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Editorial: Revolutionising glaucoma care in Africa: Online circular contrast perimetry

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ABSTRACT

Glaucoma is a leading cause of irreversible blindness worldwide. Sadly, most glaucoma cases in Africa are undetected, with late presentation resulting in irreversible vision loss. Visual field testing is critical to diagnose and monitor glaucoma. Online circular contrast perimetry allows visual field testing on any computer or tablet with no additional hardware, allowing rapid, low cost and easily available testing for glaucoma. Such technology reduces the cost and expands the scope of glaucoma diagnosis and monitoring and could be used for population screening in Africa.

INTRODUCTION

Glaucoma is a leading cause of irreversible blindness worldwide, with cases expected to rise dramatically in the coming decades. By 2040, an estimated 111.8 million people globally will be affected by glaucoma, with disproportionate impacts in Asia and Africa[1]. In low-resource settings like many African countries, lack of access to eyecare often leaves glaucoma undiagnosed or inadequately treated. This represents a tragic missed opportunity, as early detection and proper management can prevent blindness in many cases[2].

Visual field testing is critical for diagnosing glaucoma and monitoring disease progression. However, conventional perimetry machines used for visual field testing are expensive, bulky, and often unavailable outside of major hospitals in Africa. This lack of accessible testing equipment contributes significantly to high rates of undetected glaucoma across the continent despite numerous efforts from governments, local and international organisations. Additionally, Africa's rapidly growing population, exacerbates the demand for alternative glaucoma testing strategies, with online perimetry being a leading solution.

Online perimetry has recently been developed to enhance both accessibility and affordability, bringing these testing close to patient and in developing settings. One notable innovation is the Online Circular Contrast Perimetry (OCCP, Eyeonic), which has been the first of its kind to be tested in East Africa. This test allows patients to conduct visual field assessment of the 24-2, 10-2, 30-2 and driving test, using internet web application on any computer or tablet with similar results to the standard automated perimety. This innovative, cloud-based application developed by a team of Australian researchers lead by Ophthalmologist A/ Prof Simon Skalicky whose passion is to provide evidence based glaucoma care to all through global research. By making visual field testing more accessible, affordable, and user-friendly, OCCP has the potential to revolutionise glaucoma screening and care across Africa. This article will explore how online perimetry can improve glaucoma care in Africa, increasing eye health outcomes across the continent.

The birth of online circular contrast perimetry

The journey to develop OCCP began in 2019, when A/ Prof Simon Skalicky became increasingly aware of the limitations of conventional testing of glaucoma. COVID-19 has significantly disrupted patient follow-up and monitoring practices. The pandemic necessitated reduced in-person visits, leaving many patients without regular check-ups and proper disease management. This unexpected challenge prompted A/Prof. Skalicky.

There needed to be a way to make visual field testing more accessible, efficient, and enjoyable for patients, while still being clinically accurate and cost-effective.

Inspired by the success of telemedicine and remote healthcare delivery, Skalicky envisioned an online visual field application that could provide testing on any internet-connected computer or tablet. This would offer several key advantages:

1. Improved patient convenience by reducing required clinic visits
2. Streamlined clinic operations and reduced waiting room congestion
3. Expanded access to screening in rural and low-resource areas
4. More frequent monitoring for high-risk patients
5. Reduced patient anxiety around testing
6. Cost-effectiveness compared to conventional machines

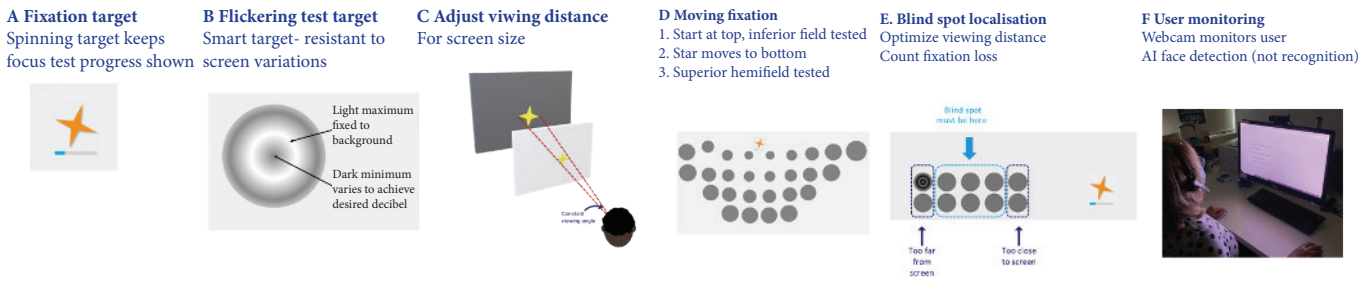
After extensive development and optimization, with support from the Microsoft for Startups program, the OCCP prototype was born. This online visual field test can be operated via any standard web browser on any computer.

Figure 1: Use of online circular contrast perimetry globally

How Online Circular Contrast Perimetry works

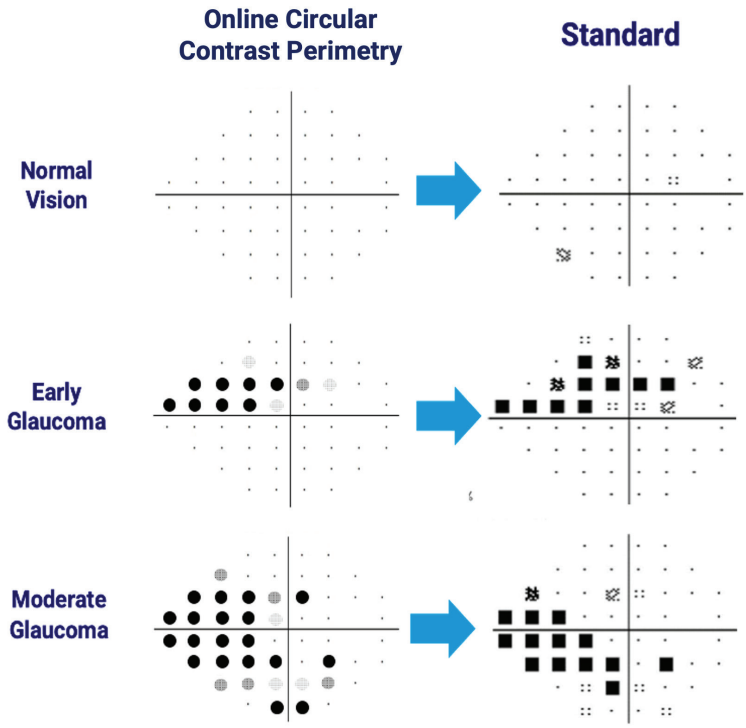
OCCP assesses 52 points over 24 degrees of visual field eccentricity (10-degree and 30-degree strategies are also available). Users are presented with a series of flickering targets consisting of alternating light and dark rings. They fixate on a spinning golden star in the centre of the screen and click when they see the flickering target in the peripheral vision. The test maps the user's blind spots and uses webcam monitoring with facial detection AI to track head position and ensure proper fixation. Verbal cues and audio feedback guide the user throughout the 3-5 minute test. Multiple languages are made available to remove language barriers for non-English-speaking patients. Importantly, Eyeonic does not require any additional hardware or equipment support beyond a standard computer or tablet.

Figure 2: The features of online circular contrast perimetry, from A to F, allowing online visual field testing on any computer or tablet



The AI-powered software analyses the results and produces detailed visual field maps and metrics comparable to conventional perimetry output. In validation studies[3-5], OCCP has demonstrated strong diagnostic accuracy similar to Standard Automated Perimetry (SAP), with high levels of agreement, reliability and repeatability. Figure 3 compares OCCP (Eyeonic) and SAP for patient with normal, early and moderate glaucoma. Eyeonic is able to detect field defect comparable to that from conventional perimetry.

Figure 3: Online circular contrast perimetry (left) visual field test result compared with SAP (right)



Addressing the need in Africa

The potential for OCCP to address gaps in glaucoma care became even clearer when A/Prof Skalicky connected with Dr. Deus Bigirimana, an ophthalmologist from Burundi who had relocated to Melbourne. Dr. Bigirimana was passionate about improving glaucoma services in Africa and painfully aware of how sparse testing resources were in African hospitals.

In many African regions, visual field testing was non-existent in routine clinical care, available only in some large urban Eye hospitals or private practices. He saw immense potential for the Eyeonic technology to revolutionise glaucoma screening and monitoring across Africa by eliminating the need for expensive, stationary perimetry machines.

This insight led to connecting A/Prof Skalicky with key collaborators in Uganda - Dr. Honorine Nizeyimana, an ophthalmology trainee, and her supervisor Dr. Simon Arunga, a respected lecturer at Mbarara University of Science and Technology and Assistant Professor at London School of Hygiene and Tropical Medicine. Together, they initiated a research project to validate the Eyeonic technology in the African context.

Validation study in Uganda

In 2022, the team in Uganda began a study aiming to collect data on 180 consecutive patients attending the university hospital. The goal was to compare results from the online OCCP visual field test to conventional visual field testing.

Despite challenges and pivots, the team persevered and continued recruiting patients and collecting data. By June 2024, data from 184 patients had been collected. The data is strong – showing OCCP via a computer to be as good as, and potentially better than, conventional visual field testing. The team is now preparing to publish their findings, which could have major implications for expanding visual field-testing access across Africa.

Figure 4: Summary statistics of Eyeonic online visual field testing compared to machine-based visual field testing among adult patients (n=184) at Mbarara University and Referral Hospital Eye Centre (MURHEC)

Visual Field Metric	Sensitivity (95% CI)	Specificity (95% CI)	AUC (95% CI)
MD	87.5 (75.9 - 94.8)	85.9 (78.7 - 91.4)	0.87 (0.81 - 0.92)
PSD	88.2 (63.6 - 98.5)	84.4 (78.0 - 89.6)	0.86 (0.78 - 0.95)
VI	73.9 (51.6 - 89.8)	87.0 (80.8 - 91.7)	0.80 (0.71 - 0.90)

MD: Mean Deviation; PSD: Pattern Standard Deviation; VI: Visual Index; AUC: Area under the Curve; CI: Confidence Interval.

Analysis of the above comparative data reveals promising performance metrics for the Eyeonic online visual field test when benchmarked against conventional machine-based testing. Using the global visual field indices of Mean Deviation (MD), Pattern Standard Deviation (PSD) and Visual Index (VI) the Eyeonic test demonstrated robust specificity, exceeding 80% for MD, PSD, and VI. Sensitivity was similarly impressive, surpassing 80% for both MD and PSD.

The AUC, a comprehensive metric combining sensitivity and specificity, showed strong results across all parameters: 0.87 for MD, 0.86 for PSD, and 0.80 for VI.

These findings indicate that OCCP may offer comparable sensitivity and specificity to conventional machine-based tests in detecting visual field defects.

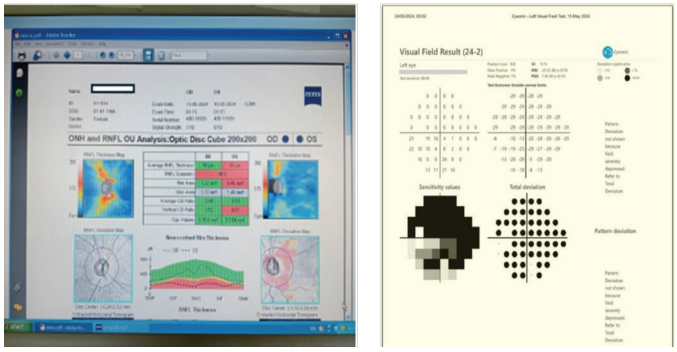
Real-world implementation

In 2023 A/Prof Skalicky was invited as an international speaker to the South African Glaucoma Congress to introduce the technology and discuss its applicability in Africa. Having received official endorsement by the SAGS committee, the test is now used routinely in many optometry and ophthalmology practices in South Africa. Similarly in Ghana, where A/Prof Skalicky had the privilege of addressing members of the Ghanaian Ophthalmology, Optometry and Ophthalmic Nurses association about Online Visual Field Testing, dozens of clinicians have signed up to the system and are using it in their routine clinical practices.

The team has also partnered with the Oromia Health Bureau in Ethiopia to work on the revolutionary Online Visual Field Test. Oromia is the largest and the most populous region in Ethiopia and Oromia Regional Health Bureau is one of the major sector bureaus in the region responsible for providing a comprehensive package of preventive, promotive, curative, and rehabilitative health services to the community at large through decentralised and democratised health system in collaboration with all stakeholders. Oromia Health Bureau is working closely with Eyeonic to deliver the Online Visual Field application to improve the availability of diagnosis and management for glaucoma. Following a successful pilot study involving a team of nine ophthalmologists in Oromia now using the Eyeonic Online Visual Field application in Oromia hospitals, the plan is to roll it into the major hospitals and remote clinics throughout Oromia.

In one illustrative case of a 46-year-old female in Oromia, the patient was evaluated with asymmetric findings suggestive of glaucoma in the left eye. Visual acuity and intra-ocular pressure were 6/6 and 14 mmHg in RE, and 6/9- and 24-mm HG in LE, respectively. The vertical cup to disc ratio was 0.3 and 0.9 in RE and LE respectively.

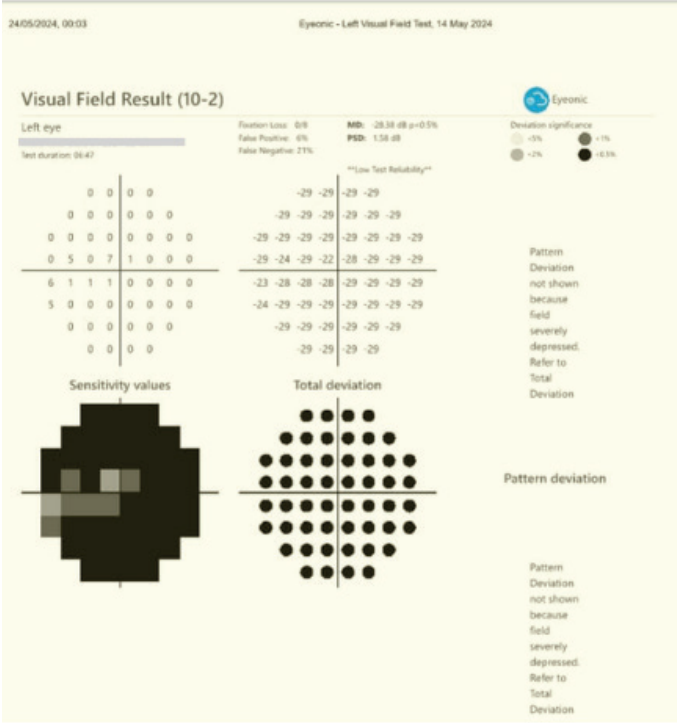
Figure 5: OCT of the RNFL, severely affected nerve in left eye



The 24-2 online visual field test (OCCP) showed severe visual field loss in the left eye, while the right eye test was normal. These results were consistent with the generalised thinning of the retinal nerve fibre layer (RNFL) in LE.

As the central 4 points are affected in the 24-degree field, it is therefore necessary to perform a central 10-2 OCCP test, which gives better assessment of the central 10-degree field for localised defects. Results are shown in Figure 6.

Figure 6: Left eye central 10-2: severe loss of vision



This case highlights OCCP's ability to detect severe glaucomatous damage and provide consistent, comprehensive visual field assessment across different test strategies. By providing detailed, quantitative visual field data using computers or tablets for visual field testing, it empowers clinicians to more accurately diagnose glaucoma and monitor progression over time that was previously unavailable in many African clinical settings.

Expanding access across Africa

The successful implementation in Uganda, South Africa, Ghana and Ethiopia has generated excitement about the potential to expand access to visual field testing across Africa. Unlike conventional perimetry machines which cost tens of thousands of dollars, require specialised maintenance, and take up significant clinic space, OCCP can be deployed anywhere there is a computer and internet connection. The low cost and ease of implementation make it feasible to dramatically increase the availability of visual field testing across Africa. This could enable earlier detection of glaucoma through expanded community screening programs, more frequent monitoring of patients, even in remote areas, improved clinical decision, and reduced burden on tertiary eye care centres by enabling follow-up testing locally.

In Uganda, East Africa, Dr. Arunga is already working to integrate the OCCP application into a new social enterprise hospital and network of glaucoma screening centres in Uganda. This model could be replicated in other African countries to rapidly scale up access to visual field testing. Such a program is also being planned in Western Francophone Africa. Cote D'Ivoire, where Eyeonic's impact also emerges, addressing critical needs in glaucoma care.

Driving licence standards

Road safety is a critical issue globally and ensuring motor vehicle drivers have adequate vision for road driving is a key part of achieving this. At-risk individuals require a binocular wide field Esterman visual field test to ensure they have sufficient field of vision for driving. Up until now this required access to a traditional visual field machine which are few and far-between in Africa. However, the OCCP system also offers a binocular suprathreshold visual field test online, with sufficient width of field for licencing requirements, and can be performed on any computer. The ease and accessibility of the system has led to Eyeonic being chosen by a leading research team in Senegal to evaluate truck drivers' binocular visual field for a landmark nationwide road safety study.

Combined with its success in Uganda, Ethiopia, Ghana and South Africa, OCCP's expansion into countries like Côte d'Ivoire and Senegal demonstrates its growing presence and potential impact across Africa. The technology's ability to provide accessible, cost-effective visual field testing is proving valuable in addressing the continent's significant eye care challenges, particularly in regions with limited resources and high glaucoma prevalence.

Patient experience and acceptance

Beyond the clinical benefits, studies have shown that patients generally find the online test more comfortable, less stressful, and more user-friendly than traditional visual field testing[3].

The familiar computer interface, the ability to take breaks if needed, and the progress bar indication reduce anxiety for many patients. The option for home-based testing is also highly valued, as it can reduce travel burden and costs associated with frequent clinic visits.

Patients readily adapt to using OCCP despite varying levels of computer literacy. The simple interface and clear audio instructions allowed even elderly patients and those with limited technology experience to successfully complete the tests.

The multi-language voice instruction capability enhances the global applicability in diverse healthcare settings. By offering instructions and interfaces in various languages, the system aims to improve accessibility for patients and healthcare workers across different linguistic backgrounds. This feature may reduce language-related barriers, potentially enhancing patient comprehension and test administration accuracy. While further research is needed to quantify its impact, this linguistic adaptability may contribute to expanding eye care services in regions where language differences have historically presented challenges. As with any medical technology, the effectiveness of this feature in improving patient outcomes and expanding access to care requires ongoing evaluation and validation in diverse clinical settings.

This high level of patient acceptance is crucial for improving compliance with visual field testing, which is a cornerstone of proper glaucoma management. By making the testing process more convenient and less intimidating, the OCCP online perimetry system may help improve long-term adherence to recommended testing schedules.

Challenges and future directions

While the potential benefits of the OCCP system in Africa are significant, there are some challenges to be considered in the future direction:

(i) Internet connectivity: Reliable internet is needed during the test to upload results and access the cloud-based analysis. This may limit use in some extremely remote areas. An app-based version of the test allowing off-line usage is currently planned for development.

(ii) Computer/tablet access: The test requires basic computing equipment, which may not be universally available in all healthcare settings.

(iii) Training requirements: While the system is user-friendly, some basic training is still needed for healthcare workers to properly administer the test and interpret results.

(iv) Integration with existing workflows: Incorporating a new testing modality into established clinical practices can be challenging.

