR 1.60, 95% CI: 1.14 to 2.25) [27], and similar findings were reported by Dandona *et al* [28]. This can be attributed to the age-related physiological changes that occur in the lens and zonules, leading to reduced accommodation and changes in the refractive state[29].

Education level above the certificate was significantly associated with refractive errors, with individuals with a master's level and above being 3.2 times more likely to have a refractive error than individuals with a certificate level. A bidirectional, two-sample Mendelian randomization revealed that every year of education was associated with more myopic error and with a causal relationship[30]. Several other studies have reported a positive association between education level and the development of myopia[31,32]. With higher levels of education, one spends more hours doing near work, which may predispose them to refractive errors[5].

Individuals with a known family history of refractive errors were more likely to have refractive errors than were those with no known family history. Molecular studies have revealed a strong association between refractive errors and genetics; therefore, refractive errors can be inherited[33]. A study conducted in Iran among staff in an academic center also revealed a significant association between positive family history and distance refractive errors[8].

This study therefore highlights the burden of refractive errors among healthcare workers and the fact that they should be periodically screened for refractive errors as part of the licensure process.

CONCLUSIONS

The prevalence of distance refractive errors among healthcare workers at MRRH was 30.1% while the age specific prevalence for presbyopia was 32.9%.

Astigmatism was the most common distance refractive error, followed by myopia. Healthcare workers aged 40 years and above, those with education beyond the certificate level, and individuals with a family history of refractive errors had increased odds of being diagnosed with refractive errors.

Strength

This is the first study done among healthcare workers in Uganda to determine their refractive status. This study is therefore a strong basis for further research among this population. The study also further demonstrates the need to routinely refract individuals with ocular symptoms despite good visual acuity.

Limitation

(a) Being a cross sectional study, the results of this study do not establish causal relationship.
(b) Due to the special population of participants recruited in this study, the results of this study may not be generalised to other hospitals that may not have such a diverse population.
(c) Non response bias from staff who were available at duty station but not willing to participate in the study. This may have led to lower prevalence of refractive errors especially if these individuals already had an idea about their refractive status.
(d) Response bias; Since the participants are healthcare workers, they could have responded to questions inaccurately hence skewing the responses to their desired side.

Recommendations

(a) Healthcare workers aged 40 years and older and individuals with a positive family history of refractive errors should undergo regular eye screenings.
(b) Key stakeholders should prioritize and implement routine eye screening for refractive errors among healthcare workers and ensure timely interventions are provided.
(c) A follow-up study is recommended to evaluate the impact of refractive errors on the work performance of healthcare workers and reasons behind the low spectacle use.

Funding: AMB was supported by Christian Blind Mission Scholarship Program. The funding organisation was not involved in the design, collection, analysis and review of this manuscript.

Consent for publication: All authors have read and approved the final version of this manuscript.

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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

Declaration: This manuscript has not been submitted to any other journal or being considered for publication elsewhere. However, this work was presented at Mbarara University of Science and Technology as part of the requirement of award of a postgraduate degree of Medicine in Ophthalmology and also presented at the COECSA congress in Ethiopia on 20th August, 2025.

Author's contributions: AMB, TDS, SN, JO conceived the design. AMB, SN, AE, SA, JO analysed the data and discussed the results. All authors reviewed the versions and have approved the final manuscript.

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Patients perception of quality eye care service delivery at Menelik II Tertiary Hospital, Addis Ababa, Ethiopia

Asrat TJ[1], Alemayehu WT[1], Ashiyana N[2], Ageru KA[3]

[1]Department of Ophthalmology, Addis Ababa University, Ethiopia
[2]King Edward Memorial Hospital, Mumbai, India, Senior Technical Advisor: Ophthalmic Training and Research/ Cure Blindness Project
[3]Strategic Initiatives / Cure Blindness Project, Addis Ababa, Ethiopia

Corresponding author: Dr. Asrat Tadesse Jembere, Department of Ophthalmology, Addis Ababa University**.** Ethiopia. Email: asratbducr7a@gmail.com

ABSTRACT

Background: Patient perception is a critical indicator of health system performance and an essential component of patient centred care.
Objective: This study assessed patients' and caregivers' perceptions of the quality of eye care services and identify factors associated with patient satisfaction.
Methods: A hospital-based cross-sectional study was conducted from September 2025 to January 2026 among adult patients and caregivers with eye conditions. A total of 422 participants were enrolled using systematic random sampling. Data were collected through face to face exit interviews using a WHO-standardized questionnaire assessing effectiveness, efficiency, acceptability, equity, safety, and overall satisfaction. Data were analysed using SPSS version 30. Multivariate logistic regression analysis was performed.
Results: About 56.8% of respondents reported being satisfied with the eye care services, while 73.9% of patients perceived improvement in their eye condition. Only 66.4% participants reported receiving clear explanations regarding diagnosis and treatment. Prolonged waiting times were common, with 81.0% waiting more than one hour (95% CI: 76.9-84.6). Factors independently associated with patient satisfaction were waiting time less than one hour (AOR = 2.8; 95% CI: 1.7-4.6), clear explanation of the disease and treatment (AOR = 3.4; 95% CI: 2.1-5.3), respectful staff behavior (AOR = 2.9; 95% CI: 1.8-4.7), and comfortable environment (AOR = 2.2; 95% CI: 1.4-3.6).
Conclusion: The perceived quality of eye care service is moderate. Addressing prolonged waiting time and strengthening patient-centred communication are essential to improving service quality with little extra resource requirement.

Key words: Quality health care, Quality eye care, Patient satisfaction, Patient perception, Quality framework

INTRODUCTION

While global and national efforts to expand access to eye care services have intensified, the quality of these services as experienced by patients has received comparatively less attention, particularly in Low and Middle Income Countries (LMICs) such as Ethiopia[1]. Eye care delivery in these settings is often constrained by limited resources, high patient volumes, prolonged waiting times, and systemic inefficiencies, all of which may negatively affect patient satisfaction and service utilisation[2,3]. Patient perception of service quality is a key indicator of healthcare system performance and informs quality improvement initiatives[2, 4]. In eye care, patient-centred quality is increasingly recognized as essential for improving adherence to treatment and achieving optimal clinical outcomes [1,5].

