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

**Wagaw KT, Alemu AM**

Department of Ophthalmology, School of Medicine, College of Health Sciences, Addis Ababa University, P.O. Box 7500, Addis Ababa, Ethiopia

**Corresponding author:** Dr. Abiye M. Alemu. Email: abmulugeta@yahoo.com

## 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 ($\geq 0.7$) or VCDR asymmetry ($\geq 0.1$) in our normal population and visual field loss typical of glaucoma. Category 2 required advanced structural damage that is 99.5th percentile VCDR ($\geq 0.75$) or VCDR asymmetry ($\geq 0.2$) 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.

## ACKNOWLEDGMENT

We would like to thank the study participants, Debre-Berhan Hospital, and Dr.Yonas Abreham for evaluating glaucoma patients and confirming the diagnosis. We are grateful.to professor Negussie Deyessa for reviewing the manuscript.

*Funding:* It was partially funded by the School of Medicine, College of Health Sciences of Addis Ababa University. The college covered the cost of stationery and transportation of screened glaucoma patients to Debre-Birhan Hospital.

*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.

## REFERENCES

1. Pascolini D, Mariotti SP. Global estimates of visual impairment: 2010. *Br J Ophthalmol*. 2012; **96**:614–618.
2. Cook C. Glaucoma in Africa: size of the problem and possible solutions. *J Glaucoma*. 2009; **18**:124–128.
3. Kyari F, Abdull MM, Bastawrous A, Gilbert CE, Faal H. Epidemiology of glaucoma in Sub-Saharan Africa: Prevalence, incidence and risk factors. *Middle East Afr J Ophthalmol*. 2013; **20**:111–125.
4. Article O. Clinical profile of steroid-induced glaucoma in Bali Mandora Eye Hospital. *Intisari Sains Medis J*. 2021; **12**(1):6–8.
5. Tham YC, Li X, Wong TY, Quigley HA, Aung T, Cheng CY. Global prevalence of glaucoma and projections of glaucoma burden through 2040: a systematic review and meta-analysis. *Ophthalmology*. 2014; **121**:2081–90.
6. Quigley HA. New paradigms in the mechanisms and management of glaucoma. *Eye* (Lond) 2005; **19**(12):1241–48.
7. Fraser S, Bunce C, Wormald R, Brunner E. Deprivation and late presentation of glaucoma: case - control study. *Br Med J*. 2021; **322:**639-643.
8. Ellong A, Mvogo CE, Bella-Hiag AL, Mouney EN, Ngosso A, Litumbe CN. Prevalence of glaucoma in a black Cameroonian population. *Sante*. 2006; **16**:83–88.
9. Ostermann J, Sloan FA, Herndon L, Lee PP. Racial differences in glaucoma care: The longitudinal pattern of care. *Arch Ophthalmol*. 2005; **123**:1693–98.
10. Martin MJ, Sommer A, Gold EB, Diamond EL. Race and primary open-angle glaucoma. *Am J Ophthalmol*. 1985; **99**:383–387.
11. Grant WM, Burke JF., Jr Why do some people go blind from glaucoma? *Ophthalmology.*1982; **89**:991–998.
12. Wilson R, Richardson TM, Hertzmark E, Grant WM. Race as a risk factor for progressive glaucomatous damage. *Ann Ophthalmol*. 1985; **17**:653–659.
13. Foster PJ, Buhrmann R, Quigley HA, Johnson GJ. The definition and classification of glaucoma in prevalence surveys. *Br J Ophthalmol*. 2002; **86**:238–242.
14. Cook C. Glaucoma in Africa: Size of the problem and possible solutions. *J Glaucoma*. 2009; **18**:124–128.
15. Buhrmann RR, Quigley HA, Barron Y, West SK, Oliva MS, Mmbaga BB. Prevalence of glaucoma in a rural East African population. *Invest Ophthalmol Vis Sci*. 2000; **41**:40–48.

16. Rotchford AP, Johnson GJ. Glaucoma in Zulus: A population-based cross-sectional survey in a rural district in South Africa. *Arch Ophthalmol*. 2002; **120**:471–478.
17. Rotchford AP, Kirwan JF, Muller MA, Johnson GJ, Roux P. Temba glaucoma study: A population-based cross-sectional survey in urban South Africa. *Ophthalmology*. 2003; **110**:376–382.
18. Ntim-Amponsah CT, Amoaku WM, Ofosu-Amaah S, Ewusi RK, Idirisuriya-Khair R, Nyatepe-Coo E, *et al.* Prevalence of glaucoma in an African population. *Eye* (Lond). 2004; **18:**491–497.
19. Salmon JF, Mermoud A, Ivey A, Swanevelder SA, Hofman M. The prevalence of primary angle closure glaucoma and open angle glaucoma in Mamre, Western Cape, South Africa. *Arch Ophthalmol.* 1993; **111**:1263–69.