Despite these challenges, the Eyeonic team is actively working to address them and expand the capabilities of the system. The low cost, high accessibility and high impact potential of the OCCP application make it a promising solution for expanding glaucoma care in resource-limited settings across Africa.

CONCLUSIONS

The OCCP Online Visual Field Test is a transformative technology for addressing the growing burden of glaucoma in Africa. By providing affordable high quality visual field testing, it opens new possibilities for expanded screening, earlier detection of glaucoma, and improved disease monitoring across the continent. Its successful implementation and validation in some African countries demonstrates the feasibility and acceptability of this approach. As the technology continues to be refined and more widely adopted, it has the potential to significantly improve eye care delivery and outcomes for people at risk of glaucoma-related vision loss.

While challenges remain, the OCCP system offers a promising path forward in the fight against glaucoma related blindness in Africa. By leveraging the power of cloud computing, artificial intelligence, and ubiquitous technology, it represents an innovative approach to overcoming long standing barriers to care. As we look to the future, technologies like OCCP will play an increasingly important role in expanding access to high-quality eye care in resource-limited settings. Through continued collaboration between technologists, clinicians, and public health experts, governments, we can work towards a future where preventable vision loss from glaucoma is truly a thing of the past - in Africa and around the world.

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Prevalence and causes of visual impairment among inmates of prison in Tanzania

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ABSTRACT

Background: Ocular disorders are among the causes of morbidity necessitating frequent attendance for medical care worldwide. Prisoners, like any other person, are prone to suffer from any ocular disorder and sometimes are at increased risk of morbidity and visual impairment due to challenges related to access to health care in a prison environment. According to the World Health Organization report on vision, about 2.2 billion people have visual impairment and blindness. The commonest cause of visual impairment among them is uncorrected refractive errors.

Objective: To determine the prevalence and causes of visual impairment among inmates of Isanga prison in Dodoma city, Tanzania.

Methodology: An analytical cross-sectional study employed systematic sampling technique to recruit 274 inmates of Isanga prison in Dodoma city. Data was analyzed by Statistical Package for Social Sciences version 23 (SPSS 23). Ethical approval was granted by Muhimbili University of Health and Allied Sciences Institutional Review Board. Permission to conduct the study was obtained from the Commissioner General of Isanga Prison.

Results: Out of 274 study participants, 85% of them were males with a median age of 45 years. Visual impairment was found in 8% of participants, where 71% had moderate visual impairment. Optic neuropathy was the leading cause (52%) of visual impairment followed by glaucoma and cataract 19% each. Increasing age was the only factor associated with visual impairment in univariate, but not in multivariate analysis.

Conclusion: There was a significant proportion of inmates with visual impairment and the leading causes of visual impairment were optic neuropathy and glaucoma.

Key words: Prevalence, Causes, Visual impairment, Inmates, Prison, Tanzania

INTRODUCTION

Worldwide at least 2.2 billion people have vision impairment and blindness out of which 1 billion could be prevented if detected early, while that of inmates of prison ranges from 1.35% to 11.3% [1-4]. Globally, it has been estimated that everyone will acquire at least one ocular disorder in their lifetime which will require appropriate care, prisoners as any other person are prone to suffer from any ocular disorder and sometimes are at increased risk due to challenges associated with imprisonment[1-3,5].

Imprisonment is associated with several consequences like loss of sense of personhood, self-inflictions, brutalization by other inmates or by guards that can cause several injuries including ocular injuries which can contribute to occurrence of ocular disorders. Prisoners are usually overcrowded which is associated with many health-related problems like spread of infectious disease, delayed health care seeking, lack of individualized treatment which may lead to poor treatment outcomes[6].

Ocular disorders can cause vision impairment which affects quality of life, for example in diseases like cataract, uncorrected refractive error, glaucoma, macular degeneration, corneal opacity, and retinopathy. Occasionally, it causes mortality in the presence of ocular malignant tumors. However, some of these disorders are reversible like in cataract and uncorrected refractive errors if appropriate care is taken but for disorders like glaucoma, macular degeneration and retinopathy are irreversible although if detected and managed early may halt its progression[7-9].

Poor eye health services in prison health facilities are likely to contribute to late detection of asymptomatic ocular disorders and poor treatment outcomes, therefore this study aimed at assessing the proportion and causes of visual impairment among inmates of Isanga prison so as the findings will help policy makers in planning for incorporating eye health services in their health protocol to improve eye care in prison.

Aim of the study: To determine the prevalence and causes of visual impairment among inmates of Isanga prison in Dodoma city, Tanzania.

Research question: What is the prevalence and causes of visual impairment among inmates of Isanga prison in Dodoma city, Tanzania?

MATERIALS AND METHODS

Study design: This was a community based analytical cross-sectional study conducted in September 2021 among adult inmates of prison aged 18 years and above at Isanga prison in Dodoma.

Sample size calculation: The sample size was obtained by the Kish and Leslie and adjusted or corrected for a finite population of Isanga prison which were 1338 inmates.
Formula n= (Nz^2 p(1-p))/ (d^2 (N-1) +Z^2 P(1-P))
Whereby
n = Sample size with finite population correction
N = Size of the population which is 1338
z = 1.96 95% confidence level which is equal to 1.96
p = Proportional of ocular disorders among prisoners found at Ilesa prison in Nigeria = 69.7%
d = Marginal error which is taken to be 3%
Calculated sample size (n) = 262

Sampling technique: Systematic sampling technique was applied to reduce bias and a total of 274-sample size reached.

Inclusion and exclusion criteria: All inmates of Isanga prison aged ≥18 years and willing to participate in the study were included. Extremely weak inmates who were unable to withstand ocular examination and those who had difficulties in communication were excluded.

Variables: Visual impairment as a dependent, was statistically organized as binary variable, with codes of '0' and '1' for absence and presence of the condition, respectively. We studied several independent variables like age, sex, duration in the prison, history of alcohol use, history of drug abuse, history of diabetes and history of hypertension.

Data collection tools: We used a semi structured questionnaire to collect data, literate and illiterate Snellen charts to assess visual acuity. A pinhole test for those with visual acuity of less than 6/18 aided to identify those requiring refraction. Icare tonometer was used to measure intraocular pressure. Blood pressure and weighing machines were used to measure blood pressure and body weight. A glucometer was used to test blood sugar in those suspected to have diabetes mellitus from fundoscopic changes. Examination of the anterior segment was done by a torch and a slit lamp (Haag Streit). The posterior segment was examined by using an indirect ophthalmoscope with 20 and slit lamp biomicroscope with 90D. Refraction was done by retinoscope and trial lenses. Near vision was tested by Jaeger eye chart with M notation at 33cm from the eye.

Data collection procedures: Data collection started with a short history of the participants on demographic characteristics, history of chronic illness like hypertension and diabetes, history of trauma and duration of stay in the prison. Then, visual acuity was assessed using Snellen literate and illiterate E charts and categorized as normal (6/6 - 6/18), moderate visual impairment (<6/18 – 6/60), severe VI (<6/60 – 3/60), and blindness (<6/60 – NPL). The intraocular pressure (IOP) was taken using Icare tonometer and was categorized as normal (10-21mmHg), high (>21mmHg) and low (<10mmHg). Blood pressure and body mass index were checked and recorded for risk factors assessment.

Slit lamp examination was done using Haag Streit slit lamp and a pen torch to assess the abnormalities in the anterior segment such as chalazion, pterygium, corneal opacities, uveitis, and cataract. Assessment of refractive status was done by an optometrist using a retinoscope and trial lenses. Fundus examination for any abnormalities on the vitreous, optic disc and the retina was done using either an overhead indirect ophthalmoscopy or slit lamp with 90D lens. All these examinations were done under the supervision of an experienced ophthalmologist.

Uncomplicated disorders like conjunctivitis were managed on the ground with eye drops. Inmates with the diagnosis of presbyopia were offered reading spectacles but inmates requiring further medical or surgical treatment like chalazion excision, pterygium excision and cataract surgery were referred to Benjamin Mkapa Hospital. All data were recorded in the structured questionnaire.

Data analysis: Data analysis was done by using Statistical Package for The Social Sciences (SPSS) version 23. Descriptive and analytical analysis was done. where odds ratios, 95% confidence intervals, and P-values computed to assess any predictive effect of the demographic characteristics and visual impairment. The P-value of <0.05 was considered statistically significant.

Ethical consideration: Ethical clearance to conduct the study was obtained from the institutional review board of MUHAS. Permission to conduct the study was given by the commissioner general of Isanga prison. Participants were informed comprehensively about the purposes and benefits of the study.

All participants signed an informed consent before recruitment into the study. Serial numbers instead of names of participants were used on the questionnaire and consent forms. Every questionnaire was attached by one copy of informed consent. Those who refused to participate in the study were managed without filling the study questionnaire.

RESULTS

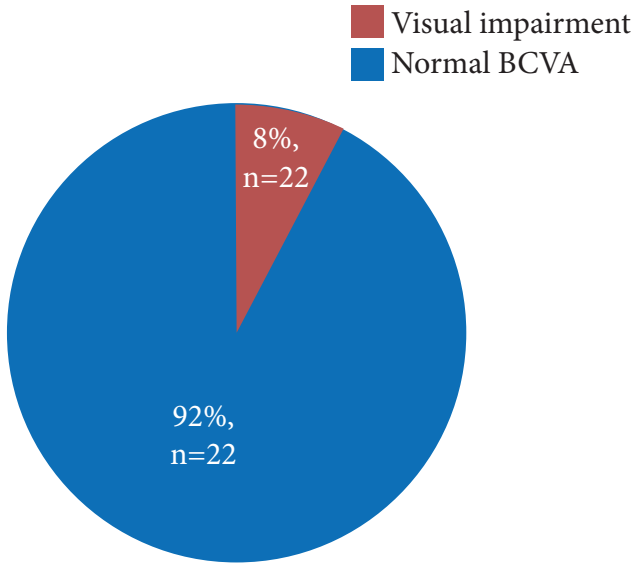
A total of 274 participants were studied and majority of them were males (85%) with a median age of 45 years and most of them (52%) have been in prison for less than 5 years (Table 1).

Table 1: Socio-demographic characteristics of study participants (n = 274)

Characteristic	Frequency	
	No.	(%)
Age group (years)		
18 – 37	96	35.00
38 – 57	129	47.10
>57	49	17.90
Median age in years (Range) 45, (18, 83)		
Sex		
Male	233	52.60
Female	41	47.40
Median duration of stay in prison in years (Range) 4 (1, 46)		

About (8%) of the study participants had visual impairment (Figure 1).

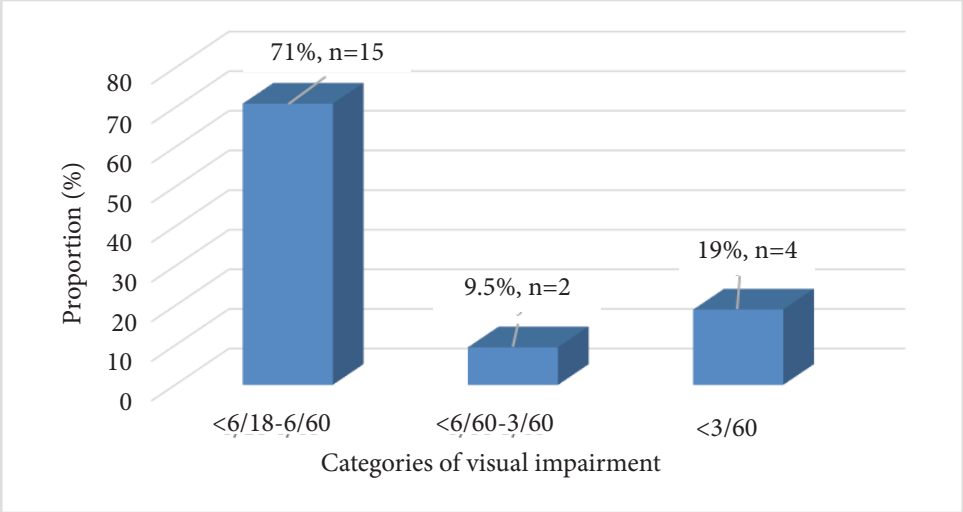
Figure 1: Proportion of visual impairment among study participants, (n=274)



BCVA – Best corrected visual activity

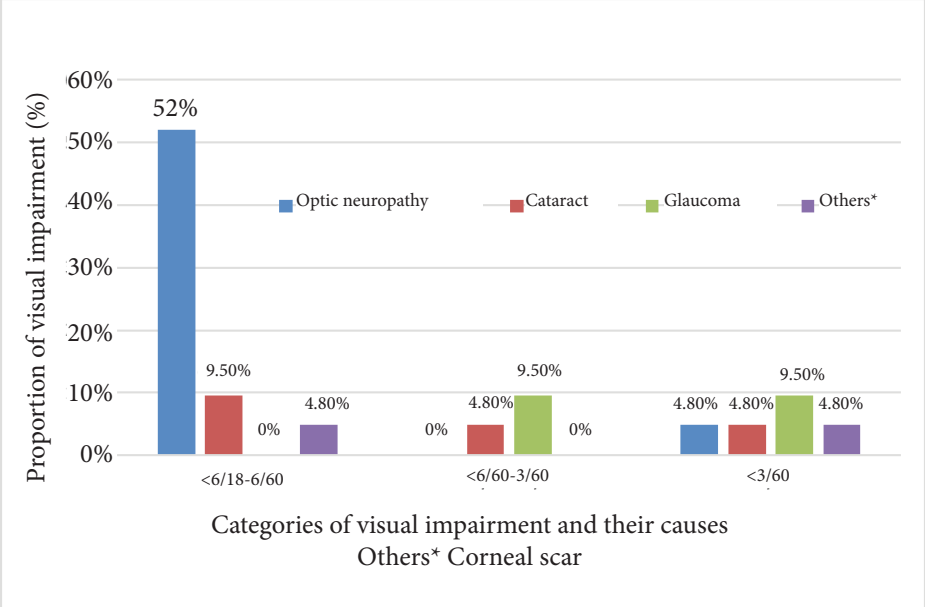
Majority of the participants (71%) with visual impairment had moderate visual impairment (<6/18-6/60) (Figure 2).

Figure 2: Categories of visual impairment among study participants, (n=22)



Most of the study participants with visual impairment (52%) were due to optic neuropathy and had moderate visual impairment (Figure 3).

Figure 3: Causes of visual impairment among study participants by categories of visual impairment (n=22)



DISCUSSION

The proportion of visual impairment among inmates of prison was 8.0% after best correction; those with visual impairment due to refractive error were given spectacle prescription. The proportion of visual impairment was slightly lower than that reported among inmates of one prison in the United States of America where the prevalence was 11.3%[4]. The difference could be because in this study we examined participants and came up with the diagnosis, this avoided over estimation of visual impairment. On the contrary, this proportion is higher than a study from Nigeria by Alexander[3] where visual impairment among inmates of prison was 4.7%, this can be explained partly by the differences in the distribution of study participants where in this study were slightly older than the study from Nigeria.

The identified causes of visual impairment were optic neuropathy, glaucoma, cataract, and corneal scar in that order. Optic neuropathy could be due to insufficient nutrients in the diet they get as it has been documented that inmates of prisons are at high risk of developing micronutrients deficiencies like vitamin A, vitamin B and D[10], on the other side could be due to trauma as has been reported in several publications but also in this study there was a considerable number of trauma before and after imprisonment[4] however its association need to be studied. Glaucoma in this study was found in 2.6% of study participants and ocular hypertension in about 2.2%. The less contribution of cataract in the causes of visual impairment could be explained by two reasons, one is due to demographic distribution of study participants as most of them (more than 82.1%) were less than 60 years old as it has been document that the prevalence of cataract

increases with age, also several programs attend the prison for cataract screening and those indicated for surgery are scheduled to attend base hospitals for the same.

The two conditions require management with ant glaucoma medication. Four patients were already on medication while nine were diagnosed and started on medication. Untreated glaucoma has the potential to cause irreversible blindness, therefore early detection and initiation of appropriate management cannot be overemphasized. Mechanisms to monitor these patients must be set up to ensure they continue with follow up for glaucoma, ocular hypertension, and optic neuropathy.

Limitation

Some investigations like blood tests, perimetry and Optical Coherent Tomography (OCT) were not done, this may over or underestimates some conditions, however clinical findings from history and examination aided to reach the diagnosis.

Participants who had optic neuropathy were not given treatment during the study period, however participants were advised on use of a balanced diet as much as possible but also to attend nearby hospitals for definitive diagnosis and treatment.

Conclusion

There is a considerable proportion of visual impairment among inmates of Isanga prison. The causes of visual impairment among inmates of Isanga prison were optic neuropathy, glaucoma, and cataract.

Recommendations

Establishment of a link between Isanga prison and regional hospital for extension of eye services and ensure constant availability of medication for diseases like glaucoma at prison dispensary. Further studies are needed to identify causes of optic neuropathy among inmates of prison.

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Availability of data and materials: The data are available from the corresponding author upon reasonable request.

Competing interests: The authors declared no conflicts of interest. However, it has been presented in Morogoro during the annual meeting of Tanzania Ophthalmology Society (TOS) in June 2022 and in Lilongwe during the COECSA annual congress in September 2022.

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Prevalence and subtypes of glaucoma in rural *Baso* and *Worena* district, Central Ethiopia

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ABSTRACT

Objective: This study aimed to determine the prevalence and sub-types of glaucoma in the rural communities of *Baso* and *Worena* District in the Amhara region of Central Ethiopia.

Methods: In October 2020, a prospective cross-sectional study was conducted in *Baso* and *Worena* District. The district's total population was 12,489, and a random sample of 405 individuals aged 40 years and above was selected. The principal investigator performed various tests, including a visual acuity test, intraocular pressure measurement, pupillary reaction assessment, handheld slit lamp examination, and fundoscopy. Diagnosed glaucoma patients were transported to Debre-Berhan Hospital, where an experienced ophthalmologist confirmed the diagnosis. Glaucoma was defined and diagnosed using the International Society of Geographical and Epidemiological Ophthalmology criteria as primary open-angle, primary angle-closure, or secondary glaucoma.

Results: Four hundred and five individuals from four villages were examined, and optic disc grading was available for the participants' 399 (98.5%) eyes. Among them, 23 individuals (5.7%) were diagnosed to have glaucoma. Primary open-angle glaucoma (52.3%) and pseudo-exfoliative glaucoma (39.1%) were the most prevalent sub-types. There was one case (4.3%) each of primary angle-closure glaucoma and uveitic glaucoma. In addition to the glaucoma cases, there were three cases of glaucoma suspects and eight cases of pseudoexfoliation syndrome.

Conclusion: The study revealed a high prevalence of glaucoma in *Baso* and *Worena* District, Central Ethiopia. Most cases belonged to the sub-types of primary open-angle glaucoma and pseudoexfoliative glaucoma. These findings highlight the need for a public health approach to address the morbidity and blindness associated with glaucoma in the region.

Key words: Angle-closure glaucoma, Glaucoma, Prevalence, Primary open-angle glaucoma, Pseudoexfoliative glaucoma, Sub-types of glaucoma

INTRODUCTION

Glaucoma, a highly prevalent and impactful condition, is the second most common cause of blindness across the globe. Notably, it is the primary culprit in irreversible blindness, significantly affecting individuals' quality of life worldwide[1]. The issue is particularly more common in sub-Saharan Africa, as evidenced by various population-based studies investigating glaucoma, blindness, and visual impairment. These studies show that approximately 4% of adults aged 40 years and above are impacted by glaucoma. More concern is that this disease is responsible for as much as 15% of all blindness within this demographic. The region, therefore, faces a significant health burden due to this ailment[2,3].