Menelik II Comprehensive Specialized Hospital in Addis Ababa, provides ophthalmic services to thousands of adult and paediatric patients each year. Despite this high service demand, no structured assessment of patient satisfaction or perceived quality of eye care services has previously been conducted at this facility. Evidence from similar settings indicates that improving technical quality alone is insufficient to achieve high-quality care without addressing patient-centred dimensions such as communication, respect, and involvement in decision-making[6]. Understanding how adult patients and caregivers of paediatric patients perceive the quality of eye care services is therefore essential for identifying service gaps, guiding targeted quality improvement interventions, enhancing patient adherence, and informing hospital management as well as national eye health policy and planning[7, 8].

This study aimed to assess patients' and caregivers' perceptions of the quality of eye care services at Menelik II Comprehensive Specialized Hospital, to identify factors associated with patient satisfaction, and to evaluate service quality across WHO quality of care domains.

MATERIALS AND METHODS

Study design and population: A hospital-based cross-sectional study was conducted from September 2025 to January 2026 at Menelik II Comprehensive Specialized Hospital, Addis Ababa, Ethiopia. The hospital is the national referral center for ophthalmic care and provides comprehensive outpatient, inpatient, surgical, and subspecialty eye services to a large and diverse patient population. The study population included adult patients receiving eye care services and caregivers of paediatric patients attending the ophthalmology outpatient and inpatient departments during the study period.

Sample size determination: The sample size was determined using the single population proportion formula, assuming a satisfaction proportion of 50% due to the absence of prior similar studies, with a 95% confidence interval and a 5% margin of error.

$$n=\frac{z^2\frac{0}{7}\,p(1-p)}{d^2}$$

Where:

n = required sample size

Z = 1.96 (95% confidence level)

p = 0.5

d = 0.05

The calculated sample size was 384. After adding a 10% non-response rate, the final sample size became 422 participants.

Sampling technique: A systematic random sampling technique was employed. Based on patient flow during the study period, an average of approximately 2,100 patients attended the ophthalmology services monthly. The sampling interval (k) was calculated as:

$K=N/n=2100/422=5$

Accordingly, every 5th eligible patient or caregiver was selected after a randomly chosen starting point within the first five participants each day.

Study variables

The dependent variable: Is patients' perceived quality of eye care service delivery (patient satisfaction).

*The independent variables***:** Include **s**ociodemographic characteristics: age, sex, residence, educational level, and occupation.

Service-related characteristics: Waiting time, accessibility, availability of services, cleanliness of the facility, privacy, and cost of services.

Provider-related factors: Communication, explanation of diagnosis and treatment, staff courtesy, respect, and patient involvement in decision-making.

Operational definitions

*Perceived quality of eye care services***:** The overall judgment by the patient or caregiver regarding the eye care received, including interpersonal, technical, and environmental aspects of care.

*Patient satisfaction***:** The degree to which patients' or caregivers' expectations regarding eye care services were met, measured using a Likert-scale-based WHO patient satisfaction questionnaire.

High satisfaction: An overall satisfaction score ≥75% or responses indicating "satisfied" or "very satisfied" across most service domains.

Low satisfaction: An overall satisfaction score <75% or responses indicating "neutral," "dissatisfied," or "very dissatisfied" on key service domains.

Caregiver: A parent or legal guardian accompanying and providing consent for a paediatric patient (under 18 years).

Data collection procedure

Data were collected using a WHO patient satisfaction questionnaire adapted from the WHO Quality of Care Framework and the SERVQUAL model. The questionnaire assessed multiple dimensions of service quality, including effectiveness, efficiency, acceptability, equity, safety, waiting time, communication, provider behavior, cleanliness of the facility, privacy, patient involvement, and overall satisfaction. The tool was adapted to the local context and pre-tested on 5% of the sample at a similar facility, and internal consistency was assessed using Cronbach's alpha (≥0.7 considered acceptable). Trained data collectors conducted face to face exit interviews in a private setting after patients completed their consultation or were discharged. Informed consent was obtained prior to data collection, and data collectors provided clarification, when necessary, without influencing participants' responses.

Qualitative component

A qualitative component was included through open-ended questions embedded in the questionnaire,

allowing participants to describe positive experiences and challenges in their own words. Responses were thematically analyzed manually, and key themes were summarized to complement quantitative findings.

Data quality assurance

- Data collectors and supervisors received training prior to the commencement of data collection.
- Continuous supervision was conducted throughout the data collection period.
- Completed questionnaires were reviewed daily for completeness and consistency.

Data processing and analysis

Data were coded and entered into EpiData version 4.6 and exported to SPSS version 30 for analysis. Descriptive statistics, including frequencies, percentages, means, and standard deviations used to summarize participant characteristics and satisfaction levels.

Bivariate analysis using the chi-square test was conducted to identify factors associated with patient satisfaction. Variables with a p-value <0.25 in bivariate analysis were entered into a multivariate logistic regression model. Statistical significance was declared at $p < 0.05$.

Ethical considerations

Ethical clearance obtained from the Institutional Review Board of Addis Ababa University, Department of Ophthalmology. Informed consent obtained from all participants prior to data collection. Confidentiality was ensured by excluding personal identifiers, and participation was voluntary.

RESULTS

Socio-demographic characteristics of participants

A total of 422 participants included in the study. Among these 302 (71.6%) were adult patients receiving eye care services, while 120 (28.4%) were caregivers accompanying paediatric patients. The mean age of adult participants was 44.8 ± 15.6 years. Male participants constituted 214 (50.7%), showing an almost equal gender distribution. Regarding place of residence, 258 (61.1%) participants were urban residents. Fifty three percent of study participants were illiterate (Table 1).

Table 1: Socio demographic characteristics of study participants

Variable	Category	Frequency (n)	(%)
Sex	Male	214	50.7
	Female	208	49.3
Age in years	18-39	68	16.1
	40-49	160	37.9
	50-59	108	25.6
	≥60	86	20.4
Educational level	Illiterate	146	34.6
	Read and write	78	18.5
	Primary education	63	14.9
	Secondary education	95	22.5
	College and above	40	9.5
Residence	Urban	258	61.1
	Sub-urban	115	27.3
	Rural	49	11.6
Occupation	Government employer	116	44.4
	Farmer	98	27.8
	Merchant	72	13.2
	Housewife	66	8.5
	Daily laborer	42	3.9
	Student	28	2.2
	Total	422	100

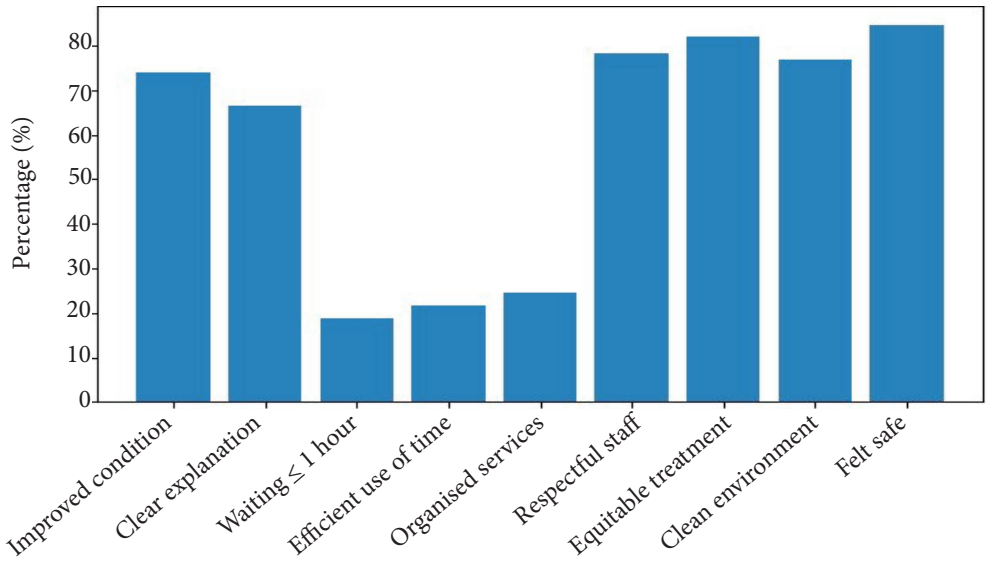
Perception of quality of eye care services by domain

Effectiveness and communication: Most respondents reported that the treatment or service they received resulted in an improvement in their eye condition (73.9%; 95% CI: 69.6%-78.0%). However, only 66.4% (95% CI: 61.8%-70.8%) of participants reported receiving clear explanations regarding their diagnosis and treatment plan, while 33.6% perceived explanations as unclear or inadequate. In addition, 295 respondents (69.9%; 95% CI: 65.4%-74.2%) reported that they were given clear instructions on how to take their medications or follow the recommended treatment, whereas 127 (30.1%) indicated that instructions were unclear or not provided (Tables 2, 3 and Figure 1).

Table 2: Perception of quality of eye care service domains by gender

Variable	Category	Male n (%)	Female n (%)	Total n (%)
Waiting time	< 1 hour	40 (18.7)	40 (18.7)	80 (18.9)
	> 1 hour	174 (81.3)	168 (81.1)	342 (81.1)
Clear explanation of diagnosis	Yes	140 (65.4)	140 (67.0)	280 (66.4)
	No	74 (34.6)	68 (33.0)	142 (33.6)
Medication instruction clear	Yes	150 (70.1)	145 (69.7)	295 (69.9)
	No	64 (29.9)	63 (30.3)	127 (30.1)
Time used efficiently	Yes	45 (21.0)	47 (22.6)	92 (21.8)
	No	162 (75.7)	140 (67.3)	302 (71.6)
Service organized	Yes	50 (23.4)	54 (25.9)	104 (24.6)
	No	164 (76.6)	154 (74.0)	318 (75.4)
Respectful staff	Yes	165 (77.1)	166 (79.9)	331 (78.4)
	No/Mixed	49 (22.9)	42 (20.1)	91 (21.6)
Clean environment	Yes	158 (73.8)	166 (79.9)	324 (76.8)
	No	56 (26.2)	42 (20.1)	98 (23.2)
Treated equally	Yes	176 (82.2)	171 (82.1)	347 (82.1)
	No/Unsure	38 (17.8)	37 (17.8)	75 (17.9)
Total		214	208	422 (100 %)

Figure 1: A clustered bar chart: Perception of quality of eye care services by domain



Efficiency and waiting time: Regarding waiting time before consultation, only 80 (18.9%) participants (95% CI: 15.3%- 22.9%) were seen by a physician within one hour of arrival, including 14 (3.3%) who were seen within 30 minutes and 66 (15.6%) who waited between 30 minutes and one hour. In contrast, 342 (81.0%) participants (95% CI: 77.1% - 84.7%) waited more than one hour before consultation, with 130 (30.8%) waiting between one and two hours and 212 (50.2%) waiting more than two hours (Tables 2, 3 and Figure 1).

Regarding perceived efficiency of service delivery, only 92 (21.8%) respondents (95% CI: 18.0%-26.0%) felt that their time was used efficiently during the hospital visit, while 302 (71.6%) (95% CI: 67.2%-75.7%) reported that their time was not used efficiently. The remaining 28 (6.6%) participants were unsure. Only 104 (24.6%) participants (95% CI: 20.6%-28.9%) reported that registration, consultation, and investigation procedures were organized and well-coordinated, whereas the majority, 318 (75.4%), reported poor coordination of services (Tables 2, 3 and Figure 1).

In terms of accessibility, 174 (41.2%) respondents reported that reaching the hospital was very easy, while 168 (39.8%) reported moderate ease and 80 (19.0%) described as difficult. Regarding affordability, 112 (26.5%) participants (95% CI: 22.4%-30.9%) reported experiencing challenges in affording the services provided, while 310 (73.5%) reported no financial difficulty. Concerning service availability, only 104 (16.6%) respondents (95% CI: 13.2%-20.5%) reported that all required services were available on-site. Partial availability was reported by 248 (24.6%) participants, while 70 (16.6%) reported that some required services were not available (Tables 2, 3 and Figure 1).

Acceptability and patient-centredness: Regarding staff behaviour, 331 (78.4%) respondents reported that healthcare providers were respectful and courteous, while 56 (13.3%) described the interaction as mixed and 35 (8.3%) reported disrespectful behavior. In terms of involvement in care, only 298 (70.6%) participants felt involved in decision-making related to their treatment, whereas 124 (29.4%) reported not involved. With respect to cultural and religious considerations, 358 (84.8%) respondents indicated that their cultural or religious needs were respected, while 64 (15.2%) reported that these needs were not adequately respected (Tables 2, 3 and Figure 1).

Equity and safety: Regarding equity, 347 (82.1%) participants reported that they were treated equally regardless of their background, while 50 (11.8%) reported unequal treatment and 25 (5.9%) were unsure. In line with this, 50 (11.8%) participants experienced some form of discrimination, whereas 372 (88.2%) did not.