A disturbing trend has emerged in recent decades, with the prevalence of glaucoma worldwide rising dramatically. This rise aligns with the global increase in population and the concurrent aging of that population[4]. In 2013, an estimated 64.3 million people were diagnosed with glaucoma worldwide, which had surged to 76.0 million by 2020. By 2040, projections suggest this number will escalate to a staggering 111.8 million, significantly and disproportionally impacting individuals in Asia and Africa[5]. However, in Africa, there appears to be a discrepancy in reporting rates of glaucoma compared to other conditions leading to blindness. This disparity in reporting might be attributed to the limited diagnostic capabilities for glaucoma in many African surveys, which ultimately skews the global burden data[6]. Several factors dictate the individual likelihood of progressing to blindness from glaucoma. These include the age at which glaucoma initially manifests, the disease's natural progression, access to healthcare services, and the quality of care received. Additionally, the patient's adherence to their prescribed treatment regimen and commitment to necessary follow-up appointments significantly influence their outcomes[7-9].

Emerging evidence suggests that glaucoma manifests at a younger age in the black population and often follows a more aggressive clinical course[3]. This particular racial disparity intensifies the already significant health impact of the disease. In Africa, additional challenges exacerbate the burden of glaucoma. These hurdles include poor

awareness of the illness and subpar access to appropriate medical care, which hinder effective diagnosis and management of the condition. Socioeconomic deprivation only amplifies these issues, resulting in a tendency for individuals to seek treatment much later in the disease's progression, often when significant visual impairment has already occurred[10-12].

Investigating glaucoma within various populations carries significant public health implications. Such studies can elucidate the scale of the disease's impact, which is vital for guiding policy and resource allocation. However, there is a considerable gap in the available literature as no community-based study on glaucoma prevalence has been conducted in Ethiopia. This study addresses this knowledge gap by assessing the extent and the subtypes of glaucoma present in the *Baso* and *Worena* District in Central Ethiopia. Such information is crucial for understanding the disease landscape in this region and can potentially guide early detection and management strategies.

MATERIALS AND METHODS

This research was a cross-sectional, community-based study conducted within the *Baso* and *Worena* District of the Amhara region. It is located at the eastern edge of the Ethiopian highlands in the Semien Shewa Zone, near the town and Woreda of Debre Berhan. The recent census data for the Amhara region indicated the total population of *Baso* and *Worena* was estimated to be 137,365. The Woreda covers 786.5 km² area and there are 30 *kebeles*, of which 88% are rural communities and 35 health facilities.

From a total of 30 *kebeles*, four (*Keyit, Kormargefia, Birbisa, and Goshebado*) were selected randomly using a lottery method. Notably, from each household, one person aged 40 years or older was included in the study population. The principal investigator, the enumerator, and health extension workers discussed how to do house-to-house visits and select eligible individuals. Those who fulfilled the inclusion criteria were made to come to the local health post center where the examination was done.

The study calculated the sample size to be 405, based on the following inputs: target population (137,365); the expected prevalence of blindness in persons 40 years and older of 4%; with a desired precision of 5%, with a 95% confidence level. A fixed number of households was assigned to select from each *kebele* to maintain proportional to the size of each *kebele* selected, contingent on the total population. The first house for sampling in each *kebele* was determined through a coin toss, maintaining a fair and unbiased approach. Subsequently, consecutive houses were sampled until the predetermined sample size for the *kebele* was achieved, and eligible study participants were sent to the nearby health post for ophthalmic assessment and data collection.

Data was collected using a structured format questionnaire with socio-demographic characteristics and ophthalmic examination results. History of diabetes, hypertension, medical treatment of glaucoma, surgery for glaucoma in the past, family history of glaucoma, ocular trauma, and use of steroid medication were collected through interviews using closed questions. Data were analyzed with SPSS version 24, and a p-value of < 0.05 was considered significant.

All participants had a comprehensive ophthalmic examination that included visual acuity testing using the Snellen chart. The assessment was done at a distance of 6 meters, in the open, in daylight, and in a shaded environment. A torch light and a portable slit lamp were used to evaluate the anterior segment of the eye, including cornea, pupillary reaction, anterior chamber depth, and status of the lens. Intraocular pressure measurement was done using handheld I-care tonometry while the participants were not breath-holding were sitting, and had no tightening around the neck. Three measurements were taken for each eye, and the average was taken. The pupil was dilated with a drop of 1% Tropicamide in cases with no contraindication, and the Vertical Cup-to-Disc Ratio (VCDR), the status of the neuro-retinal rim, and other positive findings were recorded using a direct ophthalmoscope.

Those diagnosed with glaucoma and suspected to have glaucoma were transported to Debre-Berhan Referral Hospital to confirm the diagnosis and further examination. An experienced ophthalmologist performed slit-lamp examination, gonioscopy, Goldmann applanation tonometry and disc evaluation. Gonioscopy was done for all eligible subjects using the four mirror goniolens. The anterior chamber angle was graded using the Shaffer grading system. After adequate pupillary dilation, the optic disc was examined using a 90D Volks lens (Volks Optical, Inc., Mentor, OH) at ×16 magnification on slit lamp bio-microscopy. Intraocular pressures were measured by Goldmann applanation tonometry using standard methods and recorded to the nearest one mm Hg. Tonometer were checked for calibration according to the manufacturer's recommendation. Eyes with significant corneal surface pathology and participants unable to fixate were excluded.

Glaucoma was classified according to the International Society of Geographical and Epidemiologic Ophthalmology (ISGEO) criteria, using percentile distributions of VCDR. The diagnosis of glaucoma started with VCDR findings[13]. Category 1 required structural and functional evidence that is 97.5th percentile of the VCDR (≥ 0.7) or VCDR asymmetry (≥ 0.1) in our normal population and visual field loss typical of glaucoma. Category 2 required advanced structural damage that is 99.5th percentile VCDR (≥ 0.75) or VCDR asymmetry (≥ 0.2) in the absence of visual field evidence (when a valid visual field result was not possible or available). Category

3 was applied when the optic disc was not seen, and visual field testing was not possible and used blindness (VA <3/60) with the 99.5th percentile IOP (≥28 mmHg) or diagnosed with/being treated for glaucoma.

An additional level of evidence (level 2b) was added where the optic disc was visualized. Still, the VCDR was <99.5th percentile, and visual fields were not available or visible fields were interpreted as "unlikely glaucoma", but there were other compelling evidence such as RAPD, high IOP, and / or corneal edema. Other glaucomatous optic nerve head features, such as localized narrowing of the rim, optic disc hemorrhages, and retinal nerve fiber layer defects, are not included in the ISGEO classification. So, individuals with these signs only were not classified as having glaucoma. Our study only used categories 2 and 3 since we didn't use a visual field. This study diagnosed glaucoma suspects based on IOP, ONH findings, and shallow anterior chamber.

The study received ethical approval from the Ethics, Research, and publication committee of the Department of Ophthalmology**,** Addis Ababa University, approval of the study [Ref, OREC/ 005/ 20 given on 12th September 2020. The study has used the ethical clearance letter and explained the purpose of the study to the Woreda administrators and the selected *kebele* leaders. Finally, oral informed consent was obtained from the study subjects. Moreover, privacy of study subject was maintained by interviewing alone and examined first in the health post, and referred to Debrebirhan Hospital for further confirmation. Moreover, confidentiality was considered by coding identifiers of study subjects.

RESULTS

A total of 405 adults aged ≥40 years were screened, and glaucoma was diagnosed in 5.7% (23/405) of the participants. Visual acuity was normal at presentation in majority of participants (Table 1). The diagnosis was made in 69.6% (16/23) of glaucoma patients with VCDR ≥0.75 and 4.34% (1/23) with VCDR asymmetry of ≥0.2. Other participants were assessed for level two-b and three evidence and diagnosed with glaucoma. Three (13.0%) use level 2b evidence, and the remaining 17.4% use level 3. Glaucoma was diagnosed in a total of 35 eyes of 405 participants. The age-specific prevalence and the magnitude of glaucoma are described in Table 2.

Table 1: Visual acuity of all study participants at presentation. *Baso* and *Worena* District, Central Ethiopia in 2020 (n=405)

Visual Acuity	Right eye	Left eye	Percent (Rt eye)	Percent (Lt eye)
>6/18	324	318	80.0	78.5
6/18-6/60	43	43	10.6	10.6
6/60-3/60	8	13	2.0	3.2
<3/60	30	31	7.4	7.7
Total	405	405	100.0	100.0

Table 2: Distribution of glaucoma by age and sex. *Baso* and *Worena* District, Central Ethiopia, 2020 (n=23)

Characteristics Yes (%)		Diagnosis of glaucoma No		Total
Age (years)	40-49	6(26%)	202	208
	50-59	4(17.4%)	52	56
	60-69	4(17.4%)	77	81
	70-79	8(34.8%)	42	50
	>80	1(4.3%)	9	10
Sex	Male	15(65.2%)	197	212
	Female	8(34.8%)	185	193
Total		23(5.67%)	382	405

The gonioscopic examination was performed on 23 (46 eyes) patients, of which 22 (44 eyes) had an open angle, and one patient (2 eyes) had a closed angle. Primary open-angle glaucoma was found in 12 (52.3%), and ten secondary open-angle glaucoma (pseudoexfoliative glaucoma in nine and uveitic glaucoma in one), Primary angle closure glaucoma in 1 (4.3%). Additionally, there were three cases of glaucoma suspect and eight cases of pseudoexfoliation syndrome with no signs of glaucoma (Table 3).

Table 3: Diagnosis and sub-types of glaucoma in *Baso* and *Worena* District, central Ethiopia. 2020 (n=405)

Type of glaucoma	Frequency	(%)
No glaucoma	382	94.32
POAG	12	2.96
PACG	1	0.25
PXG	9	2.22
Other	1	0.25
Total	405	100

Among the study participants, 9 (2.2%) were blind. The main cause of blindness was glaucoma (33.3%). Thirteen percent of glaucoma patients were blind. There was no family history of glaucoma, no glaucoma patient on treatment and only one patient had a history of glaucoma surgery. The relative afferent pupillary defect was positive in 18 (78.3%) glaucoma patients. There were 12 cases of bilateral and 11 cases of unilateral glaucoma. At presentation, most glaucoma patients had high intraocular pressure (Table 4).

Table 4: Intraocular pressure of glaucoma diagnosed participants. *Baso* and *Worena* District, Central Ethiopia, 2020 (N=405)

Intraocular pressure	Diagnosis of glaucoma		Total
Right eye	Yes	no	
<22 mmHg	7	378	385
'22-28mmHg'	6	4	10
'29-40 mmHg'	7	0	7
>41 mmHg	3	0	3
Left eye			
<22 mmHg	3	380	383
n'22-28mmHg'	11	2	13
'29-40 mmHg'	6	0	6
>41 mmHg	3	0	3
Total	23	382	405

DISCUSSION

The prevalence of glaucoma in SSA is estimated to be 4% in people aged 40 years and older[14]. This study has shown that the prevalence of all types of glaucoma in those above 40 years and older in *Baso* and *Worena* District rural farmers was 5.7%. All of them were not on treatment because they were newly diagnosed, moreover they were from remote area where there was no eye care service. This prevalence is high and comparable to studies done in the Kongwa District of Tanzania (4.2%), Hlabisa (4.5%), and Temba (5.3%) of South Africa[15-17].

Open-angle glaucoma was approximately six times more prevalent than angle-closure glaucoma in SSA[15-18]. The exception is those of mixed South-East Asian and Western European origin in Mamre, South Africa[19]. In this study, Salmon *et al*[19] reported a prevalence of 2.3% for angle closure and 1.5% for open-angle glaucoma. This finding indicates that in SSA, angle-closure glaucoma is more prevalent in those of Southeast Asian origin. This study found that the most common glaucoma subtypes are open-angle glaucoma (52.2%) and pseudoexfoliative glaucoma (39.1%).

This study has shown a higher prevalence of pseudoexfoliative glaucoma than other African studies. Exfoliative glaucoma was responsible for 16% of all glaucoma in Temba and 21.6% in Hlabisa of South Africa but was not detected in Kongwa, Tanzania[15-17]. The proportion of participants with glaucoma who were blind in this study was 33%, comparable to Temba (32%) in South Africa[20]. But more than studies done in Kongwa, Tanzania (14.1%), Mamre, South Africa (15.2%), and 9.5% in Akwapim-south, Ghana[15,18,19].

In Hlabisa, South Africa, the prevalence of blindness was 3.2% (CI 2.2-4.6%) in people aged 40 years and above, and 22% was due to glaucoma[16]. In Temba, South Africa, the prevalence of blindness was 5.6% (CI 3.9-7.7%) in people aged 40 years and older, and the proportion due to glaucoma was 32%[17].

In our study, 2.2% of the study population had a presenting VA worse than 3/60, and the leading cause of blindness was attributed to glaucoma (33.3%). Thirteen percent of glaucoma patients were blind, which is comparable to 9.5% of Ghana, 14% of Tanzania, and 15% of Temba[15,17,18]. Glaucoma-specific blindness prevalence in our study shows 0.7%**.** Many studies from which data on glaucoma-specific blindness prevalence were derived did not have VF assessments. These data, therefore, underestimate glaucoma-specific blindness, which, if using the WHO definition of blindness, should also include those with a central VF of less than 10 degrees in the better eye. The earlier age of onset of the disease in blacks has already been reported, and this has been corroborated in our study and shows a prevalence of glaucoma being 1.5% in the age group of 40-49 years.

In this study, the prevalence was higher in males but not clinically significant. This study has highlighted that the prevalence of glaucoma in Central Ethiopia is high and is the major cause of blindness. Primary open-angle and pseudoexfoliative glaucoma are the predominant subtypes. It has an early onset and is a public health problem in Ethiopia. Thus, case-finding strategies must be targeted at younger ages to reduce morbidity from glaucoma. The public health approach is needed for control and mainly targets at-risk people.

Limitations of the study: This include a visual field examination that was not done, which might impact the diagnosis of glaucoma. It was done only in one district and generalization is not possible. The principal investigator used direct ophthalmoscopy to assess the optic nerve head and might have missed early glaucoma with underestimation of cupping.

Conclusion: The study conducted in *Baso* and Worena District, Central Ethiopia, unveiled a concerning high prevalence of glaucoma, with the majority of cases falling under the sub-types of primary open-angle glaucoma and pseudoexfoliative glaucoma. These findings underscore the urgency for implementing a public health approach to tackle the morbidity and blindness linked to glaucoma in the region. The high prevalence indicates a critical need for increased awareness, early detection, and access to appropriate treatment to mitigate the impact of this sight-threatening disease on the population.

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Consent for publication: Department of Ophthalmology as well as the School of Medicine encourage publications of research works. All participants gave a written consent for their personal and clinical details.

*Availability of data and materials***:** The original data collected and compiled is available with corresponding author.

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

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Pattern and management of traumatic cataract in children aged 0 to 15 years at the University Hospital of Abeche (CHU-A) and at the "Voir la Vie" Clinic

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ABSTRACT

Objective: This study was carried out to evaluate the postoperative visual outcome and management of traumatic cataract in children.
Methods: This was a retrospective and descriptive multicenter study conducted at the University Hospital of Abéché and the "Voir la Vie" Clinic. Children aged 0 to 15 years and operated for traumatic cataract were included in this study. The variables studied were epidemiological, clinical and therapeutic. The data collected were entered using Excel 2013 and analyzed by SPSS 18.0 software.
Results: The average age was 10.25 ±3.19 years. The age group 10 to 15 years was the most represented with 131 (66.8%), 5 to 9 years 55 (28.1%) and 0 to 4 years 10 (5.1%). The sex ratio M/F was 1:9. One hundred and fifty five (79.1%) of the patients came from rural areas. One hundred and fifty one (77%) of the main mechanism were bruises. One hundred and ten (56.1%) of the circumstances of occurrence were child's play and 107 (54.6%) of the main traumatizing agent were vegetable bodies. One hundred and thirty two (67.3%) of preoperative visual acuity were less than 1/10 of cases. One hundred and seventeen (59.7%) of the most common type of anesthesia were locoregional of cases. 1Nineteen (8.7%) patients of the most common intraoperative complication were vitreous loss. At 30 days postop, 55.10% (n=108) of patients had distance visual acuity greater than or equal to 1/10.
Conclusion: Traumatic cataract in children is predominant in males. It is the main cause of unilateral blindness. Adequate management with the placement of implants in the posterior chamber gives better functional vision.

Key words: Traumatic cataract, Children**,** Traumatizing agent, Vision, Surgery outcome, Abeche

INTRODUCTION

Post-traumatic cataract refers to any lens opacity by an external insulting agent. It is secondary to a bruise or perforating trauma with or without an intraocular foreign body[1]. In the world population, an estimated 1.6 million blindness, 2.3 million low vision and 19 million monocular blindness are due to trauma[2].

On an annual basis, there is an estimated incidence of approximately 20 children with blinding cataract (congenital or infantile). The backlog or incident cases of children with traumatic cataract has not yet been estimated in Africa, but is likely to be lower than congenital or infantile cataract[3]. It is a common condition due to the increase in ocular trauma, accounting for 1.3 to 3.7% of trauma emergencies[4]. It is a frequent cataract despite prevention efforts and the progress of ophthalmologic microsurgery[5].

The circumstances of occurrence are dominated by games, beating or corrective punishment, brawls, and public road accidents[6]. The traumatizing agents are due to a braid needle, projections by stone thrower and pieces of wood[7]. Its frequency is 7.63%[8].

In Chad, no studies have been devoted to traumatic cataract in children. For this reason, we wanted to carry out this work with the aim of improving the management of traumatic cataract. To carry out this work, we set ourselves the following objectives:

General objective: To find out the pattern of traumatic cataracts and the postoperative outcome in children aged 0 to 15 years at the Ophthalmology Department of the University Hospital of Abéché and at the "Voir la Vie" clinic.

Specific objectives: To describe the sociodemographic profile of patients; To identify the anatomical forms of traumatic cataract and to assess outcomes of traumatic cataract in children 0-15 years of age.

MATERIALS AND METHODS

Study design: This was a multicentre descriptive retrospective study conducted at the University Hospital Center of Abéché (UHC-A) and at the "Voir La Vie" Clinic located in the Ouaddaï Region in Eastern Chad, from January 2016 to June 2020.

Ethical considerations: This study adhered to the tenets of Helsinki declaration. To conduct this study, we obtained the research authorization of the Dean of the Faculty of Health Sciences of Abéché, those of the Direction of the UHC of Abéché and of the "Voir la Vie" Clinic. Post-operative consultations were free in order to reduce no-shows.

Case definition: Traumatic cataract is defined as the clouding of the lens following trauma. Visual acuity was assessed according to WHO standards (<1/10, 1/10 to <3/10 and 3/10).

Inclusion criteria: All patients aged 0 to 15 years who underwent surgery for traumatic cataracts during the study period were included in this study.

Exclusion criteria: We did not include children above 15 years of age because they have already been addressed in our recent study; Patients absent from the appointment; All cases of non-traumatic cataracts were excluded; All cases of traumatic cataracts for which the surgical indication has not been established.

Data collection and analysis: The data collected was entered using Excel 2013 and analyzed by SPSS 18.0 software.

RESULTS

Socio-demographic aspect

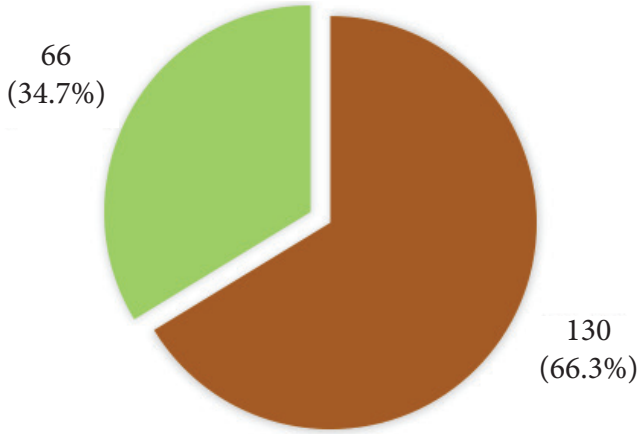
Age: The age range of 10 to 15 years was the most represented with 131 (66.8%). The mean age of the patients was 10.25 ± 3.19 years with extremes of 8 months and 15 years (Table 1).

Table 1: Distribution by age group

Age (years)	No.	(%)
0 – 4	10	5.1
5 – 9	55	28.1
10 – 15	131	66.8
Total	196	100

Gender: Male predominance was observed with 130 (66.3%) of the cases than female 66 (34.7%). The sex ratio was 1:9 (Figure 1).

Figure 1: Distribution according to the gender



Residence: One hundred and fifty five (79%) of the children were from rural areas.

Circumstances of occurrence: The main circumstance of occurrence of eye trauma was child play with 110 (54.1%) of the cases, followed by fights with 50 (25.51%) and domestic accidents in 26 (13.26%) (Table 2).

Table 2: Distribution by circumstances of occurrence

Circumstances of occurence	No.	(%)
Public Road Accident	4	2.04
Domestic accidents	26	13.27
Brawls	50	25.51
Children's game	110	56.12
Others	6	3.06
Total	196	100

Nature of the traumatizing agent: Plant agents were the most vulgar with 107 (54.6%) of the cases (Table 3).

Table 3: Distribution by nature of the injuring agent

Injuring agent	No.	(%)
Punch	52	26.5
Braid needle	7	3.6
Metallic	13	6.6
Stiks	107	54.6
Stone throw	8	4.1
Others	9	4.6
Total	196	100

Clinical aspects

Time between the trauma and the consultation: The time between the occurrence of the trauma and the consultation was more than one year in 56.6% of the cases.

The affected side: Traumatic cataract involvement of the right eye was the most reported with 102 (52%).

Mechanism of trauma: In our study contusion represented 151 (77%) of the cases; cataract with corneal wound or perforation was found in 45 (23%) of the cases.

Associated anomalies: Traumatic cataract without any associated lesion was found in 183 (93.36%) of the cases.

Type of cataract: In our study, cataract was cortical in 151 (77.55%) of the cases, it was anterior capsular in 30 (15.30%) and posterior subcapsular in 14 (7.15%).

Treatments

Type of anesthesia: The most common type of anesthesia was locoregional anesthesia with 117 (59.7%) of the cases.

Implant intraocular: The patients had received an intraocular lens in 150 (76.5%) of the cases.

Surgical technique: The most used operative technique was lensectomy + posterior chamber implant in 150 (76.5%) of the cases.

From the glass: Intraoperative vitreous loss was observed in 19 (8.7%) patients

Visual acuity before surgery and at D30 postoperation: Visual acuity was less than1/10 before management in 132 (67.3%) of the cases (Table 4).

Table 4: Preoperative Visual Acuity (VA)

Visual acuity (VA)	No.	(%)
< 1/10	132	67.3
1/10 - 3/10	9	4.6
≥ 3/10	8	4.1
Unmeasurable	47	24.0
Total	196	100

Table 5: Postoperative D30 Visual Acuity (VA)

Visual Acuity (VA)	No.	(%)
<1/10	6	3.06
[3]1/10 to 3/10	32	16.32
>3/10	76	38.77
Unmeasurable	29	14.79
Absent from the appointment	53	27.04
Total	196	100

After surgery, at 30 days postop, 108 (55.10%) of patients had a VA greater than or equal to 1/10. Chlidren underwent surgery and were absent from the appointment on D30 represented 27.04%.

DISCUSSION

Clinical aspects

All patients had consulted for unilateral visual impairment. The circumstances of occurrence of this visual acuity decline were dominated by children's game accidents with 56.12% of the cases followed by fights in 25.1%. This figure was close to those of Dembélé *et al*[7] in 2015 in Mali and Mensah *et al*[10] in 2004 in Abidjan, who observed 54.3% and 52.84% of the cases following children's game accidents respectively. On the other hand, Ben Zina *et al*[11] in 1998 in Tunisia and Sordet *et al*[12] in 2002 in France both found 35% of the cases of game-related trauma. All authors agree that play in the absence of adult supervision is the main circumstance in which eye injuries occur in children.

Regarding the vulnating agents, wooden objects/sticks dominated in 44.4% followed by punches in 26.5% of the cases. This result is consistent with that of Diomande[13] in 2012 in Ivory Coast who had stated that 44% of wooden objects were the cause of traumatic cataract. On the other hand, it is different from those of Ben Zina *et al*[11] in Tunisia in 1998, Traoré *et al* [14] in 2002 in Mali who obtained 67% and 52% of wooden vulnating agents respectively.

The reason of this predominance of plant bodies is likely related to the high prevalence of patients from rural areas where parents practice agricultural activities and wooden objects are within the reach of children.

Seventy seven percent of the common mechanism of trauma was a contusion. This rate is different from Doutetien *et al*[9] in Benin who found 92.8% of the cases of cataract following a bruise ocular trauma. Baklouti *et al*[15] in Tunisia and Karim *et al*[1] in Morocco in 1998, found different results respectively 55% and 53.3%.

Regardless of the mechanism, whether perforating or a contusion, any trauma to the eyeball, however minimal, is likely to cause a cataract, either by direct damage to the lens or by disruption of its metabolism.

For the delay of consultation, it varied from one week to more than one year. One hundred and eleven patients (56.6%) had consulted one year after the trauma. The delay in consultation is reported in developing countries. This delay can be explained by various reasons;

(i) The socio-economic conditions of a very poor population;
(ii) The scarcity of specialized ophthalmology centers;
(iii) Parental neglect in the face of unilateral eye damage and,
(iv) The use of traditional treatment still practiced by the majority of our African populations.

Fifty two percent of the findings about laterality revealed a predominance of right eye involvement. Soumahoro *et al*[16] in 2014 in Abidjan (Ivory Coast) and Sordet *et al*[12] in France in 2002, had noted respectively 63% and 56% right eye involvement. The predominance of right eye involvement is explained by the high exposure of this side in patients. In addition, the directing eye comes into play. Indeed, if the directing eye is the right one, when children's game, the child will tilt his head more to the left, exposing his right eye to trauma.

This result is consistent with the fact that the dominant side is always exposed during games as well as at work, as it is always involved in the manipulation of objects. Sordet *et al*[12], Vatavuk *et al*[17] in 2004 and Diamonde[13] reported a predominance of the left eye with a percentage of 56%, 56.2% and 66% of the cases respectively. The most common circumstance of occurrence in these studies was a fight.

This means that the left eye is directly exposed to a blow from a right-handed opponent. The initial visual acuity was reduced and limited to light perception in 67.3% of the cases. Doutetien *et al*[9], Karim *et al*[1], Sordet *et al* [12] and Soumahoro *et al*[16] noted respectively 78.2%, 95.5%, 88% and 91% of initial visual acuity collapse.

The collapse in initial visual acuity was thought to be related to delay in consultation as discussed above. As for associated lesions, traumatic cataract was isolated in 93.3% of patients. The most common corneal lesion was adherent leukoma in 2.5%. According to Karim *et al*[1], there are two possible outcomes of perforative cataract:

(i) If the lens is in place, with the capsule intact, the corneal wound will be sutured urgently and the cataract will be operated on later "cold" within a period varying from three weeks to one month according to the authors, with the insertion of an artificial lens.

(ii) If there is an exit of crystalline masses in the anterior chamber with an increased risk of ocular hypertonia and inflammation, these patients should be operated on earlier. The practice of emergency intraocular implantation is controversial. It is even discouraged by most authors because of the increased risk of infection and inflammation. On the other hand, the scarred state with cataract was a good indication for posterior chamber implantation except in cases of lens subluxation or large capsular opening. In these cases, scleral or anterior chamber implantation and fixation could be used. Lens opacification was complete in 77.5% of patients. This result was close to those Dembélé *et al*[7] in Mali and Baklouti *et al*[15] in Tunisia, who represented 65.7% and 75% of total cataracts respectively. This predominance of total cataract is synonymous with a too long delay between the date of the trauma and the date of treatment.

Therapeutics and prognosis

The patients were operated on under loco-regional anesthesia in 59.7%. General anesthesia is generally used in children for whom locoregional anesthesia is not indicated and in young children.

We noted vitreous loss in 8.7% of patients. Karim *et al*[1] found 4 cases of vitreous loss in 45 children in Morocco. Doutetien *et al*[9] represented 33.3% of vitreous loss in Benin.

As for postoperative visual acuity, it improved in 55% with visual acuity > 1/10. Diomandé[13] found 56.4% of patients with visual acuity ≥ 1/10. Moudenne *et al*[18] in 2009 pointed out that 53.84% of patients had recovered a final visual acuity greater than 1/10. Vatavuk *et al*[17] reported visual acuity ≥ 1/10 in 31.25%.

These results show that traumatic cataract surgery can restore vision, especially when the patient is seen early and the operative technique is accompanied by intraocular lens. After a follow-up at D30 post-op, we found 27.04% of patients lost to follow-up. This was due to the fact that the patients came from remote rural areas and lack of compliance to medical recommendations as soon as an improvement in the child's visual acuity was noted.

Visual acuity was not measurable in 14.7% of patients. This is due to the difficulty of measuring visual acuity and the lack of understanding of visual acuity by children.

Limitation

We were not able to categorize the visual acuity from mild to severe visual impairment postoperative and this constituted the limitation of this study.

Recommendations

We recommend emphasis on the prevention of ocular trauma.

CONCLUSION

Traumatic cataract in children is predominant in males. It is the main cause of unilateral blindness. The main circumstance of occurrence of eye trauma was child play and the age range of 10 to 15 years was the most represented. The time between the occurrence of the trauma and the consultation was more than one year and the most associated lesions to the cataract were corneal wound or perforation. In most of cases, cataract was cortical. Majority of the patients had received an intraocular lens. The results show that traumatic cataract surgery can restore vision, especially when the patient is seen early and the operative technique is accompanied by intraocular lens.

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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

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Epidemiological aspects of paediatric cataracts in Kinshasa, Democratic Republic of the Congo

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ABSTRACT

Objective: To assess epidemiological aspects of paediatric cataracts among children who attended a secondary Eye clinic in Kinshasa, Democratic Republic of the Congo (DRC).
Methods: A cross-sectional study was conducted in the Eye Department in Kinshasa. One hundred and seventeen children with bilateral cataracts aged from 0.5 to 16 years and their mothers were recruited in the study. Children with unilateral and traumatic cataracts were not included in the study. Data were collected during the period from February 2021 to March 2021. A pre-tested questionnaire was administrated to mothers to evaluate socio-demographics, the history of pregnancy, and a perinatal history of the child. The blood samples for both children and their mothers were collected for antibodies titration. At the same time, the following parameters, namely: age at surgery, type of cataract, associated ocular and systemic lesions. Rubella and toxoplasmosis IgG results were recorded.
Results: The mean age was 7.37±4.28 years (min: 0.5 years, max:16 years). Cataract was congenital and infantile in 58.1% and 41.9% of children respectively. Aetiology of cataract was found idiopathic in 74 children, infectious in 16 children and genetic in 16 children . Then it was isolated in 50.4% and associated to one ocular abnormality in 34.2% of children. Rubella IgG antibody was positive in 26.5% of children.
Conclusion: Paediatric cataract was the mostly congenital, idiopathic and isolated. Rubella infection was present in almost a quarter of children with cataract. Rubella vaccination can be used to reduce the burden of childhood cataract in Kinshasa.

Key words: Epidemiology, Paediatric cataract, Children, Kinshasa, DRC

INTRODUCTION

Paediatric cataract is a total or partial opacification of the lens due to an embryological or developmental abnormality[1]. Congenital cataract is a rare finding in neonates and occurs in 4.24/10,000 live births[2]. Congenital and infantile cataract are responsible for a fifth of the world's blind children despite its treatable nature[3]. Cataract develops due to disruption of the normal lens protein structure or function, resulting in opacity. This may occur as a result of stressors applied to lens proteins including those acquired *in utero* or during childhood. However, a significant proportion is due to mutations in the genes encoding lens proteins that directly affect their role within the lens[4]. About half of the bilateral congenital cataracts are inherited, either as an isolated trait or as part of a multisystemic condition or chromosomal abnormality[2]. Most unilateral and a significant number of bilateral cataracts are of unknown aetiology, the diagnosis of such cases is made after excluding other causes. Congenital cataract is hereditary at 8.3%-25% of cases, with 75% being autosomal dominant inheritance[5]. The serology of the mother and child should be checked for toxoplasmosis, rubella, cytomegalovirus, herpes, but also varicella, Epstein-Barr virus, and syphilis at the context points to of an embryo-foetopathy[6].

Intrauterine infection with rubella virus, herpes simplex virus, and toxoplasmosis virus plays an important role in the development of congenital cataract[7]. Important environmental factors to consider include congenital infections such as toxoplasma, syphilis, varicella zoster, parvovirus B19, coxsackievirus, rubella, cytomegalovirus (CMV) and herpes simplex virus I and II (TORCH). Trauma and iatrogenic causes such as medications and radiation exposure are also relevant but rare in this age group[8]. A recent study conducted in Tanzania

(2020) suggested that congenital infection with rubella or HCMV (human cytomegalovirus) is an important cause of congenital bilateral cataract cases in infants/children[9]. In DRC, there is no published works focused on infectious and environmental aetiologic factors of paediatric cataract.

The aim of this study was to assess epidemiological and aetiological aspects of bilateral paediatric cataracts among children identified in the community in Kinshasa.

Research hypothesis: A high percentage of children with bilateral cataract screened by the community-based rehabilitation service and referred at the Eye Department at the Saint Joseph's Hospital in Kinshasa, is believed to be related to embryofetopathies of viral or protozoa origin considering the lack of rubella vaccination in the health system in DRC.

MATERIALS AND METHODS

Study design: This is a cross-sectional study of a case series carried out at St Joseph Hospital. We reviewed medical files of the children who were diagnosed with bilateral paediatric cataract during the period from January 2019 to December 2020.The register from the community-based rehabilitation program was consulted to identify the children with cataract identified during screening sessions, for whom the diagnosis of cataract in both eyes was confirmed by the ophthalmologist at the eye health center.The mothers were invited to come along with their children to the hospital where they were asked to complete a questionnaire used to collect information. Data and blood samples were collected from February 2021 to March 2021. Clinical and socio-demographic data collected were the following: age, sex, ethnical group, and family history of cataract. In addition, the following factors were considered: laterality of the cataract, the notion of consanguineous and endogamic marriage, the obstetrical history of the mother, the perinatal environment, the medical history of the mother, the associated ocular and systemic abnormalities, the serological results for rubella and toxoplasmosis of the child and the mother.

The aetiological and clinical classification of the cataract referred to the Fahkoury's categorizations[7] as follows: (i) Cataract was congenital when it appeared at birth or within 12 months after birth. (ii) It was infantile or developmental when it appeared after 1 year of age. (iii) It was idiopathic or of unknown aetiology when no evident aetiology was found. (iv) It was of genetic aetiology when there was a positive family history of paediatric cataract with a 1st degree relationship. (v) It was of infectious aetiology to rubella or toxoplasmosis when the serological test by ELISA was positive with presence of IgG in the child and his mother. (vi) Cataract was teratogenic when the mother was exposed during the first trimester of pregnancy to X-rays and if there was a notion of taking abortive drugs or chemotherapy during the same period and was categorized as either isolated or associated with ocular or systemic abnormalities, and (vii) It was isolated when it was not associated with any either ocular or systemic abnormality.

Inclusion criteria: All children who responded to the clinic invitation were received. A total number of 117 children with bilateral cataracts with their mothers were included in the study. Children with unilateral, secondary and traumatic cataract were not included in this study.

Blood samples collection: All individuals who met the inclusion criteria donated 5ml of blood in an appropriate tube. The blood samples were kept in the fridge at -60°C and antibody titration (IgG) of the rubella and toxoplasmosis panel was performed. Serological tests were performed at the Institut National de Recherche Biomedicale (INRB). Antibodies titration was carried out by using ELISA technique (Calbiotech, USA, rubella and toxoplasmosis Kit). Interpretations of serological results were as follows: (i) Titration < 0.9 (no IgG antibodies); (ii) Titration 0.9-1.1 (positive limit); (iii) Titration > 1.1 (rubella or/and toxoplasmosis antibodies); (iv) The case was considered positive when IgG antibodies were in positive limit in both child and mother.

Statistical analysis: Data were entered into EPI data and exported to an MS Excel file (Microsoft, Albuquerque, New Mexico, USA) and then analyzed with SPSS version 21.0 International Business Machines Corporation (IBM), *Armonk, New York, USA).* Statistics used to describe variables were the mean ± SD for continuous quantitative variables with a normal distribution and the median for those with a non-Gaussian distribution. Qualitative variables were described in terms of relative (%) and/or absolute (*n*) frequency**.** The search for associations to cataract was carried-out using Pearson's Chi Square or Fisher's exact test comparing proportions. A value of $p<0.05$ was considered as a threshold of statistical significance.

Ethical considerations: The study complied with the local laws and the principles of the Declaration of Helsinki. It was approved by the Ethics Committee of the School of Public Health of The University of Kinshasa on 3rd February 2021 (Approbation number ESP/CE/22/B/2021). An informed consent form written in French and Lingala (local language) was signed by parents or guardians of the children who were included in the study. We also obtained consent from children aged 7-16 years to collect their blood sample for the study. The ethical principle of beneficence of the participants in our research was also considered. For this purpose, children who have not been treated were taken care of and those with incurable pathologies were referred to visual rehabilitation structures in Kinshasa.

RESULTS

Socio-demographic characteristics of children and their mothers: We recruited 117 children with bilateral cataract and their mothers. All children with unilateral and traumatic cataract were excluded. The mean age was 7.37±4.28 years (min: 0.5 years; max: 16 years), 73 children were male (62.4%) with a sex ratio of 0.6 in favor of male. The age of the mother at the child's birth (*n*=117 mothers) was: < 20 years old: 3 (3%); 20-40 years old: 107 (91%); > 40 years old: 7 (7.3%). Consanguineous marriage was present in 2 (1.7%) children and endogamic marriage among parents was encountered in 34 (29%) children.