Concerning safety and hospital environment, 324 (76.8%) respondents perceived the waiting areas and clinics, as clean and hygienic, while 98 (23.2%) reported dissatisfaction with sanitation, overcrowding, or comfort. Regarding information on treatment risks or side effects, 289 (68.5%) participants reported being informed, whereas 133 (31.5%) were not. Overall, 357 (84.6%) participants felt safe during their eye care experience, 39 (9.2%) did not feel safe, and 26 (6.2%) were unsure (Tables 2, 3 and Figure 1).

Overall satisfaction with eye care services: Overall, 240 (56.8%) of respondents reported being either satisfied or very satisfied with the eye care services provided, while 182 (43.2%) reported dissatisfaction to varying degrees. Accordingly, 290 (68.7%) participants stated that they recommend the hospital's eye care services to friends or family members, while 132 (31.3%) indicated they would not recommend the services.

Factors associated with patient satisfaction: Bivariate analysis identified several factors associated with overall satisfaction, including waiting time, clarity of explanation, staff courtesy, cleanliness of the facility, and history of previous visits. Bivariate analysis was initially conducted, and variables with $p < 0.25$ were entered into a multivariate logistic regression model. Table 3 presents the results of the multivariate logistic regression analysis, showing Adjusted Odds Ratios (AOR).

Table 3: Factors associated with overall patients satisfaction (N=422)

Variable	Category	No.	(%)	AOR (95%CI)	P-value
Waiting time	< 1 hour	80	18.9	2.8 (1.7-4.6)	< 0.001
	> 1 hour	342	81.1	1 (Ref)	-
Clear explanation of diagnosis	Yes	280	66.4	3.4 (2.1-5.3)	<0.001
	No	142	33.6	1 (Ref)	-
Clear medication instruction	Yes	295	69.9	2.6 (1.7-4.1)	<0.001
	No	127	30.1	1 (Ref)	-

Time used efficiently	Yes	92	21.8	2.9 (1.8-4.6)	<0.001
	No	302	71.6	1 (Ref)	-
	Unsure	28	6.6	-	-
Service organized	Yes	104	24.6	2.4 (1.6-3.8)	<0.001
	No	318	75.4	1 (Ref)	-
Respectful staff	Yes	331	78.4	2.9 (1.8-4.7)	<0.001
	No/Mixed	91	21.6	1 (Ref)	-
Clean environment	Yes	324	76.8	2.2 (1.4-3.6)	<0.001
	No	98	23.2	1 (Ref)	-
Treated equally	Yes	347	82.1	2.1 (1.2-3.6)	<0.001
	No/Unsure	75	17.9	1 (Ref)	

Qualitative findings (open-ended responses): Participants highlighted strengths of the eye care services, like:

- Perceived technical competence of ophthalmologists.
- Relative affordability compared to private facilities.

Commonly reported challenges include prolonged waiting times, poor communication at registration and pharmacy units, overcrowding, and insufficient information regarding procedures and follow-up care.

DISCUSSION

This study examined patients' and caregivers' perceptions of the quality of eye care services at Menelik II Comprehensive Specialized Hospital across multiple WHO quality domains. The findings indicate a moderate level of overall satisfaction, with important strengths in perceived clinical effectiveness and provider behaviour, but marked deficiencies in efficiency, communication, and service organisation.

Overall satisfaction in the study was 56.8% (95% CI: 52.0%–61.5%), and about 68.7% (95% CI: 64.3%–73.1%) of participants reported that they would recommend the hospital to others. This level of satisfaction is lower than that reported from Jimma University Medical Centre[9], where approximately 68% of patients were satisfied with ophthalmic outpatient services, and substantially lower than satisfaction levels reported from tertiary eye hospitals in India[3,10], where satisfaction frequently exceeds 80%. Compared to the study conducted at Jimma University Medical Center (68% satisfaction), the present study reported lower satisfaction (56.8%), which may be explained by the higher patient volume at Menelik II Comprehensive Specialized Hospital as a national referral center, the longer waiting times observed in this study, and differences in service organisation and patient flow. The lower satisfaction observed in the present study may therefore reflect the heavy patient load and system-level constraints typical of public referral hospitals in low-resource settings[3,9,10].

Perceived effectiveness of care is relatively high, with 73.9% (95% CI: 69.7%-78.1%) of participants reporting improvement in their eye condition after receiving care. This finding is consistent with studies from India (82%)[3] and China (78%)[11], where perceived clinical improvement strongly predicted patient satisfaction. Despite this, communication-related aspects of care is suboptimal. Only 66.4% of participants receive clear explanations regarding their diagnosis and treatment plan, and 69.9% report receiving clear instructions on medication use or follow-up. Similar communication gaps reported in studies from South Africa (63%)[12] and Tanzania (61%)[13], where inadequate explanation and counselling negatively affect patient satisfaction despite acceptable clinical outcomes.

Efficiency is the poorest-performing domain in the study. More than four-fifths of participants wait longer than one hour before consultation, and half wait more than two hours. Additionally, 71.6% of respondents felt that their time was not used efficiently, and 75.4% reported poor coordination of registration, consultation, and investigation services. These findings are consistent with reports from public hospitals in Ethiopia[14] and other sub-Saharan African countries[15], where prolonged waiting times and fragmented service delivery are common causes of dissatisfaction. In contrast, studies from better-resourced eye care systems demonstrate significantly higher satisfaction with short waiting times and service flow is streamlined[5].

Acceptability of care rated relatively favourably, with 78.4% (95% CI: 74.5%-82.3%) of participants reporting respectful and courteous behavior from healthcare providers. This aligns with findings from Jimma, Ethiopia (76%)[9] and Tanzania (74%)[13], where interpersonal aspects of care are often rated more positively than organisational efficiency. However, patient-centredness

remain incomplete, as nearly one-third report not being involved in decisions about their care. Similar limitations in shared decision-making documented in Egypt[16] and Ethiopia[14,15], particularly in high-volume public hospitals.

Equity-related findings show that 82.1% (95% CI:78.5%-85.7%) of participants perceive equal treatment regardless of background, comparable to reports from Addis Ababa public hospitals (around 80%)[14]. Nevertheless, 11.8% (95% CI: 8.7%-14.9%) report experiencing discrimination. Safety indicators are generally positive, with 76.8% (95% CI: 72.8%-80.8%) reporting the hospital environment as clean and hygienic and 84.6% (95% CI: 81.2%-88.0%) feeling safe during care.

These findings are similar to studies from South Africa (78% of patients rated facility cleanliness positively)[12] and Tanzania (75% of respondents expressed satisfaction with facility cleanliness)[13], where cleanliness and perceived safety were significant contributors to satisfaction. However, the fact that nearly one-third of participants not informed about potential treatment risks or side effects highlights gaps in informed consent practices, an issue also noted in other low-resource settings[13-15].

Shorter waiting time, clear explanation of diagnosis and treatment, respectful staff behavior, and a clean and comfortable environment are independent predictors of high satisfaction. These determinants are consistent with evidence from systematic reviews and multicenter studies, which emphasize that both interpersonal communication and service organization are critical drivers of patient satisfaction in eye care services[17].

Qualitative findings support the quantitative results. Participants value the technical competence of ophthalmologists and the affordability of services compared to private facilities, similar to reports from India[10] and Ethiopia[14]. Prolonged waiting times, poor communication at registration and pharmacy units, overcrowding, and inadequate information regarding procedures and follow up care identified as key challenges, consistent with findings from India, South Africa, Tanzania, and Ethiopia[10,12-15].

CONCLUSION AND RECOMMENDATIONS

Prolonged waiting times, poor coordination of services, limited patient involvement in decision-making, and incomplete communication regarding diagnosis, treatment, and potential risks are major contributors to dissatisfaction. Overall satisfaction is strongly influenced by modifiable factors such as waiting time, clarity of explanation, staff courtesy, and cleanliness of the facility. Reducing waiting times through improved appointment systems, patient flow optimization, and better use of allied eye health personnel is essential. Strengthening communication, shared decision-making, and culturally sensitive care will further enhance patient satisfaction.

ACKNOWLEDGMENT

We would like to acknowledge the Cure Blindness Project for their financial support. We would like to express our sincere gratitude to Addis Ababa University, and Menelik II Hospital for providing the institutional support necessary for the conduct of this research. We are also grateful to the nurses who generously assisted during patient recruitment and data collection. Finally, we extend our heartfelt appreciation to study participants for their willingness to participate.

Grants: Cure Blindness Project, Addis Ababa, Ethiopia.

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Predictors of response to intravitreal bevacizumab in diabetic macular edema: A prospective study at a National Hospital in Tanzania

Masuki H, Haji Z

Department of Ophthalmology, School of Clinical Medicine, Muhimbili University of Health and Allied Sciences, Tanzania

Corresponding author: Dr. Heavenlight Masuki, Department of Ophthalmology, Muhimbili University of Health and allied Sciences, P.O. Box 65001, Dar es Salaam, Tanzania. Email: sukiheven@gmail.com

ABSTRACT

Objective: To assess the clinical outcomes and predictors of response to Intravitreal Bevacizumab Injections (IVB) in patients with diabetic macular edema at Muhimbili National Hospital (MNH).

Methodology: A prospective longitudinal study was conducted at MNH over a 6-month period. Patients received monthly IVB (1.25mg/0.05mL) for three consecutive months. Baseline and post-treatment assessments included ocular examination, spectral-domain Optical Coherence Tomography (OCT), and laboratory investigations. Main outcome measures were changes in Best-Corrected Visual Acuity (BCVA, logMAR) and Central Macular Thickness (CMT, µm) at 12 weeks. Data were analysed using SPSS v25 with paired t-test and linear regression, and $p < 0.05$ was considered statistically significant.

Results: Of the 60 patients analysed, 58.3% were male, with a median age of 60.5 years (IQR, 44 years). More than half (56.7%) had been living with diabetes for 11–20 years, and 83.3% had an HbA1c level >7%. Baseline mean BCVA was 0.876 ± 0.592 logMAR, and mean CMT was 453.02 ± 71.94µm. At 12 weeks, mean BCVA improved by 0.216 ± 0.523 logMAR ($p = 0.002$), equivalent to a >10-letter gain, and mean CMT decreased by 95.78 ± 57.65 µm ($p < 0.001$). Longer diabetes duration was significantly associated with less CMT reduction, with each additional year corresponding to a 0.434µm increase in CMT ($p = 0.003$). Elevated HbA1c also predicted poor anatomical response, with each 1% increase associated with a 0.434µm increase in CMT ($p = 0.003$).

Conclusion: Three intravitreal bevacizumab injections resulted in a significant reduction in diabetic macular edema, marked by a decrease in central macular thickness and accompanied by a significant improvement in mean best-corrected visual acuity. Longer diabetes duration and poor glycemic control are associated with a poorer anatomical response, highlighting the importance of integrated diabetes management and structured treatment protocols in resource-limited settings.

Key words: Bevacizumab, Intravitreal injection, Diabetic macular edema, Diabetic retinopathy

INTRODUCTION

Diabetic Macular Edema (DME) is a leading cause of central visual impairment among patients with diabetic retinopathy, with a reported global prevalence of approximately 6.8%[1]. In sub-Saharan Africa, prevalence estimates vary, ranging from 3.2% in South Africa and 4.1% in Kenya to 15.4% in Tanzania[1,2]. These figures are expected to rise in parallel with the increasing burden of diabetes mellitus and improved life expectancy among affected individuals. It is estimated that approximately 25–30% of patients with diabetes will develop DME during their lifetime[3]. If left untreated, DME progressively impairs central vision, leading to visual deterioration ranging from mild visual impairment to blindness. This loss of visual function significantly affects personal independence, economic productivity, and overall quality of life[3].

Given its substantial clinical and socioeconomic impact, timely diagnosis and effective management of DME remain critical priorities, particularly in low-resource settings. Diagnosis is based on clinical history and detailed ophthalmic examination, with Optical Coherence Tomography (OCT) playing a crucial role in confirming the diagnosis, assessing disease severity, and monitoring treatment response. The mainstay of treatment is intravitreal injection of anti–Vascular Endothelial Growth Factor (anti-VEGF) agents. However, other treatment modalities, including laser photocoagulation, corticosteroids, and vitreoretinal surgery, may also be considered depending on the clinical context[4].

Bevacizumab is a recombinant humanised monoclonal immunoglobulin G1 antibody that inhibits Vascular Endothelial Growth Factor (VEGF), thereby reducing vascular permeability and macular edema[5]. Due to its relatively low cost, bevacizumab is widely used as a

first-line anti-VEGF agent in many clinical settings, often administered with fewer injections than those recommended in Randomised Controlled Trials (RCTs)[5]. Previous studies have shown that visual outcomes following Intravitreal Bevacizumab (IVB) injections are influenced by baseline visual acuity, with poorer baseline vision associated with reduced visual gains[6]. Additionally, reductions in Central Macular Thickness (CMT) following IVB treatment have been associated with significant improvements in visual acuity[5].