Maternal and obstetrical history: The following factors were encountered as personal history of children with bilateral cataract: low birth weight (45%), stay in the incubator (19%), prematurity (15%), neonatal infection (12%), neonatal hypoxia (6%), and overweight at birth (3%). Hypertension (50%), the use of skin whitening creams (26%), chronic alcoholism (8%), diabetes mellitus (8%), dystocic delivery (5.1%), hypothyroidism (4%) were encountered as main maternal factors. Dystocic delivery was the only obstetrical factor with high significant association with infantile cataract (p=0.00)**.**

Clinical and aetiological classification of cataract: Congenital cataract represented 68 (58.1%) and infantile cataract was 49 (41.9%). Cataract was of unknown origin in 74 (63%) children, genetic in 16 (14%) children, and infectious in 27 (23%) children. It was isolated in 50%, associated to one ocular abnormality in 34%. Strabismus and nystagmus were encountered in 46% and 38% of children respectively. The most common ocular abnormalities associated to cataract were microphthamia / microcornea (10%), lens subluxation (3%), persistent fetal vasculature (1%) and others. Systemic abnormalities were associated to cataract in 21 (17.9%) children. They consisted of multi-systemic disorders in (24%), growth retardation (21%), intellectual disability (17%), Marfan syndrome (5%), albinism (5%), deafness (5%); malnutrition (5%), heart abnormalities (4%), epilepsy (2%) and others.

IgG serology was positive for rubella (child and mother) in 30 (25.6%) children, among them 19 (63.3%) children were only positive to rubella and 11 (36.7%) children were positive for both rubella and toxoplasmosis. IgG serology was positive for toxoplasmosis (child and mother) in 20 (17.1%) children. Serological profile in titer associated cataracts was in favor of rubella in one quarter of all patients in our series. All findings are summarized in Tables 1-3. In contrast, Table 4 shows the distribution of children according to their serological titration for rubella and toxoplasmosis.

Table 1: Socio-demographic characteristics and clinical classification of paediatric cataracts

Parameters	Congenital cataract (n=68) (58.1%)	Infantile cataract (n= 49) (41.9%)	Total n (%)
Age of the children (years)			
Mean : 7.37 ± 4.28	5.9 ± 4.2	9.6 ± 3.5	
(min: 0.5; max: 16)	[1-16]	[2-16]	
Age of the mother at the child's birth (years)			
< 20	1	2	3 (3%)
20-40	64	43	107 (91%)
> 40	3	4	7 (7.3 %)
			p = 0.59
Sex			
Male	41	32	73 (62.4%)
Female	27	17	44 (37.6%)
(Sex ratio of 0.6 in favor of male)			p = 0.36
Clinical aetiology of cataract			
Isolated cataract	27	32	59 (50.4%
Cataract associated to ocular or systemic abnormality			
Children with cataract associated to one ocular abnormality	26	14	40 (34.2%)
Children with cataract associated to more than one ocular abnormality	2	1	3 (2.6%)

Children with cataract associated to one systemic abnormality	4	1	5 (4.3%)
Children with cataract associated to more than one systemic abnormality	1	0	1 (0.8%)
Combination of ocular and systemic abnormality - children with cataract associated to one ocular abnormality a one systemic abnormality	5	1	6 (5.1%)
Children with cataract associated to more than one ocular and systemic abnormality	3	0	3 (2.6%) p = 0.00

Table 2: Distribution of mothers according to their obstetrical and medical history

Determinants	Congenital cataract (n = 68)	Infantile cataract (n = 49)	Total n (%)
Obstetrical, medical history of the mother			
Dystocic delivery			
Yes	0	6	6 (5.1%)
No	68	43	111 (94.9%) p = 0.00
Skin rash in pregnancy			
Yes	1	1	2 (1.7%)
No	67	48	115 (98.3%) p = 0.66
Pre-eclampsia			
Yes	1	0	1 (0.8%)
No	67	49	116 (99.8%) p = 0.58
Hypertension			
Yes	8	5	13 (11.1%)
No	60	44	104 (88.9%) p = 0.52
Diabetes mellitus			
Yes	1	1	2 (1.7%)
No	67	48	115 (98.3%) p = 0.66
HIV positive serology			
Yes	1	0	1 (0.8%)
No	67	49	116 (99.2%) p = 0.58
Hypothyroidism			
Yes	1	0	1 (0.8%)
No	67	49	116 (99.2%) p = 0.58
Use of steroid skin creams			
Yes	4	3	7 (6.4%)
No	64	46	110 (93.6%) p = 0.63

Table 3: Distribution of children according to their neonatal history

Determinants	Congenital cataract (n = 68)	Infantile cataract (n = 49)	Total n (%)
Neonatal child history			
Prematurity			
Yes	6	4	10 (8.6%)
No	62	45	107 (91.4%)
			p = 0.59
Low weight at birth (≤ 2.500 kgs)			
Yes	19	10	29 (24.8%)
No	49	39	88 (75.2%)
			p = 0.24
Overweight at birth (> 4.500 kgs)			
Yes	0	2	2 (1.7%)
No	68	47	115 (98.3%)
			p = 0.17
Perinatal hypoxia			
Yes	2	2	4 (3.4%)
No	66	47	113 (96.6%)
			p = 0.56
Neonatal infection			
Yes	4	4	8 (6.8%)
No	64	45	109 (93.2%)
			p = 0.45
Staying in the incubator			
Yes	6	6	12 (10.3%)
No	62	43	105 (89.7%)
			p = 0.38

Table 4: Distribution of children according to their serological titration for rubella and toxoplasmosis

Determinants	Congenital cataract (n = 68)	Infantile cataract (n = 49)	Total n (%)
Serologic titration for rubella and toxoplasmosis			
Rubella IgG positive (child and mother)			
Yes	13	18	31 (26.5%)
No	55	31	86 (73.5%)
			p = 0.03
Toxoplasmosis IgG positive (child and mother)			
Yes	11	10	21 (17.9%)
No	57	39	96 (82.1%)
			p = 0.36
Rubella IgG and toxoplasmosis IgG positive (child and mother)			
Yes	5	6	11 (9.4%)
No	63	43	106 (90.6%)
			p = 0.28

DISCUSSION

This study observed that children arrived late at the time of surgery. Similar study in Cameroon reported the same delay at moment of diagnosis and surgery (mean age 7.6±7.22 and 6.6 years)[10,11]. This delay in diagnosis and surgery as well as the predominance of males among children with cataract are common in countries with limited resources. The key challenge for child eye program in a low and middle-income countries is to find and timely refer the visually impaired children. Gender and other barriers to having cataract surgical services are well documented in Africa and DRC[12,13]. The study noticed that mothers were very young, aged between 20 and 40 years, and endogamous marriage was frequent among parents. The association between age of mothers and endogamy marriage have never been studied in the literature, but it may initiate research into the genetic mechanisms of cataract in children to whom parents are members of the same ethnic group or tribe. A positive history of familial cataract was present in 14% of children. Our results are in line with those described by Bremond-Gignac *et al*[8], who found a frequency of 18% of positive history of familial cataract in their study series. Consanguineous marriage was rare in our series (1.7%) as an associated factor with paediatric cataract. A study in Switzerland found a frequency close to ours (just one family out of 25 families) of 4%[14]. Pandey *et al* [15] reported a high incidence of consanguinity (80%) in autosomal recessive cases of congenital cataract in India; while a study by Fahkoury *et al*[7] in France found 11% of consanguinity in their series. The frequency of consanguinity differs between countries and cultures. Globally, genetic disease is also a common cause of early life cataract with consanguineous marriage, relatively common in several countries across the world[16].

Low weight at birth was in this study the most common personal history factor associated with paediatric cataract in our study, however, we didn't find any significant association between paediatric cataract in relation with low weight at birth. The association between cataract and low weight at birth within a population is broadly in harmony with the association of paediatric cataract and under five mortality rates[17].

The dystocic delivery in this study was significantly associated to infantile cataract. A study by Shagufta *et al*[18] found that some environmental factors like hypertension and severe specific adverse perinatal events (hypoxia, hypothermia, hypoglycemia) were linked to congenital cataract. This study reported that congenital cataract was caused more by environmental than genetic factors[18]. Bilateral cataracts in children was predominantly congenital, idiopathic, isolated, and associated to one ocular anomaly. In fact, from the point of view of many studies, most of congenital cataracts are of unknown origin and isolated[8]. Strabismus and nystagmus were the most common ocular abnormalities associated with cataract. This has been reported lately in a publication on surgical outcomes of 298 children operated on for cataract at St. Joseph Hospital and is correlated to the delay at presentation[19]. Systemic abnormalities were associated with cataract in 21 children and consisted of psychomotor retardation, intellectual disability, and multisystemic impairment. Our results are similar to those that found by Fakhoury *et al*[7] who reported that congenital bilateral cataracts were associated to several systemic conditions. When a child presents a bilateral congenital cataract, a clinical assessment is compulsory to investigate systemic anomalies, especially galactosemia and Lowe syndrome, considering that both two conditions can be life-threatening for children.

The rubella serology titration (IgG) was positive in a quarter of the children and rubella-toxoplasmosis comorbidity was present in eleven children demonstrating that some children with cataract had a mixed congenital infection. Our results are similar to those reported in some developing countries (such as Tanzania and India), where approximately 25% of infantile cataracts were due to congenital rubella infection[9,15]. Another study in Pakistan found a frequency of 32.5% of rubella among children with cataract[18]. There should be a potential selection bias associated to the study design, and then a case control study will be needed to further confirm rubella and toxoplasmosis as aetiologies of paediatric cataract in Kinshasa. The expected spin-offs of this research are linked to an improvement in knowledge of the epidemiological and aetiological features of paediatric cataract and, in particular, the possibility of carrying out primary prevention of cataract by means of vaccination, which, moreover could be integrated into the current vaccination schedule for pregnant women, which is not yet carried out in the DRC. This could reduce the incidence of congenital cataract in the DRC and in Kinshasa environment.

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Capacity for glaucoma screening and treatment at primary and secondary level health centers in Uganda: Situational analysis

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ABSTRACT

Objective: To measure the capacity for glaucoma screening and treatment at primary and secondary level health centers in southwestern Uganda.
Methods: In a cross-sectional study, we used quantitative methods to conduct a situation analysis at primary (health center IVs, district hospitals) and secondary level health facilities (referral hospitals) within southwestern Uganda. Survey questionnaires were administered to eye health workers at the health facilities to ascertain glaucoma awareness. An inventory checklist was used to establish equipment and consumables available to screen, diagnose and treat glaucoma in the primary and secondary level setting.
Results: There were 86 primary and secondary level health facilities enrolled in this study. Out of the 86 facilities, 45 (52.3%) did not have any eye care worker. Majority lacked functioning basic eye equipment and consumables for the diagnosis of glaucoma. Only 28 (32.6%) facilities had a direct Ophthalmoscope. Timolol was the most common eye drop and was available in 12 (14%) of the health facilities. The lowest level of knowledge about glaucoma was observed at health center IVs (34.6%), while the highest level of knowledge was observed at regional referral hospitals (82.7%).
Conclusion: There is need to improve the availability of equipment, diagnostic consumables and essential medicines for glaucoma at health facilities in southwestern Uganda. Additionally, training and deployment of more eye care workers at the primary and secondary health facilities is necessary for quality access to eye care services.

Key words: Glaucoma, Screening, Developing, Uganda, Sub-Saharan Africa

INTRODUCTION

Glaucoma is a major cause of visual impairment and blindness affecting 76 million people globally[1]. Glaucoma causes irreversible blindness by causing progressive damage to the optic nerve, a vital structure responsible for transmitting electrical signals from the retina to the brain for interpretation[2]. The burden of glaucoma is highest in sub-Saharan Africa where the prevalence is estimated to be 4.8%, twice the global average[1,3]. Recent global estimates have predicted a substantial increase in absolute numbers of individuals affected in African populations over the next decade if no interventions are made[1].

In sub-Saharan Africa and other Low- and Middle-Income regions, 90% of glaucoma is undetected until too late[4]. Glaucoma causes severe visual impairment and irreversible blindness which impacts the ability to work, economic empowerment, autonomy and dignity of the affected. An ideal situation for reducing avoidable blindness due to glaucoma is having a system where the population is knowledgeable about the condition, a strong mechanism to screen and find early cases, strong referral linkages to where the care is, an armamentarium of good treatment options, follow up and rehabilitative services. Unfortunately, such a system does not exist in Uganda and many other resource limited setting areas.

In Uganda, glaucoma was reported to cause 38.5% of all blindness, second only to Nigeria which had 42%[5]. This is due to several sequential factors which ultimately lead to blindness among patients with glaucoma. There is very low level of awareness among the population and a resource-limited primary health system to enable identification of patients at risk, no capacity to support active case finding, a weak disjointed referral system and a highly centralised and less accessible glaucoma care. Ultimately, majority of patients present late to the tertiary hospitals with sight loss in one or both eyes[4].

As part of a 3-year glaucoma screening and treatment project in southwestern Uganda, in collaboration with Mbarara University of Science and Technology (MUST), Ruharo Mission Hospital, and Christian Blind Mission, this study was conducted with an aim of measuring the

baseline capacity for glaucoma screening and treatment at primary and secondary level health centers in southwestern Uganda.

MATERIALS AND METHODS

Ethics statement: This study protocol adhered to the tenets of the Declaration of Helsinki and was granted ethical approval in Uganda by the Mbarara University of Science and Technology research ethics committee (Approval reference number 2021-257 and Uganda National Council of Science and Technology (Approval reference number HS2016ES. In addition, permission was sought from Uganda Ministry of Health and the District Health Offices to approach the facilities. Informed consent was sought from the health facility in-charges prior to the data collection.

Study design and setting: In a cross-sectional study design, primary and secondary level health facilities within the project area (southwestern and south-central Uganda) were enrolled. Primary health facilities consisted of health center IVs and district hospitals. Secondary level facilities were the four regional referral hospitals across four districts (Masaka, Kabale, Fort Portal and Mbarara).

The health system in Uganda is organized based on a tier system comprised of seven levels with the lowest unit being at the village level. Patients are referred along this tier system depending on the complexity of care required for the condition they present with.

Sampling: All the health facilities within the project area were enrolled into this baseline survey. This included 72 Health Centre IVs, 10 district hospitals and 4 regional referral hospitals. Consideration of these levels was guided by the Uganda Ministry of Health scheme of service where ophthalmology services are provided for starting at a health center IV level.

Data collection: Data collection was done in 2022 by trained research assistants. These travelled to the health facilities and administered in person interviewer guided questionnaires and checklists. The tools included a staffing profile checklist to ascertain the number of eye health cadres available at the selected facilities, survey questionnaires with glaucoma picture quizzes to ascertain the level of knowledge on glaucoma, an inventory checklist to establish equipment and consumables available and functioning to screen, diagnose and treat glaucoma. Other general parameters like outpatient attendance and registered diagnoses (eye conditions) in the past 12 months were recorded.

Data analysis: Data was entered and cleaned using Microsoft excel workbook, analysis was done using excel and STATA v15. We used descriptive statistics to report health facility, patient characteristics, and human resource capacity at the health facilities. Inventory of the available glaucoma diagnostic equipment and medicines was presented by proportions in a bar graph. Knowledge was reported as percentage scores of a test that had 26 questions on: i) Seven questions on parameters for diagnosis of glaucoma; ii) Six questions on presentation of glaucoma; iii) Four questions about investigations for glaucoma; iv) Five questions on management of glaucoma, and v) Four picture quizzes about diagnosis of glaucoma (Appendix 2). The total scores of the participants were calculated out of 26 and multiplied by 100 to get the percentage score. The median score for the primary and secondary level health facility was calculated, and presented along with the interquartile and full ranges. The list of questions and picture quiz have been attached as supplementary material.

RESULTS

A total of 86 facilities were enrolled in this study, 72 (83.7%) were health center IVs (primary level health center), 10 (11.6%) were district hospitals (primary level health facilities) and 4 (4.7%) were regional referral hospitals (secondary level health facilities). Table 1 shows health facility and patient characteristics. The total outpatient attendance at these facilities for the past 12 months was 956,725 of which majority (63.8%) were female. Of these, 22,090 (2.3%) had an eye condition and only 67 (0.007%) had a diagnosis of glaucoma.

Table 1: Health facility and patient characteristics

Variable	No.	(%)
Level of Health Centre		
Health Centre IV	72	(83.7)
District Hospital	10	(11.6)
Regional Referral Hospital	4	(4.7)
Outpatient attendance in the last 12 months		
Male	346,328	(36.2)
Female	610,397	(63.8)
Patients with an eye condition*		
Male	4,476	(1.3)
Female	17,614	(2.9)
Proportion of patients with diagnosis of glaucoma†		
overall	67	(0.007)
Male	24	(0.007)
Female	43	(0.007)

*The proportion for eye condition were percentages of the total number of males (346,328) and females (610,397) †Proportion for the diagnosis of glaucoma were percentages of total number of patients (956,725), total number of males (346,328) and females (610,397)

In terms of human resource staffing coverage (Table 2), 45 out of 86 (52.3%) facilities did not have any eye care worker. Eye care workers were considered as ophthalmic assistant, ophthalmic nurse, ophthalmic clinical officer, and ophthalmologists. This study did not consider optometrists because they are currently not yet included in the Uganda Ministry of Health scheme of service. All the facilities without any eye care worker were health center IVs.