However, treatment response to IVB remains variable, with a subset of patients demonstrating persistent DME despite repeated injections[7]. This heterogeneity in response is influenced by several systemic factors, including diabetes duration, glycemic control, blood pressure, renal function, and lipid profile. These factors play important roles not only in the pathogenesis and progression of DME but also in determining both anatomical and functional responses to anti-VEGF therapy[6].

At Muhimbili National Hospital (MNH), a significant number of patients with DME are routinely managed, with IVB injections serving as the primary treatment modality for over a decade. Despite its widespread use, there is limited local evidence on treatment outcomes and predictors of response in this setting. Therefore, this study aims to evaluate clinical outcomes-both functional (Best-Corrected Visual Acuity, BCVA) and anatomical (Central Macular Thickness, CMT)-and predictors of response to IVB treatment among patients with DME at MNH. Understanding these factors will help individualized treatment, improve clinical decision-making, and better manage patient expectations regarding visual recovery.

MATERIALS AND METHODS

Study design and duration: An observational prospective longitudinal study was conducted from June to December 2022.

Study setting: This study was conducted at Muhimbili National Hospital (MNH), which has a well-established eye department providing tertiary eye care to paediatric and adult patients. Data collection took place at the retina clinic, which sees approximately 40–50 patients per day. The clinic is conducted twice weekly, with an average of one to three new cases of Diabetic Macular Edema (DME) seen per week. Each clinic session is managed by two retina specialists.

Study population: All newly diagnosed patients with diabetic macular edema during the study period.

Inclusion criteria: The study included all newly diagnosed patients with diabetic macular oedema who had Best-Corrected Visual Acuity (BCVA) < 6/9 and CMT > 250μm, and who were planned for intravitreal bevacizumab injection[7].

Exclusion criteria: Patients with coexisting visually significant cataracts, advanced glaucoma, optic atrophy and other retinal diseases.

Data collection procedure: All patients underwent visual acuity (BCVA) assessment using the Snellen visual acuity chart and pinhole before pupil dilation with 0.5% tropicamide eye drops for fundus examination. For statistical analysis, Snellen visual acuity measurements were subsequently converted to logarithm of the Minimum Angle of Resolution (logMAR) values. A comprehensive anterior segment and fundus evaluation was performed by a retina specialist using a slit lamp biomicroscope with 78D and 90D Volk lenses. Patients with features suggestive of diabetic macular edema, i.e., macular thickening with or without hard exudates, were identified.

Newly diagnosed patients with clinical features of DME underwent Optical Coherence Tomography (OCT) using the 3D OCT Maestro1 (Topcon Medical Laser Systems) to quantify Central Macular Thickness (CMT). Patients with significant central macula edema defined as CMT > 250μm and VA < 6/9, who were planned for intravitreal bevacizumab injection, were considered eligible for the study. These patients were approached and informed about the study; those who provided written consent were consecutively recruited.

All enrolled patients underwent blood pressure measurement and baseline laboratory investigations, including glycated haemoglobin (HbA1c), lipid profile (total cholesterol, High-Density Lipoprotein [HDL], Low-Density Lipoprotein [LDL]), and renal function tests (serum creatinine and blood urea nitrogen), prior to intravitreal bevacizumab injection. Patients received counselling on the management of diabetic retinopathy, emphasizing strict glycemic control and lifestyle modifications. In addition, detailed counselling regarding the intravitreal bevacizumab injection procedure was provided.

Under aseptic conditions, all patients received intravitreal bevacizumab injections (1.25 mg/0.05mL). Each patient received three consecutive monthly injections. One month after the third dose, re-assessments were performed, including visual acuity and IOP measurement, dilated fundus examination, OCT, and repeat laboratory tests (HbA1c, lipid profile, and renal function tests).

The decision for additional bevacizumab injections beyond the third dose was based on clinical judgment and OCT findings. However, outcomes following the fourth and subsequent injections were outside the scope of this study.

Data analysis: Data were analysed using the Statistical Package for the Social Sciences (SPSS) software, version 25.0 (IBM Corp., Armonk, NY, USA). A paired t-test was applied to compare mean Central Macular Thickness (CMT) and Best-Corrected Visual Acuity (BCVA) at baseline and three months after Intravitreal Bevacizumab (IVB) treatment. Linear regression analysis was performed to determine factors associated with visual and anatomical outcomes. Statistical significance was defined as a p-value <0.05.

Ethical considerations: Ethical approval for this study was obtained from the Institutional Review Board of Muhimbili University of Health and Allied Sciences (MUHAS). Permission to conduct the study was also granted by the Executive Director of Muhimbili National Hospital. Written informed consent was obtained from all participants prior to enrollment. Participants were informed of their right to withdraw from the study at any time without affecting their standard of care. No financial incentives were provided, and participation posed no additional risk beyond routine treatment. All patients continued their treatment program as clinically indicated, including those who required more than three bevacizumab injections. The study adhered to the principles of the Declaration of Helsinki (1964) and its subsequent amendments.

RESULTS

A total of 69 newly diagnosed patients with diabetic macular edema were initially recruited for the study. Of these, nine patients were excluded from the final analysis due to predefined exclusion criteria: two had advanced glaucoma, two were scheduled for focal laser therapy, four were lost to follow-up, and one voluntarily withdrew from the study. In total, 63 of the 120 eyes were included in the final analysis.

More than half of the patients (35, 58.3%) were male. Half of the participants (30, 50%) were older than 60 years, 29 (48.3%) were aged between 40 and 60 years, and 1 (1.7%) was younger than 40 years. The median age of participants was 60 years (IQR:44). Many 28 (46.7%) participants had attained college or higher education, 19 (31.7%) had secondary education, 9 (15%) primary education, 4 (6.7%) had no formal education. All patients had type 2 diabetes mellitus.

More than half (34, 56.7%) of patients had a diabetes duration of 11-20 years. Baseline Visual Acuity (VA) was worse than 1.0 LogMAR in 23 (38%) patients. Nearly two-thirds (39, 62%) of participants had a baseline central macular thickness of 400-499µm. The majority (50, 83.3%) of patients had elevated HbA1c (Table 1).