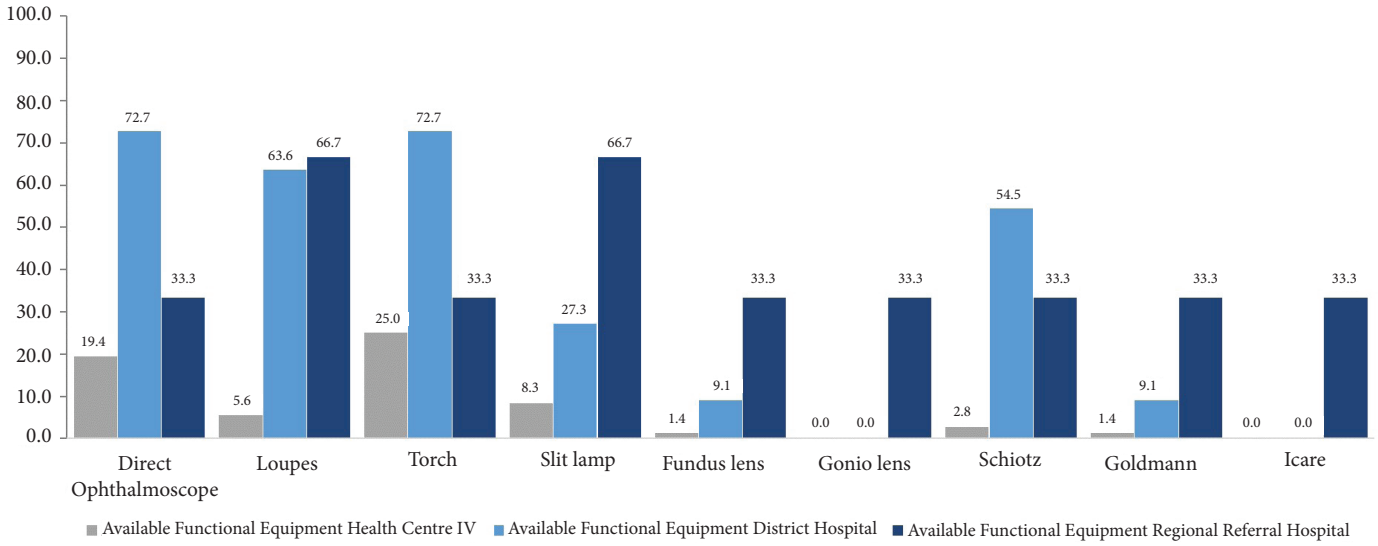
Table 2: Human resource capacity at the health facilities

Cadre type	Staffed facilities, No.	Total number of facilities, No.	(%)
Ophthalmic assistant coverage			
Health Centre IV	3	72	(4.2)
District Hospital	4	10	(40)
Regional Referral Hospital	1	4	(25)
Ophthalmic nurse coverage			
Health Centre IV	2	72	(2.8)
District Hospital	4	10	(40)
Regional Referral Hospital	2	4	(50)
Ophthalmic Clinical Officer coverage			
Health Centre IV	25	72	(34.7)
District Hospital	9	10	(90)
Regional Referral Hospital	4	4	(100)
Ophthalmologist coverage*			
Health Centre IV	0	72	(0.0)
District Hospital	0	10	(0.0)
Regional Referral Hospital	4	4	(100)

*According to the Uganda Ministry of Health scheme of service, Ophthalmologists are expected to be at a regional referral hospital level. The other eye care workers are expected to be deployed at health center IVs, district hospitals and regional referral hospitals

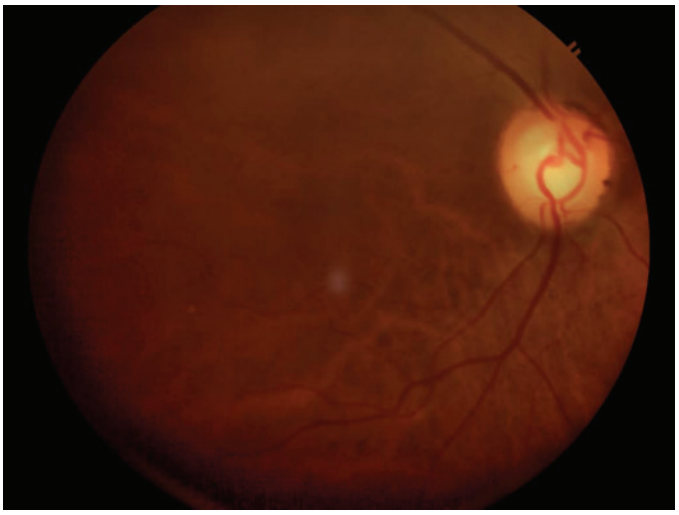
In regard to equipment, this study considered a direct Ophthalmoscope (used for viewing the optic nerve head) and any intraocular pressure measurement device (Shiotz tonometer, Perkin's tonometer and icare tonometer) as basic tools for diagnosis of glaucoma. A summary of these findings is presented in Figure 1. Only 28 (32.6%) facilities had a direct Ophthalmoscope of which 22 were functional at the time of the study. Availability of this equipment was more at the district and regional referral hospitals. Only 10% of the facilities had a Schiotz tonometer, while the icare and perkins tonometer were rare at 1.2%.

Figure 1: Available functional equipment inventory at the different health facility levels (n=86)

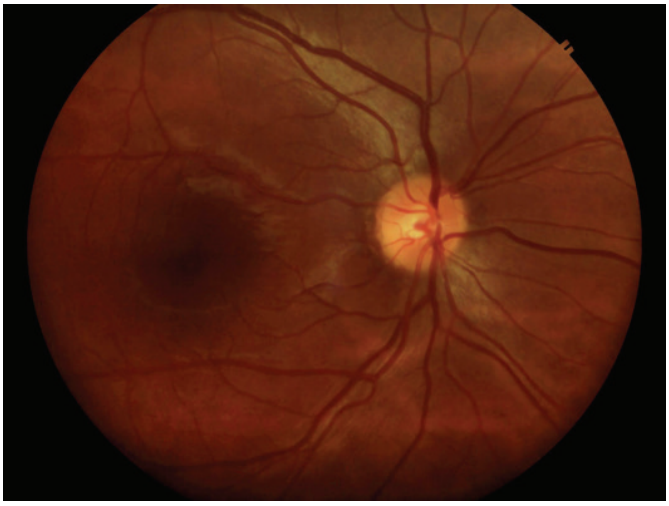


Concerning glaucoma consumables at the 86 facilities, this study noted a low supply of glaucoma medications at the health facilities as indicated in the Figure 2. We found that only 16 (18.7%) had dilating drops, 12 (14.0%) had amethocaine and 7 (8.1%) had fluoresceine strips. Timolol eyedrops a basic glaucoma treatment drug was available in stock at only 12 out of 86 health facilities (14.0%).

Figure 2: Availability of glaucoma medicines and consumables at the health facilities



Fundus image of a patient with a cupped disc that was used in the picture test



Fundus image of a normal disc that was used in the picture test

Knowledge of ophthalmic clinical officers and other eye care providers: Knowledge among all cadres of eye care was lowest at health center IVs with a median test score of 34.6% (IQR 25 – 53.8, full range 0.0 - 92.3), moderate at district hospitals with a median test score of 67.3% (IQR 51.9 – 81.7, full range 42.3 - 96.2), and highest at regional referral hospitals with a median test score of 82.7 (IQR 79.8 – 86.5, full range 76.9 -92.3).

DISCUSSION

In Uganda, the prevalence of glaucoma is estimated to be that of Africa which is around 4.8%[1]. However, our study revealed a gross under diagnosis of the condition with a prevalence of glaucoma in the study population standing at only 0.007%. Therefore, for every glaucoma case diagnosed, about 685 other cases are missed. This shocking finding suggests that there is a gross under diagnosis of glaucoma in the country, highlighting the gross under capacity to diagnose and manage glaucoma and eye health in general within the health system. Underpinning these were the grossly low staffing levels, low levels of knowledge among the heath workers, lack of equipment and drugs.

The study also assessed the knowledge about glaucoma among healthcare workers at various levels of care. The lowest level of knowledge was observed at health center IVs, while the highest level of knowledge was observed at regional referral hospitals. The results showed that the knowledge about the condition was commensurate with the available cadre at the eye facilities.

As per the staffing norms set by the Uganda Ministry of Health, it is expected that every healthcare facility at the HC IV level and above should have an Ophthalmic Clinical Officer (OCO) among the staff. However, our findings indicate that 52.3% of the health facilities lack an eye health worker, resulting in patients being attended to by non-ophthalmic staff members who possess limited knowledge of eye care[6,7]. The insufficient staffing levels at these facilities may contribute to the low utilization of eye care services, as evidenced by only 2.3% of individuals presenting for treatment of eye conditions in this study. This raises concern as early diagnosis and treatment are crucial in preventing the progression of glaucoma and avoiding blindness[8]. Insufficient Human Resources for Eye Health (HREH) is a prevalent issue in many sub-Saharan African countries, impeding the achievement of the Vision 2020 staffing target[9,10].

The findings of this study highlight a concerning lack of essential eye equipment and diagnostic and treatment resources for glaucoma in the majority of health facilities. This situation mirrors the challenges faced by several developing countries, underscoring the urgent need for enhanced infrastructure and increased availability of resources to support the diagnosis and management of glaucoma in Uganda[11]. Notably, the study revealed that only 14.0% of the surveyed health facilities stocked Timolol eye drops, a fundamental medication for glaucoma treatment. It is worth noting that Timolol is not only the most affordable antiglaucoma medication but also listed as a basic requirement for glaucoma management by the International Agency for the Prevention of Blindness[12]. Consequently, it is imperative that Timolol be made readily available in all facilities offering eye services, especially considering that a 5ml bottle of locally made eye drops costs approximately US$4 in the market.

Limitations

This study evaluated the capacity of the facilities to screen and treat for glaucoma at a specific point in time, potentially coinciding with a period when the facilities may have experienced stockouts.

Strengths

This study provides insightful information for advocacy towards strengthening eye care services in the country.

CONCLUSION

The study highlights the need for improved eye care services in Uganda, particularly in the diagnosis and management of glaucoma. There is a need for increased awareness and education about the condition, as well as improved infrastructure and resources. Addressing these issues will go a long way in reducing the burden of glaucoma and preventing blindness in the country.

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

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Questionnaire 1: Health centre data tool

Health Centre data collection tool. This tool will be used for collecting information from the health centre on knowledge, capacity, and practise in management of glaucoma. It has four parts; general information, knowledge on glaucoma, capacity of the health centre and information on treatment practise for glaucoma.		
Name of the HC		write
1. Study Number	(write)	
2. Location (district)	(write)	
3. Level of the HC	1=HCIV, 2=District Hospital, 3=RRH	
4. Geo location of HC	Write Latitude	
	Write Longitude	
5. How would you describe the road access to your HC?	1=Mostly murram (not graded), 2=Mostly graded murram 3=Mostly tarmacked	
6. What is the population coverage of your HC?	Write number	
7. Is there a functional latrine/toilet?	0= No, 1 = Yes	
8. Is there a water source at the HC?	0= No, 1 = Yes	
9. What is the main water source do you have at the HC?	0= none, 1=Well, 2, 3 = Piped, 4= Roof collected tank, 5=Borehole, 6=protected spring	
10. How far is the nearest water source?	0= water at HC, distance in metres	
11. What is your main type of electricity supply?	0= None, 1 = solar, 2=Hydro, 4=Generator	
12. Is there mobile phone network?	0 = No, 1 = Yes	
13. What is the distance in KM of the next referral centre		
14. Name of the next referral centre		
15. Geo location of the next referral centre	Write Latitude	
	Write Longitude	
16. What is the Level of the next referral HC	1=HCIV, 2=District Hospital, 3=RRH	

HC Capacity					
17.	What is the total number of staff at your HC?	Write number			
18.	What is the total number of the following types of staff cadre available at your HC? If none write 0	1=Ophthalmic assistant			
		2=Ophthalmic nurse			
		3=Ophthalmic Clinical Officer			
		4=Ophthalmologist			
19.	Equipment for screening/treating glaucoma				
20.	What eye equipment is available to you: (If available, ask about condition and number)	Item	Available 0=No, 1=Yes	Number of functional equipment	Number of non-functional equipment
		Direct Ophthalmoscope			
		Magnifying loupes			
		Torch			
		Slit lamp			
		Fundus diagnostic lenses (D90/D78/D60)			
		Gonio lens			
		Schiotz tonometer			
		Goldman tonometer			
		Icare tonometer			
		Perkin's tonometer			
21.	Which of the following glaucoma diagnostic consumables do you have currently?	Fluorescein strips	0=No, 1=Yes		
		Amethocaine eye drops	0=No, 1=Yes		
		Dilating eye drops	0=No, 1=Yes		
22.	Drugs				
23.	Which of the following glaucoma treatment stocks do you have currently?	Timolol eye drops	0=No, 1=Yes		
		Betoxolol eye drops	0=No, 1=Yes		
		Pilocarpine eye drop	0=No, 1=Yes		
		Acetazolamide tablets	0=No, 1=Yes		
		Latanoprost eye drops	0=No, 1=Yes		
		Bimatoprost eye drops	0=No, 1=Yes		
		Brimonidine eye drops	0=No, 1=Yes		
		Dorzolamide eye drop	0=No, 1=Yes		
		IV Mannitol	0=No, 1=Yes		
24.	Knowledge-information to be obtained from the OCO or person who usually sees eye patients or the in charge				
25.	What is your training in eye care?	0=None, 1=partial (as part of my course), 2= Certificate in eye care, 3=Diploma in eye care, 4=Specialist			

26. How much in percentage time of your training was spent on eye care?	Out of 100%		
27. According to you, what is the definition of glaucoma? 0=Not mentioned, 1=Mentioned		Optic nerve disease	
	Progressive		
	Visual field loss		
	Blindness		
	Irreversible		
	Raised IOP		
	Cupped disc		
28. According to you, how is a patient of glaucoma most likely to present? 0=Not mentioned, 1=Mentioned		Blind/reduced vision	
	RAPD		
	Visual field loss		
	Pain (occasionally)		
	Cupped disc/disc changes		
29. Here is one picture of the back of the eye, can you mention which structures you are able to identify? 0=Not mentioned, 1=Mentioned		Normal Retina	
	Normal Optic disc		
	Normal blood vessels		
30. What would you say is the diagnosis in the picture shown? 0=Not Mentioned, 1=Mentioned		Normal Eye	
	Other (write)		
31. Here is another picture of the back of the eye, can you mention which structures you are able to identify? 0=Not mentioned, 1=Mentioned		Cupped optic disc	
	Pale disc		
	Peri papillary atrophy		
	Nasal shifting of the vessels		
32. What is the most likely diagnosis in this picture? (write) 0=Not mentioned, 1=Mentioned		Normal Eye	
	Glaucoma		
	Other (write)		
33. Assuming you had all the resources available to you, how would you confirm this condition? 0=Not mentioned, 1=Mentioned		IOP check	

	Visual fields		
	History of glaucoma/blindness		
	OCT		
	CCT		
	Anterior segment OCT		
	Gonioscopy		
34. Assuming you had all the resources available to you, how would you treat this condition? 0=Not mentioned, 1=Mentioned		Refer	
	Counselling		
	Eye drops		
	Surgery		
	Laser		
35. According to you, do you think this condition can be reversible?		0=No, 1=Yes	

Questionnaire 2: HMIS data tool

Health Centre data collection tool. This tool will be used for collecting information from HMIS summary from the health facilities by district to determine the proportion of people presenting with glaucoma in Southwestern Uganda.		
Variable		write
1. Name of facility	(write)	
2. Location (district)	(write)	
3. Total number of patients seen in the past 12 months	(write)	
4. Total number of males seen in the past 12 months	(write)	
5. Total number of adults seen in the past 12 months	(write)	
6. Total number of male adults seen in the past 12 months	(write)	
7. Total number of Children seen in the past 12 months	(write)	
8. Total number of male children seen in the past 12 months	(write)	
9. Total number of patients with eye conditions seen in the past 12 months	(write)	
10. Total number of males with eye conditions seen in the past 12 months	(write)	
11. Total number of adults with eye conditions seen in the past 12 months	(write)	
12. Total number of male adults with eye conditions seen in the past 12 months	(write)	
13. Total number of Children with eye conditions seen in the past 12 months	(write)	
14. Total number of male children with eye conditions seen in the past 12 months	(write)	
15. Total number of patients with glaucoma seen in the past 12 months	(write)	
16. Total number of males with glaucoma seen in the past 12 months	(write)	
17. Total number of adults glaucoma seen in the past 12 months	(write)	
18. Total number of male adults with glaucoma seen in the past 12 months	(write)	
19. Total number of Children with glaucoma seen in the past 12 months	(write)	
20. Total number of male children with glaucoma seen in the past 12 months	(write)	

Ethiopian National Retinoblastoma Guidelines for Care

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ABSTRACT

Retinoblastoma is a rare childhood eye cancer with a promising outcome upon early detection and treatment. The survival rate in developed countries is more than 99%. In Ethiopia, our previous published studies showed that 47% of them died from cancer.

Retinoblastoma is one of the focus areas of the WHO under Global Initiatives for Childhood Cancer. To catch up with the global initiatives in May 2018, we conducted the first retinoblastoma symposium in Ethiopia by hosting various ophthalmologists, paediatric oncologists, pathologists, parents, and support groups. Leaders and experts (focal eye care and disease control) from the Federal Ministry of Health led the symposium. World-known retinoblastoma experts from Canada, the USA, and Kenya participated in this symposium and shared knowledge on developing retinoblastoma guidelines.

At the end of the two-day meeting, a technical group comprising ophthalmologists, paediatric oncologists, pathologists, public health experts, parents with retinoblastoma, and organizations supporting children with cancer was established to develop a national retinoblastoma guidelines.

This team has worked on this guidelines to promote early cancer detection, smooth referral systems between institutions, standardize clinical care among health facilities, and support families and children with retinoblastoma. This guideline was reviewed, commented and enriched by experts in retinoblastoma from

Canada, Kenya, Israel, DRC, and France. This guideline will be the second for the sub-Saharan African region. It is also endorsed by the Federal Ministry of Health and to be implemented among all sectors and stakeholders.

INTRODUCTION

Retinoblastoma (RB) is the most common intraocular malignancy of childhood, but a relatively rare disease, occurring in approximately 1: 16,000–18,000 live births[1]. The tumor(s) arises from embryonic retinal cells, so most cases occur under the age of 4 years. This aggressive tumor proliferates, metastasizes early, and can be fatal; however, it is also curable if treated early. The most common presentation is leukocoria, a whitening of the ordinarily red reflex in the eye. Still, if this early sign does not prompt the family to seek care, the tumor can continue to grow and spread relatively undetected until it may be too late for a cure, which can happen within months[2]. Mortality from retinoblastoma in Africa and Asia is 40-70%, much higher than 3-5% in Europe, Canada, and the USA[2]. Likewise, the disease burden is much more significant in Low and Middle-Income Countries (LMICs), with an estimated 84% of all children with cancer in the world residing in LMICs[3]. Survival and visual outcome in retinoblastoma are dependent on the severity of the disease at the time of presentation, so early detection is paramount to survival; however, children in East Africa present an average of 9 to 11 months later than their counterparts in the US and Canada, one leading to poor survival rates[4].

Ethiopia has one of the highest incidences of retinoblastoma in sub-Saharan Africa, claiming 19% of all cases in a recent study of select sub-Saharan African countries. The number of cases is likely underreported[4]. In a recently published Ethiopian study, 40.1% of patients had extraocular retinoblastoma at presentation, with a median delay of 12 months between the onset of symptoms of retinoblastoma and presentation to Menelik II Hospital (the leading RB center in Ethiopia)[5]. Unpublished research from the same center indicated a low survival rate (49.5%). The patient's delayed presentation caused significant mortality at the center for retinoblastoma treatment[6]. In the US and Canada, early screening and treatment contribute to 95-97% survival, while survival in Africa and Asia ranges from 30-60%[2].

Ophthalmologists, oncologists, paediatric nurses, imaging specialists, pathologists, pharmacists, child-life specialists, and social workers are just a few of the members of a multidisciplinary team that is most suited to treating retinoblastoma[7]. Late referral and delayed diagnosis result in difficult-to-treat large tumors, blindness, extraocular disease, and mortality. There is evidence that earlier diagnosis improves treatment outcomes[8].

The purpose of this protocol is to improve the quality of care for retinoblastoma patients by standardizing the care across health institutions and providing a guide to Ethiopian health workers and policymakers on early detection and proper management and follow-ups of RB patients.

MATERIALS AND METHODS

The Ethiopian National Retinoblastoma Guideline technical group was established in 2018 to increase survival and decrease mortality from retinoblastoma in Ethiopia through;

(i) Ensuring early diagnosis of retinoblastoma by increasing awareness among the health care workers as well as the general public.
(ii) Ensuring early detection and immediate referral of children suspected of retinoblastoma.
(iii) Improving the quality of medical treatment of children with retinoblastoma through standard treatment and quality pathologic reports.
(iv) Ensuring psychosocial support for families with retinoblastoma.
(v) Influence national strategic planning for cancer care to include retinoblastoma diagnosis and treatment in Ethiopia

The core and expert committee were selected from the first Ethiopian Retinoblastoma symposium, which was conducted in May 2018. This committee comprises local and global retinoblastoma experts, a retinoblastoma support group, and a Federal Ministry of Health representative from Ethiopia.

Guideline development

This document aims to improve the quality of care for retinoblastoma patients by standardizing the care across health institutions and providing a guide to Ethiopian health workers and policymakers on early detection and proper management and follow up of RB patients.

As seen from the committee list, the Expert Committee that prepared this document comprised individuals from the medical field, researchers, representatives from the government, family support organizations, and public health experts in screening, diagnosis, genetics, and treatment.

In order to develop recommendations in each aspect of RB care, we identified the clinical problems in RB care and conducted an extensive literature review.

The criteria for evaluating the references used to support the recommendations were taken from previously published standards (Table 1)[9].

Table 1: Criteria for assigning a level of evidence to recommendations

Level of evidence	Criteria
1	Randomized Controlled Trials (RCTs) (or meta-analyses) without important limitations
2	RCTs (or meta-analyses) with important limitations Observational studies (non-RCTs or cohort studies) with overwhelming evidence
3	Other observational studies (prospective cohort studies, case-control studies, case series)
Consensus	Inadequate or no data in population of interest Anecdotal evidence or clinical experience 100% agreement of Steering & Expert Committee members

SCREENING

Early detection, when tumors are still small, maximizes survival and vision outcomes and reduces the need for radiation, chemotherapy, and enucleation. In addition, serial examinations help detect tumors early and protect vision because retinoblastoma tumors can grow gradually during early childhood[10,11].

Screening close relatives at risk of the disease are invaluable in early detection and treatment. In addition, early detection and immediate referral of children with retinoblastoma increase the possibility of saving lives and eyes and preserving functional vision. Hence, the ultimate goals of screening children at risk for retinoblastoma are the early diagnosis of the tumor followed by appropriate treatment when they are minimal and manageable with local therapies. Screening is based on risk stratification, including genetic testing and counseling.

Vision screening guidelines: In preschool, all children should undergo eye exams for conditions like RB and cataracts, as well as amblyopia or conditions that increase their chance of developing it. The child's general practitioner /paediatrician makes sure that these examinations are carried out. Regular children's vision screening may help to detect RB earlier. The Canadian Paediatric Society (CPS) suggested checking for RB symptoms during routine eye exams[12].

Table 2: Vision screening guidelines from the Canadian Paediatrics Society[12]

Age	Screening guideline
Newborn to 3 months	A complete examination of the external eye structures including the conjunctiva, cornea, iris, and pupils
	Red reflex inspection of the red reflex to rule out lenticular opacities or RB.
	Failure of visualization or abnormalities of the reflex are indications for an urgent referral to an ophthalmologist
	High-risk newborns (at risk of retinopathy of prematurity and family histories of hereditary ocular diseases) should be examined by an ophthalmologist
6 to 12 months	Conduct examination as above
	Ocular alignment should again be observed to detect strabismus. The corneal light reflex should be central and the cover-uncover test for strabismus normal
3 to 5 years	Conduct examination as above
	Visual acuity testing should be completed with an age appropriate tool
6 to 18 years	Screen as above whenever routine health examinations are conducted
	Examine whenever complaints occur

SCREENING - RECOMMENDATIONS

(i) We recommend that all infants and children in whom someone has observed a white pupil (either in person or in a photograph) have a full dilated-eye examination, including a red reflex test within 72 hours by an ophthalmologist or medical practitioner who is fully aware of the importance of leukocoria as a sign of RB[7,13].

(ii) We recommend that health workers look for a white pupil or strabismus during routine immunization visits [Consensus].

(iii) We recommend that any child aged less than five years of age with strabismus or suspected strabismus be seen by their primary care provider (General Practitioner (GP) /paediatrician:

(a) We recommend that the oblique viewing red reflex test be applied to any child with

strabismus or suspected strabismus after pupillary dilation[14].

(b) We recommend urgent referral (within 72 hours) to an ophthalmologist of any child with strabismus or suspected strabismus and an abnormal red reflex[7].

(c) We recommend that secondary or tertiary RB centers see the child in (b) above within 72 hours for the above signs or abnormalities, which constitutes an emergency (see "Referral and Diagnosis" section) [Consensus].

(iv) We support the Canadian Paediatric Society (CPS) recommendations concerning the suggested timing of vision screening for the general population[12].

(v) We recommend incorporating information related to retinoblastoma screening in the national immunization information booklet [Consensus].

(vi) We recommend that primary doctors and paediatricians do a routine red reflex test for all sick children under five years visiting their outpatient clinics [Consensus].

FEATURES AND CLASSIFICATION OF RETINOBLASTOMA CENTRES IN ETHIOPIA

According to a recent study, 19% of retinoblastoma patients in sub-Saharan Africa were from Ethiopia. The number of cases is likely underreported[4]. The need for RB centers and human resources is challenging in caring for retinoblastoma patients. This guideline section discusses the mandatory resources that should be allocated for primary, secondary, or tertiary-level retinoblastoma centers. For appropriate resource and expertise allocation, we recommend that the retinoblastoma service-providing centers be classified as primary, secondary, and tertiary (Table 2).

*Primary centers***:** These centers aim to make a preliminary disguise of retinoblastoma by first contact level health providers (nurses, health officers, general practice doctors, and paediatricians). Based on the referral system of Ethiopia, health posts, health centers, district-level hospitals, and privately owned clinics will be considered Primary RB Centers.

Secondary level RB centers: These centers should be able to make a clinical diagnosis of retinoblastoma, treat it by enucleation, and send the eye for pathological examination by a qualified pathologist. Regional referral hospitals, private or public comprehensive hospitals, and specialized eye centers will be labeled secondary RB Centers.

Tertiary level RB centers: The tertiary retinoblastoma centers should be able to confirm the diagnosis with B-Scan ultrasound and/or MRI and treat retinoblastoma by focal treatment, chemotherapy, and enucleation. In addition, these centers can manage complex cases with advanced treatment modalities and conduct various research. University teaching hospitals with training, service and research capacities in the eye cancers field are considered tertiary centers.

Retinoblastoma specialist: A paediatric ophthalmologist, retinal specialist, ocular oncologist, oculoplastic surgeon or a general ophthalmologist with specialized training on RB (and sometimes more than one, working as a team) will manage the ongoing care of children with RB. The primary treatment for unilateral RB is the removal (enucleation) of the affected eye. A surgeon specializing in RB will know how to harvest tumors for genetic studies after eye removal. Specific training in the overall management of RB will include knowledge about and experience with focal therapy.

Paediatric oncologists and radiotherapists: A paediatric oncologist(s) dedicated to treating RB patients will participate in the care and lead management when chemotherapy is required. They will evaluate Cerebrospinal Fluid (CSF) and bone marrow when the child is at risk for metastatic disease. In addition, the oncologist actively recruits patients who need chemotherapy to suitable multicenter clinical trials, as available.

Social worker/Psychosocial support: A specifically dedicated social worker helps RB families cope with the emotional and financial implications of a new cancer diagnosis, providing counseling to facilitate coping with the crisis, adjustments, support and resource management, and education about RB and the treatment process. In addition, psychosocial support includes palliative care and bereavement support for end-of-life patients and their families.

Table 3: Minimum mandatory staffing and resources requirements for secondary and tertiary RB centers in Ethiopia

Facility	Secondary level RB centers	Tertiary level RB centers
Personnel	Ophthalmologist	Ophthalmologist
	Pathologist	RB specialist
	Anaesthetist	Paediatric oncologist
		Radiologist
		Pathologist with RB expertise
		Anaesthesiologist
		Social worker/psychosocial support
		Genetic councilor
		Ocularist
Surgical capacity	Examination under anaesthesia	Examination under anaesthesia
	Capacity to perform enucleation	Capacity to perform enucleation
Treatment		Laser therapy (Transpupillary thermotherapy by diodd laser)
		Cryotherapy
		Chemotherapy
	B-Scan ultrasound	B-Scan ultrasound
	MRI	MRI
	CT Scan	CT Scan
		Genetics – Ocular screening of Proband's family
Research	Basic research	Basic research
		Clinical trials

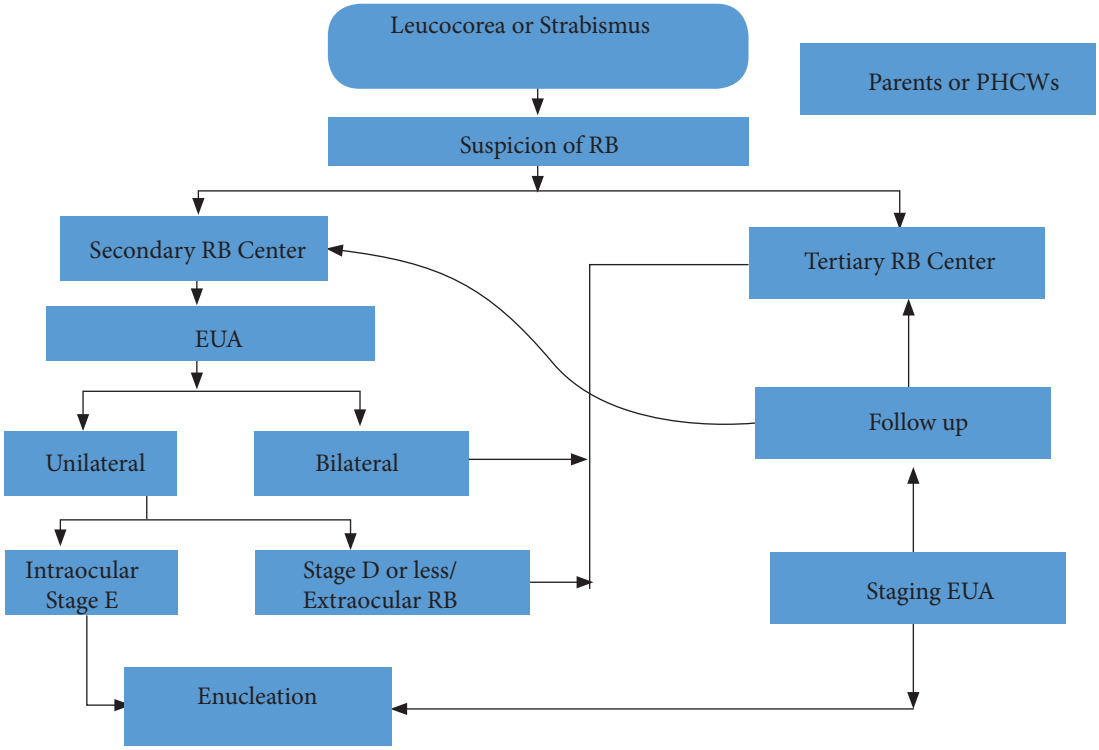
REFERRAL AND DIAGNOSIS

Early referral to the appropriate retinoblastoma centers is essential for timely diagnosis and good treatment outcomes in the care of retinoblastoma families. The primary care physician plays a critical role in the referral process. Secondary and tertiary RB centers further establish the diagnosis and develop the initial treatment plan.

The delay in referral lag (time between the initial visit with a primary healthcare professional and appointment with an ophthalmologist) had serious consequences for some patients with RB[15].

A retrospective study in Ethiopia showed that 28 (74.5%) patients delayed seeing a healthcare provider for three months after the onset of symptoms. The delay in presentation was due to a lack of knowledge and cost. Cost and distance are significant barriers to seeing referred RB centers and receiving appropriate treatment[16].

Figure 1: Referral algorithm for retinoblastoma cases in Ethiopia



REFERRAL AND DIAGNOSIS-RECOMMENDATIONS

(i) We recommend that any child with signs consistent with RB be referred to an ophthalmologist to receive a full retinal examination with dilated pupil and have a detailed history taken to confirm or rule out a diagnosis of RB [Consensus].

(ii) We recommend that secondary and tertiary centers accept direct referrals with suspicion of RB from primary healthcare providers, such as general practitioners and paediatricians [Consensus].

(iii) We recommend that primary healthcare providers obtain and record a complete contact address, including telephone contacts, and immediately refer all RB cases to a secondary or tertiary RB center [Consensus].

(iv) We recommend that all children referred with any possibility of RB be seen within 72 hours, or as soon as possible, at the secondary or tertiary RB center for a thorough ocular and systemic examination to confirm or rule out a diagnosis of RB. The referring physician has a responsibility to communicate with the nearby secondary or tertiary center about the referral[7,13].

(v) We recommend that difficult unilateral cases (e.g., a very young child, potential to save the eye; unilateral multifocal and (or) germline RB1 mutation), or risk for extraocular disease and bilateral cases be referred from a secondary center to a tertiary center[7,13].

(vi) We recommend that any child with high-risk pathological features (see "Follow-up" chapter) be referred to a tertiary center[7,13].

(vii) We recommend that the RB center promptly inform the referring physician of the diagnosis, management, and outcome of the referral and invite the referring physician to remain involved with the non-RB care and follow-up of the child, as appropriate [Consensus].

(viii) We recommend that in order to reduce risks associated with radiation exposure, all children with RB have an MRI of the head and orbits at diagnosis rather than a CT scan, if possible, to check for evidence of intracranial cancer and the extent of the disease[7,13].

(ix) We recommend developing RB programs at Tertiary Eye Care Units (TECUs) because they will likely have a paediatric oncology service and palliative care support [Consensus].

(x) In secondary label RB centers, if the patient's socio-economic conditions don't allow him/her to travel to third-level RB centers, we recommend that unilaterally affected eyes be enucleated unless that unilateral eye is group A or B [Consensus].

(xi) We recommend that all bilateral RB patients be referred to tertiary RB Centers for treatment and follow-up [Consensus].

(xii) We recommend the establishment of RB centers per the country's strategy for childhood cancer [Consensus].

GENETIC COUNSELLING

Retinoblastoma was first cancer for which a causal genetic mutation was discovered[17]. Any other family members may be at risk if retinoblastoma is diagnosed in one member of the family. When molecular genetic testing is available, genetic counseling can provide families with more precise information about their cancer risks[7]. Effective genetic information translation enables individuals who are at-risk to adhere to routine cancer surveillance for both themselves and their at-risk springs. Additionally, it encourages people to adopt a healthy lifestyle and make informed reproductive choices in order to reduce their risk of developing second cancer[18]. Due to the lack of genetic counseling in Ethiopia, the medical team is responsible for counseling the parents /guardians of RB. Patients with a family history of retinoblastoma should undergo genetic testing to determine their risk level[19].

When retinoblastoma is diagnosed, clinicians and parents communicate in an emotionally charged manner that includes explaining the disease's malignant nature to them, telling many of them that the removal of their child's eye(s) is necessary to save their life, and starting palliative care as needed. This is when genetic counseling takes place[18]. Ethiopian healthcare providers do not yet have access to a genetic counseling discipline.

GENETIC COUNSELLING- RECOMMENDATIONS

(i) We recommend antenatal history, including a detailed family history of eye disease, and referral to an ophthalmologist when this history is positive. For all individuals with RB and/or a family history of RB, except those excluded by genetic testing[7,13].

(ii) We recommend that expectant couples undergo early prenatal counseling and their infants undergo perinatal management to facilitate the earliest possible treatment[20,21].

(iii) We recommend standardized counseling in the absence of genetic testing for patients, parents, and other relatives to discuss RB, the risk and hereditary pattern of RB, pregnancy options, post–delivery surveillance screening protocols to diagnose tumors early in infants at risk, and treatment options[22,23].

(iv) We recommend that family members at risk be screened as soon as possible after birth, frequently until age seven years, according to the empiric risk of developing RB[20,21,23].

(v) We recommend awareness counseling about the risk of other cancers in adult survivors and relatives[21,24,25].

(vi) We recommend that children with RB be offered repeated genetic counseling as they grow up so that they completely understand their options and appropriate care for themselves and their children [Consensus].

(vii) We recommend RB1 gene mutation identification testing for the first affected person (proband) in each RB family[20,26].

(viii) When the RB1 gene mutation in a proband /family becomes known, we recommend genetic testing for all at-risk relatives[26,27].

(ix) We recommend that surveillance be discontinued for relatives determined to be NOT at risk by genetic testing [22,23,28].

PUBLIC AWARENESS AND EDUCATION

Lack of awareness about the symptoms of retinoblastoma among the public and health professionals is the main reason for the late presentation of patients. Hence, increasing knowledge and educating healthcare workers on Retinoblastoma (RB). In this guideline, we describe various successful public awareness campaigns on RB. Finally, we recommend increasing RB awareness and education in Ethiopia.

Public awareness campaigns: Awareness campaigns to educate the public on the signs and symptoms of leukocoria are likely to increase the rates of early detection of RB. In Ethiopia, a study was conducted to assess the referral pattern of patients with RB in 2018. Among the 73% (30/41) patients who presented ≥3 months after to the RB Center in Addis, 97% (29/30) of them did not think the white pupillary reflex was a problem. Hence, the lack of awareness among the public was the cause of the late presentation.

In Honduras, an RB awareness campaign was initiated to promote early diagnosis. Information about RB was disseminated, using posters and flyers, to parents via government health clinics during the annual vaccination campaigns beginning in 2003. Following the public awareness campaigns, extraocular RB decreased from 73% to 35%. The median age at diagnosis and the median time between the first sign or symptom and diagnosis was 3.8 and 1.7 months[29]. In Brazil, 20 new RB cases were diagnosed due to a national campaign for early diagnosis of RB. This program was initiated in September 2002, with a public service announcement highlighting leukocoria as a symptom of cancer (www.tucca.org.br) which was broadcasted on several television stations throughout the country. In addition, a toll-free telephone number was offered to the public so that anyone could call to get more information. In addition to the television advertisement, educational materials were provided to the general public, primary healthcare workers, and ophthalmologists[30]. Ethiopian RB patients' mean parental lag time was 7.97 months[16].

Health workers awareness: According to recommendations from the American Paediatric Association, every child in their first year of life should undergo the red reflex test at least once as part of a regular checkup[31].

A study among paediatricians in southern Ethiopia found that their awareness of the ranges of presentation and available treatment for RB needed to be improved[32].

Medical students' understanding of RB was increased in Jordan by modifying the teaching curriculum for the ophthalmology rotation and placing a stronger emphasis on red flags of RB[33]. Teaching retinoblastoma awareness could be added to training programs for undergraduate medical and nursing students, and refresher courses could be held for those currently working.

PUBLIC AWARENESS AND EDUCATION – RECOMMENDATIONS

(i) We recommend that RB be included in children's vaccination cards [Consensus].
(ii) We recommend that information on RB be included in under five clinic patient education sessions [Consensus].
(iii) We recommend that basic information on signs and symptoms of RB be given to local and religious leaders [Consensus].
(iv) We recommend the dissemination of information about RB using flyers and posters in the local language[29].
(v) We recommend disseminating information about RB through professional talks and articles in printing, electronic and social media[30].
(vi) We recommend public transport to spread awareness about RB[13].
(vii) We recommend organizing public awareness campaigns at the national level once per year in line with the RB week globally [Consensus].
(viii) We recommend working closely with the NGOs (Like local religious authorities and doctors without borders) to raise awareness of RB care and patient follow-up [Consensus].

EDUCATION FOR HEALTH WORKERS – RECOMMENDATIONS

(i) We recommend that major paediatric and vision screening associations provide information on signs and symptoms of RB in their print, mass media, and online public information materials [Consensus].
(ii) We recommend that information about the proper performance of the red reflex test be provided to all those with a responsibility to perform this screening (paediatricians, GPs, nurses, public health officers) (see "Screening" section) [Consensus].
(iii) We recommend that information on signs and symptoms of RB be provided to healthcare professionals who see young children and pregnant women in their clinics [Consensus].
(iv) We recommend that RB education be included in the healthcare curricula [Consensus].
(v) We recommend incorporating RB into existing paediatric cancer and eye disease programs [Consensus].
(vi) We recommend that basic signs and symptoms of "white Pupillary reflex " in addition to RB are taught to health extension workers [Consensus].
(vii) We recommend that professional societies working on eye and children (Ophthalmological Society of Ethiopia, Ethiopian Paediatric Society, etc.) include RB as part of their continued education [Consensus].
(viii) We recommend establishing a national RB center focusing on increasing awareness, conducting and disseminating research, and advocating for better RB Care in Ethiopia [Consensus].
(ix) We recommend establishing and strengthening family support groups on RB to enhance awareness and care towards RB [Consensus].