Table 1: Clinical characteristics of study participants (N=60)

Characteristic	Frequency	
	No.	(%)
Duration of DM (years)		
5-10	21.0	35.0
11-20	34.0	56.7
>20	5.0	8.3
Best corrected VA (logMAR)		
0.00-0.2	4.0	6.3
0.3-0.5	18.0	28.6
0.6-0.9	18.0	28.6
1.0-1.3	13.0	20.6
>1.3	10.0	15.9
Central macular thickness (µm)		
200-299	0.0	0.0
300-399	11.0	17.5
400-499	39.0	61.9
500-599	8.0	12.7
600-699	3.0	4.8
>700	2.0	3.1

Glycated haemoglobin (HbA1c)		
Normal	10.0	16.7
Elevated	50.0	83.3
Systolic Blood Pressure (SBP) (mmHg)		
≤ 130	24.0	40.0
>130	36.0	60.0
Diastolic Blood Pressure (DBP) (mmHg)		
≤80	36.0	60.0
>80	24.0	40.0
Total cholesterol (mmol/L)		
0-5.17	44.0	73.3
>5.17	16.0	26.7
High density lipoprotein (mmol/L)		
≤1.55	44.0	73.3
>1.55	16.0	26.7
Low density lipoprotein (mmol/L)		
≤3.34	39.0	65.0
>3.34	21.0	35.0
Urea (mmol/L)		
2.5-6.7	52.0	86.7
>6.7	08.0	13.3
Creatinine (µmol/L)		
50.4-98.1	41.0	68.3
>98.1	19.0	31.7

There was a significant improvement in mean logMAR BCVA from 0.876 ± 0.592 at baseline to 0.660 ± 0.589 one month post the 3rd injection ($p < 0.002$).

Similarly, CMT demonstrated a significant reduction from 453.02 ± 71.94µm at baseline to 357.23 ± 65.19µm post-treatment ($p < 0.001$) (Table 2).

Table 2: Mean BCVA and mean CMT at baseline and after three IVB injections (N = 63 eyes)

	Mean (±SD)	Paired t-test	P -value
Mean BCVA at baseline	0.876 (±0.592)	3.199	<0.002
Mean BCVA after 3 IVB injections	0.660 (±0.589)		
Mean change in BCVA	0.216 (±0.523)		
Mean CMT at baseline	453.02 (±71.944)	12.87	<0.001
Mean CMT after 3 IVB injections	357.23 (±65.192)		
Mean change in CMT	95.783 (±57.645)		

P-value generated using the two-tailed t-test; BCVA = Best Corrected Visual Acuity in logMA; IVB = Intra-vitreal Bevacizumab; CMT = Central Macular Thickness

Among patients with normal HbA1c levels, the mean BCVA was 0.553 logMAR, compared to 0.767 logMAR in those with elevated HbA1c levels. Although the BCVA appeared better in patients with tighter glycemic control, the difference was not statistically significant. Similarly, CMT was lower in patients with normal HbA1c (342.53µm) than in those with elevated HbA1c (371.93µm). In contrast, elevated serum creatinine levels (>98.1 µmol/L) were significantly associated with increased CMT. Patients with higher creatinine levels had a mean CMT of 398.65µm, compared with 340.86µm in those with lower creatinine levels (p = 0.019) (Table 3).

Table 3: Factors associated with mean BCVA and mean CMT change after IVB injection (N = 60)

Factor	No. (%)	Mean BCVA (logMAR)	Two- tailed t-test P-value	Mean CMT (microns)	Two- tailed t-test P-value
Duration of DM (years)					
≤10	21 (35.0)	0.695		359.38	0.372
>10	39 (65.0)	0.650	0.163	345.18	
Glycated haemoglobin (HbA1c)					
Normal	30 (50.0)	0.553		342.53	
Elevated	30 (50.0)	0.767	0.163	371.93	0.081
Systolic Blood Pressure (SBP)					
≤130 mmHg	23 (38.3)	0.726		358.48	
>130 mmHg	37 (61.7)	0.619	0.498	356.46	0.908
Diastolic Blood Pressure (DBP)					
≤80 mmHg	45 (75.0)	0.649		353.27	
>80 mmHg	15 (25.0)	0.693	0.803	369.13	0.419
Total cholesterol					
≤5.17 mmol/L	52 (86.7)	0.644		352.69	
>5.17 mmol/L	08 (13.3)	0.763	0.602	386.75	0.171
Low Density Lipoprotein (LDL)					
≤3.34 mmol/L	47 (78.3)	0.638		352.15	
>3.34 mmol/L	13 (21.7)	0.739	0.100	374.62	0.254
High Density Lipoprotein (HDL)					
≤1.55 mmol/L	49 (81.6)	0.627		353.84	
>1.55 mmol/L	11 (18.3)	0.809	0.358	372.36	0.399
Urea					
≤6.7 mmol/L	55 (91.7)	0.636		351.51	
>6.7 mmol/L	05 (08.3)	0.920	0.307	420.20	0.295
Creatinine					
≤98.1 µmol/L	43 (71.7)	0.579		340.86	0.019
>98.1 µmol/L	17 (28.3)	0.864	0.091	398.65	

P-value generated using the two-tailed t-test, CMT = Central Macular Thickness in *µm*; BCVA = Best Corrected Visual Acuity in logMAR

Linear regression analysis following three intravitreal bevacizumab injections revealed that a 1% increase in glycated haemoglobin (HbA1c) was associated with a 0.247 logMAR increase in BCVA, indicating a trend toward poor visual outcomes with higher HbA1c levels. However, this association did not reach statistical significance.

In contrast, a statistically significant relationship was observed between DM duration and CMT. Each additional year of DM duration was associated with a 0.434µm increase in CMT. Similarly, HbA1c levels were significantly associated with CMT changes, where a 1% increase in HbA1c corresponded to a 0.434µm increase in CMT (Table 4).