TREATMENT

Retinoblastoma treatment options can range between different centers worldwide and are constantly evolving. Nevertheless, all retinoblastoma experts generally have the same fundamental objectives: protecting life and preventing metastatic disease, preserving the globe, and eventually optimizing vision[34]. The extent of the retinoblastoma at the time of diagnosis (the intraocular disease classification and the stage of systemic disease), the condition of the contralateral eye, the child's general health, their socioeconomic situation[35], and their access to specialized care are all factors in how the disease will be managed[2,36].

Systemic Intravenous Chemotherapy (IVC) typically entails the monthly administration of 2, 3, or 4 chemotherapeutic drugs using a central or peripheral catheter for 6–9 consecutive cycles[37]. Three medications, including vincristine, etoposide, and carboplatin, make up the most popular treatment protocol (VEC)[37,36]. In addition, patients with bilateral illness, known germline mutations, retinoblastoma in the family history, or probable occurrences of the optic nerve or choroidal invasion are currently considered criteria for IVC[37].

Intra-Arterial Chemotherapy (IAC) is a complex and frequently expensive procedure that is best carried out in an angiography suit[34]. In addition, IAC delivers a chemotherapeutic dose to the eye that is ten times more than IVC[39]. Therefore, it is essential to the current management of retinoblastoma, particularly in unilateral

tumors[40]. However, IAC might not be possible in developing nations due to the cost, and specialist training needed[39].

In addition to IVC or IAC, focal therapy is frequently employed to consolidate tumors. Cryotherapy and transpupillary thermotherapy are the two most often used focal therapies nowadays (TTT)[34]. Cryotherapy is indicated in treating small tumors and foci of sub-retinal or pre-retinal seeds[34]. Chemo-cryotherapy increases intraocular medication concentration[37]. Transpupillary Thermotherapy (TTT) with a diode laser is used with chemotherapy as the primary treatment for tiny cancers smaller than 3mm in diameter and 2mm in thickness[41].

External Beam Radiation (EBRT) is mostly of historical significance in developed nations due to the numerous side effects. With orbital recurrence, extraocular tumor expansion, and a positive optic nerve margin after enucleation, EBRT still has a place in treatment; it has a role in developing countries[45]. It has been reported that 71% of patients receiving EBRT and IVC for orbital retinoblastoma achieve tumor control[41].

Brachytherapy is typically used as a secondary treatment for medium-sized (≤16mm in largest basal diameter and > 3 to ≤ 9mm in thickness) chemo-resistant tumors with or without localized vitreous or subretinal seeding, following recurrence after IVC or IAC. It can also be used to manage diffuse anterior segment retinoblastoma with or without IVC in the absence of choroidal or retinal tumors[42].

Enucleation is the fastest and least costly treatment. It is reserved for massive group E tumors, poor tumor visualization (e.g., due to vitreous hemorrhage), presence of extraocular extension, suspected invasion of the optic nerve or choroid, or recalcitrant tumors that have failed previous globe salvage therapies[44,45]. Children with extraocular RB usually present with severe pain caused by an orbital mass[46]. Retinoblastoma symptoms in Ethiopia revealed that extraocular tumors were found in 40.1% of cases[5].

Enucleation remains the primary therapy option for patients in advanced stages in Ethiopia. According to a prospective study conducted in Ethiopia, 114 (45.4%) of the 251 eyes were subjected to primary enucleation (87/114, or 76.5%) or exenteration (27/114, or 23.5%)[5].

Table 4: AJCC Clinical Staging1 8th edition, 2017[46]

cT1		Intra-retinal tumour(s) with subretinal fluid ≤5mm from base of any tumour
	cT1a	Tumours ≤3mm and further than 1.5mm from disc and fovea
	cT1b	Tumours >3mm or closer than 1.5mm from disc or fovea
cT2		Intraocular tumour(s) with retinal detachment, vitreous seeding, or subretinal seeding
	cT2a	Subretinal fluid >5mm from the base of any tumour
	cT2b	Vitreous seeding and/or subretinal seeding
cT3		Advanced intraocular tumour(s)
	cT3a	Phthisis or pre-phthisis bulbi
	cT3b	Tumour invasion of choroid, pars plana, ciliary body, lens, zonules, iris, or anterior chamber
	cT3c	Raised intraocular pressure with neovascularization and/or buphthalmos
	cT3d	Hyphaema and/or massive vitreous haemorrhage
	cT3e	Aseptic orbital cellulitis
cT4		Extraocular tumour(s) involving orbit, including optic nerve
	cT4a	Radiologic evidence of retrobulbar optic nerve involvement or thickening of optic nerve or involvement of orbital tissues
	cT4b	Extraocular tumour clinically evident with proptosis and/or an orbital mass
N1		Evidence of preauricular, submandibular, and cervical lymph node involvement
cM1		Clinical signs of distant metastasis
	cM1a	Tumour(s) involving any distant site (e.g., bone marrow, liver) on clinical or radiologic tests
	cM1b	Tumour involving the CNS on radiologic imaging (not including trilateral retinoblastoma)
H		Hereditary trait

	HX	Unknown or insufficient evidence of a constitutional RB1 gene mutation
	H0	Normal RB1 alleles in blood tested with demonstrated high-sensitivity assays
	H1	Bilateral retinoblastoma, retinoblastoma with an intracranial primitive neuroectodermal tumour (i.e., trilateral retinoblastoma), patient with family history of retinoblastoma, or molecular definition of a constitutional RB1 gene mutation
pT1		Intraocular tumour(s) without any local invasion, or with focal choroidal invasion, or preor intralaminar involvement of the optic nerve head
pT2		Intraocular tumour(s) with local invasion
	pT2a	Concomitant focal choroidal invasion and pre- or intralaminar involvement of the optic nerve head
	pT2b	Tumour invasion of stroma of iris and/or trabecular meshwork and/or Schlemm's canal
pT3		Intraocular tumour(s) with significant local invasion
	pT3b	Retrolaminar invasion of the optic nerve head, not involving the transected end of the optic nerve
	pT3c	Any partial-thickness involvement of the sclera within the inner two thirds
	cT3d	Full-thickness invasion into the outer third of the sclera and/or invasion into or around emissary channels
cT4		Extraocular tumour(s) involving orbit, including optic nerve
	cT4a,	Evidence of extraocular tumour: tumour at the transected end of the optic nerve, tumour in the meningeal spaces around the optic nerve, full thickness invasion of the sclera with invasion of the episcleral adjacent adipose tissue, extraocular muscle, bone, conjunctiva, or eyelids.

Table 5: International Intraocular RB Classification (IIRC)[47]

Group A: Very low risk (T1a)	**Small discrete tumours not threatening vision** **All tumours are 3mm or smaller, confined to the retina** • Located at least 3mm from the foveola and 1.5mm from the optic nerve • No vitreous or subretinal seeding
Group B: Low risk (T1b)	**No vitreous or subretinal seeding** **Tumours any size or location not in Group A** • No vitreous or subretinal seeding • Subretinal fluid no more than 5 mm from tumour base
Group C: Moderate risk (T2)	**Focal vitreous or subretinal seeding and discrete retinal tumours of any size and location** • Local, fine, and limited seeding (T3) • Discrete intraretinal tumours of any size and location (T2b) • Up to one quadrant of subretinal fluid (T2a)
Group D: High risk (T3b)	**Diffuse vitreous or subretinal seeding** • Diffuse intraocular disseminated disease Extensive or "greasy" vitreous seeding • Subretinal seeding may be plaque-like • More than one quadrant retinal detachment

Group E: Very high risk (T4a)	**Very high risk with one or more of the following:** • Irreversible neovascular glaucoma • Massive intraocular hemorrhage • Aseptic orbital cellulitis • Tumour anterior to anterior vitreous face • Tumour touching the lens • Diffuse infiltrating Rb • Phthisis or prephthisis

TREATMENT –RECOMMENDATIONS

(i) We recommend that children with RB be cared for by a multidisciplinary team that provides coordinated and collaborative care in and shared between specialized centers, with expertise and up-to-date protocols and equipment for optimal management of RB [Consensus].

(ii) We recommend that tertiary RB centers work together to ensure optimal care for each child. This might include cross-referrals and cross-consultations to access specific technical or human resources [Consensus].

Ocular treatment

Enucleation

(iii) Immediate enucleation is indicated for all Group cT3/ group E[7].
We recommend that upfront enucleation without pre-enucleation chemotherapy be performed for any cT3 /IIRC Group E eyes, which impose risk for difficult-to-treat systemic metastases. Pre-enucleation chemotherapy is dangerous since it may mask features of extraocular extension, causing under staging and under treating of systemic disease[48].

(iv) We recommend that enucleation be performed for Group cT2/group D eyes when the other eye is normal or Group A/cT1a[7].

(v) We recommend enucleation for recurrent tumors when all other treatment modalities (including EBR) have failed to prevent tumor spread outside the eye or when complications prevent evaluation and treatment of progressive disease[7].

(vi) We recommend enucleating a unilateral RB, except if there is sufficient experience and accessibility (geographic and financial) for eye salvage [Consensus].

Cryotherapy

(vii) We recommend cryotherapy for the treatment of small peripheral RB and (or) laser therapy for small posterior RB, primarily in Groups A/cT1a, B/cT1b, and C/ cT2a, or recurrences after other therapy[7].

(viii) We recommend that cryotherapy through a conjunctival incision may be used for posterior RB refractory to laser focal therapy[7].

(ix) We recommend using pre-chemotherapy cryotherapy 24–72 hours before chemotherapy to increase drug penetration into the eye, particularly for vitreous seeding, but not in the presence of retinal detachment[7].

Chemotherapy

(x) We recommend that chemotherapy consolidated by focal therapy replace primary EBRT[49].

(xi) We recommend systemic chemotherapy for the primary treatment of bilateral Group B/cT1b, C/ cT2a, or D/cT2b eyes and limited therapy for unilateral IIRC Group B /cT1b or C/cT2a eyes with good visual potential[7].

(xii) We recommend pre– enucleation chemotherapy to reduce the tumoral volume in severely buphthalmic eyes[50].

Radiotherapy

(xiii) We recommend that radiotherapy be used only as salvage therapy for the remaining eye after chemotherapy and focal therapy have failed to control the tumor[7].

Laser

(xiiii) We recommend laser coagulation for small tumors (Groups A/cT1a and B/cT1b eyes), residual tumors after chemotherapy, or recurrences following chemotherapy, particularly for lesions posterior to the equator[51].

Extraocular disease

For decision-making for treatment:

(xv) We recommend that patients with extraocular disease be categorized as having the intention to cure or to palliate.

Intention to cure = Patients with high-risk features on histology, or patients who present with proptosis without evidence of systemic metastasis.

Palliation = Those with evidence of metastasis clinically or investigations [Consensus].

(xvi) We recommend that ophthalmologists involved in the child's case review the pathological features of every enucleated eye for high-risk features, including invasion of the optic nerve, sclera, choroid, or anterior segment, that could predispose to extraocular disease or metastasis[52].

(xvii) We recommend treatment with prophylactic chemotherapy when high-risk features are observed, including invasion of the optic nerve, sclera, choroid, or anterior segment[52].

(xviii) We recommend adjuvant chemotherapy for children with post-laminar optic nerve involvement[53,54], with or without a tumor in the resection margin, or any degree of scleral involvement[55].

(xix) We recommend that metastatic disease be treated in palliative, using doses of doxorubicin or spot radiotherapy for symptom relief. We recommend avoiding three drug chemotherapy. These patients should be kept as close to their families as possible [Consensus].

(xx) We recommend that for extraocular RB (in the absence of systemic metastasis), treatment protocols generally include, but are not limited to: orbital radiation for orbital recurrence post-enucleation and systemic chemotherapy [Consensus].

(xxi) We do not recommend exenteration of the orbit for RB since chemotherapy will provide more effective palliation, even for massive proptosis[56,57].

(xxii) We recommend that extraocular RB treatment protocols generally include, but not be limited to, orbital radiation for orbital recurrence post-enucleation, systemic chemotherapy, stem cell/bone marrow transplant after an excellent response to systemic chemotherapy, and intrathecal chemotherapy for CNS disease with meningeal spread[58].

(xxiii) If RB metastasis is present in bone marrow, bone, or other organs or tissues, we recommend enucleation of the eye, adjunctive chemotherapy, and hematopoietic stem cell transplant if there is a chemotherapy response[58].

(xxiv) If RB extends into the orbit, to the cut end of the optic nerve, optic chiasm, or brain, we recommend enucleation of the eye, adjunctive chemotherapy, extended doses of intrathecal chemotherapy, irradiation of the involved tissues, followed by hematopoietic stem cell transplant if there is a chemotherapy response[58].

(xxv) If the RB tumor involves the meninges of the brain and spinal cord, we recommend palliative treatment [Consensus].

FOLLOW UP

Retinoblastoma is a cancer that most often affects very young children. Children with RB are particularly vulnerable to the long-term implications that the illness and the treatments given to them may have impact on organ development and function[59]. The need for lifelong follow up arises from the possibility of secondary tumors arising in heritable retinoblastoma survivors[60]. In a prospective investigation of around half of all new instances of retinoblastoma that were identified in treatment facilities around the world in 2017, the 3-year survival rate ranged from 57.3% in low-income countries to 99.5% in high-income countries[61]. Retinoblastoma is still a fatal illness in less affluent settings, and East African nations have reported survival rates as low as 30%[62]. In addition, descriptive research conducted in two sub-Saharan African nations revealed that two-thirds of the patients were lost at follow-up[63]. Delay with advanced disease, the stage at presentation and high rates of patient care default contribute to poor survival outcomes in developing countries[64]. Our earlier research revealed that Ethiopia's 40.9% of retinoblastoma cases were lost to follow-up[5]. A lack of resources may hinder long-term follow-up, patient awareness, and adult care system ignorance about the needs of childhood cancer survivors, particularly those with particular needs, like RB survivors[7]. Financial limitations were the leading cause of follow-up failure in the Ethiopian RB referral study[16].

FOLLOW UP –RECOMMENDATIONS

(i) We recommend that all survivors of RB receive individualized, lifelong follow-up and surveillance, counseling, and interventions for late effects of disease and treatment, delivered by a multidisciplinary team.

Ophthalmology follow-up

(ii) We recommend that following completion of treatment, EUAs for children at risk of developing new RB tumors continue as often as every three weeks or at longer intervals as tumor activity decreases until the risk of new tumors and recurrences is low. The child can cooperate in a clinic at about three years of age. The frequency of examinations will be highest when the child has a proven RB1 germline mutation[20,26,65].

(iii) We recommend that following the end of EUAs, clinic visits for the retinal exam should continue

every six months to age 9, annually to age 15, and every 2–3 years after that for life[7].

(iv) We recommend that children shown to not carry the RB1 mutant allele of their family through a blood test do not require EUA or intense surveillance[7].

(v) We recommend the examination of an enucleated socket for infection, a fit of prosthesis, and implant exposure or extrusion at every EUA and clinic visit[7].

(vi) We recommend prescribing and monitoring protective eyewear for functionally uniocular children[7].

(vii) We recommend that RB survivors of school age with significantly reduced visual fields or visual acuity less than 6/12 undergo visual assessment and referral to a low vision clinic[7].

Oncology follow-up

(viii) We recommend that RB survivors treated with chemotherapy or EBR undergo oncology clinic follow-up at 3- to 6-monthly intervals for five years after finishing chemotherapy, and then every 1–2 years until age 18 years, and then lifelong follow-up every two years in an adult oncology facility[7].

(ix) We recommend that persons carrying an RB1 germline mutation, or nongermline RB survivors treated with chemotherapy or EBR, be seen in an oncology clinic for counseling about the risk of secondary non-RB cancers annually for life by an oncologist[7].

(x) We recommend MRI, if possible, in patients with RB1 germline mutations since diagnostic radiation may increase their already significant risk of secondary non-RB malignancies[66].

(xi) When there is clinical or pathological evidence of risk of extraocular RB (TNM staging), we recommend bone marrow aspirate and (or) lumbar puncture every three months for three years after the last chemotherapy[58].

(xii) We recommend that persons at risk for systemic metastases based on pathological examination of the enucleated eye be monitored for five years with periodic bone marrow aspirates, MRI of the head and orbits, and whole-body MRI, if available[7].

(xiii) We recommend that patients at risk for CNS metastases be monitored every 3 to 8 months for five years, with lumbar punctures, MRI of the head, orbits, and spine, and whole-body MRI, if available, followed by lifelong annual surveillance via an alternative follow-up program as locally available[7].

(xiv) We do not recommend oncology clinic follow-up for children with unilateral RB, treated only by enucleation [Consensus].

PSYCHOSOCIAL CARE AND ACCESS TO SERVICES

The psychosocial burden of caregiving directly or indirectly affects the outcome of cancer patients[67]. Previous studies have found a correlation between coping among parents of RB patients and the disease's progression[60,68-70]. Parental coping with paediatric RB is correlated with the progression of the illness, including suspicion, initial discovery, the final diagnosis of the disease, surgery, hospital discharge, recovery from surgery (1–3 months), and recovery over the years following the diagnosis of the illness. Additionally, it appears that anxiety, insecurity, and uncertainty serve as common coping mechanisms for each of these stages[68,70].

Parents of children with retinoblastoma are expected to adjust to fear of the death of their child, their inability to control their child's future, a new way of caring for their child, and dependence on healthcare services[71].

Our prior work showed that 40% of Ethiopian retinoblastoma cases present with an extraocular disease with almost no chance of cure[5]. These contributed to more aggressive and multiple modes of treatment that may add more burden to caregivers. In addition, intense mental distress was reported by the Ethiopian RB caregivers who participated in our study, suggesting the need for psychosocial support and care for RB caregivers[72]. This corroborates previous research that has shown that parents of children with RB have poor psychological health and require professional assistance or counseling [68,70].

PSYCHOSOCIAL CARE AND ACCESS TO SERVICES-RECOMMENDATIONS

(i) We recommend ongoing psychosocial support and timely and equal access to care for all RB children and their families[7].

(ii) We recommend that RB families have easy and equitable access to:

- A social worker or clinical psychologist with RB or childhood cancer expertise from the time of diagnosis onwards.
- Structured psychosocial assessments at diagnosis and key points during treatment.
- Accurate, understandable, as-needed information in a variety of formats.
- Risk/informed consent information meeting parent language/age/education criteria.
- Advocacy services by professionals or community agencies for parents requiring additional support to access appropriate services.
- A centralized referral source providing links to hospital and community support groups.

- Long-term psychosocial support from diagnosis through adulthood.
- High-level genetic testing at a certified laboratory and genetic counseling for all affected family members.
- Financial support for out-of-pocket costs related to treatment.
- Visual rehabilitation services.
- Aids for low vision.
- Prosthetic eye service.
- Paediatric palliative care and bereavement services[7].

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