Table 4: Linear regression analysis of factors associated with change in CMT and BCVA after three IVB injections (N = 60)

	CMT		BCVA	
Factor	Coefficient Beta	P-value	Coefficient Beta	P-value
Duration of DM	0.434	<0.003	-0.054	0.703
HbA1c	0.434	<0.003	0.247	0.108
Systolic BP	-0.035	<0.835	-0.112	0.548
Diastolic BP	0.155	<0.294	0.116	0.471
Total cholesterol	0.199	<0.34	0.236	0.302
HDL	-0.335	<0.094	-0.061	0.778
LDL	-0.125	0.489	-0.25	0.21
Creatinine	-0.382	0.42	-0.43	0.408
Urea	0.704	0.145	0.534	0.311

DISCUSSION

This study aimed to evaluate the functional and anatomical outcomes of Intravitreal Bevacizumab Injection (IVBI) in patients with Diabetic Macular Edema (DME) at Muhimbili National Hospital (MNH) and to identify clinical factors associated with treatment response. DME is a significant vision-threatening condition that commonly affects patients with diabetes and is a leading cause of visual impairment among working-age individuals globally[5]. Due to poor vision, the overall quality of life, productivity, and independence of these patients are affected[5]. IVB injection has demonstrated good visual and structural outcomes in the treatment of DME. Quantitative central macular thickness data from OCT have become commonly used as indicators for decision-making and monitoring disease progression in clinical practice[8].

The results of this study showed a significant improvement in BCVA after three bevacizumab injections. The mean BCVA change was 0.21 LogMAR; this is similar to other studies[2,8,9]. The results differ from those of the study done by Lam *et al.*[10] in Hong Kong. This difference may be explained by variations in baseline visual acuity between the study populations. Patients with poorer baseline visual acuity generally have greater potential for visual gain because they have more room for improvement, whereas patients with relatively better baseline visual acuity may demonstrate smaller gains despite successful treatment.

There was a significant decrease in macular edema at 12 weeks after bevacizumab injections. The mean decrease in central macular thickness in our patients was 95.783µm (±57.645), indicating a favourable anatomical response to treatment. These findings are similar to those of the study by Kabuga *et a.l*[5] in Uganda, which also reported a similar reduction in CMT. The similarity may be explained by comparable baseline characteristics of the study participants, including similar follow-up time, baseline CMT values, mean age, and duration of diabetic mellitus. Different results were reported in a study by Bafaraj *et al.*[9], which showed marked improvement in CMT. The difference in this study is due to a longer follow-up period for participants after three IVB injections. Over time, anti-VEGF continues to bind soluble VEGF, restoring the integrity of the blood-retinal barrier and resulting in a progressive decrease in CMT.

Our study showed that glycemic control is associated with improved BCVA after three IVB injections, whereas a 1-unit increase in HbA1c was associated with a 10-letter decrease in BCVA on the LogMar chart, though this association was not statistically significant. The

finding was consistent with other studies[11-13]. There was a statistically significant association between glycemic control and CMT change, such that a 1% increase in HbA1c was associated with a 0.434 micron increase in CMT. This means that poor blood glucose control leads to reduced CMT. This was consistent with the results of other studies[11,13,14]. Good glycemic control helps slow the progression of DME, thereby improving BCVA and reducing CMT. Chronic hyperglycemia is associated with the accumulation of advanced glycation end products, which disrupt the blood-retinal barrier and break down endothelial cell junctions, resulting in macular oedema.

The macular oedema decreased more in patients with DBP of 80mmHg or lower than in those with DBP above 80mmHg. Linear regression analysis shows that a 1-unit increase in DBP is associated with a 0.116 LogMar-unit decrease in BCVA, but this difference was not statistically significant. There was no statistically significant difference in the mean change in CMT and DBP. Systolic blood pressure was not found to have any statistically significant association with the change in CMT and BCVA after IVB injections. These findings contrast with the study by Janeite *et al.*[6]. High blood pressure decreases retinal perfusion, thereby increasing VEGF production, which leads to DME progression through increased vascular permeability.

Our study showed that patients with shorter diabetes duration experienced a greater reduction in macular edema following three intravitreal bevacizumab injections than those with longer diabetes duration. Linear regression analysis demonstrated a significant association between longer diabetes duration and poorer anatomical response, as reflected by less reduction in central macular thickness. However, there was no statistically significant association between diabetes duration and change in best-corrected visual acuity. These findings are similar to those of the study by Wong *et al.*[14]. The long duration of diabetes results in continuous microvascular damage, which, in turn, increases vascular permeability, thereby facilitating the progression of DME. Minimal improvement in BCVA may reflect damage to ganglion cells resulting from macular oedema.

This study shows an association between hyperlipidemia and visual acuity and structural outcomes: participants with normal total cholesterol levels showed improvements in BCVA and CMT after IVB injection, though the association was not statistically significant. The results also show that no statistically significant association was found between high- and low-density lipoprotein and BCVA or CMT change among study participants. Similar findings were reported in the study by Chew *et al.*[15] in the ETDRS report 22 and in Das *et al*.[16]. This can be attributed to the normalization of lipid levels, which reduces retinal leakage and exudate deposition, thereby decreasing CMT.

There was a statistically significant decrease in mean central macular thickness among participants with normal creatinine levels compared with those with high creatinine levels. There was no statistically significant association between changes in BCVA and creatinine levels. This finding differs from that reported in a study by Wong *et al*.[14]. Participants with high urea levels showed less improvement in BCVA post-IVB injections, with a 1-unit increase in urea level resulting in a 0.534 logMAR worsening in BCVA. On the other hand, patients with high urea levels showed less improvement in CMT than those with normal urea levels, although this difference was not statistically significant. These findings differed from those of Woodward *et al*.[17]. Impaired renal function disrupts the osmotic balance in the kidney, promoting Blood-Retinal Barrier (BRB) vascular damage and increasing macular oedema, leading to a poor treatment response.

Strengths and limitations of the study

The strength of the study is its prospective follow-up of each participant to assess the outcome of a single-agent injection. The limitation of the study is that patients were followed for only three months; further prospective studies with longer follow-up are needed.

CONCLUSION

Three intravitreal bevacizumab injections resulted in a significant reduction in diabetic macular oedema, as evidenced by decreased central macular thickness and a significant improvement in mean best-corrected visual acuity. Longer diabetes duration and poor glycemic control are associated with a poorer anatomical response, highlighting the importance of integrated diabetes management and structured treatment protocols in resource-limited settings.

Funding: The research was not funded.

Consent for publication: All the authors provided consent for the submission of this manuscript for publication.

Availability of data and materials: The original full article is available with the author and at Muhimbili University Library. Any additional data or information required may be obtained by contacting the corresponding author.

Competing interests: The authors declare no conflict of interest.

Authors' contributions: Masuki H and Haji Z participated in conception, research design, data collection, data analysis and interpretation as well as drafting of this manuscript.

ACKNOWLEDGMENT

We acknowledge the support we got from all members of Eye Department from Muhimbili University and Muhimbili National Hospital for making this work possible.

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