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Prevalence and Causes of Visual Impairment among Patients with Diabetes Mellitus at Gulu Regional Referral Hospital, Northern Uganda

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Abstract

Background: Diabetes Mellitus (DM) is the leading cause of Visual Impairment (VI) globally and VI is the most common and debilitating complication of DM; it significantly impacts the quality of life, productivity, and independence of affected individuals yet its burden and its specific causes among diabetic patients is lacking incomprehensive in a Ugandan community. This presents a major barrier to developing effective eye health strategies tailored for diabetic populations. **Objective:** To determine the prevalence and causes of visual impairment among patients with Diabetes Mellitus attending Diabetic clinic at Gulu Regional Referral Hospital (GRRH). **Methods:** A cross-sectional descriptive study was done including 181 patients with DM from August to October 2020; Sociodemographic characteristics and clinical data were collected using a structured questionnaire, fasting blood sugar was measured using an On-Call plus Glucometer machine. Visual acuity was assessed using Snellen's chart and the causes of VI were determined using torch examinations, slit Lamp and ophthalmoscopic fundoscopy. Data was analyzed using Statistical Package for Social Science Version 16 and presented in form of tables and graphs. **Results:** Of the 181 participants examined, 108 (59.7%) were females and 73 (40.3%) males. The prevalence of visual impairment was 24.9% and common in those aged above 60 years. Cataract was the commonest cause of visual impairment (44.4%) followed by refractive error (20%), maculopathy

(13.3%), diabetic retinopathy (6.7%), glaucoma (4.4%), corneal scar (4.4%), optic atrophy (4.4%) and chorioretinopathy with (2.2%). Diabetic retinopathy proportion was 1.7%. **Conclusion:** Visual Impairment among patients with DM attending GRRH Diabetic Clinic was 25% and cataract was the commonest cause while the prevalence of diabetic retinopathy was low (1.7%).

Keywords

Visual Impairment, Diabetes Mellitus, Prevalence, Causes, Uganda

1. Introduction

1.1. Global Burden of Diabetes

Diabetes Mellitus (DM) is the eighth leading cause of morbidity globally [1], DM accounted for about 463 million people globally with a general prevalence of 9.3% and the prevalence is expected to rise to 10.2% (578 millions) in 2030 and 10.9% (700 million) by 2045 [2]. Recent studies document that Sub-Saharan Africa and low income countries have the highest relative increase in the number of people with DM [3].

1.2. Diabetes and Visual Impairment

Diabetes Mellitus is still the leading cause of VI and blindness globally [4] [5]. Visual impairment is one of the most common and debilitating complications of diabetes mellitus; it significantly impacts the quality of life, productivity, and independence of affected individuals. A hospital based crossectional study in Uganda done in Mbarara Regional Referral Hospital estimated a prevalence of 28.6% [6] and this is in line with a systematic review based in Sub-Saharan Africa found an overall pooled prevalence of VI to be 29% (95% CI: 22% - 35%) among patients with diabetes mellitus highlighting the need to properly control sugars in diabetic patients [7]. Another Indian SMART crossectional study revealed that diabetes is strongly associated with VI with aOR of 3.06 at [95% CI 1.25 - 7.51] [8], further highlighting the association between DM and VI.

1.3. Definition and Causes of Visual Impairment

Visual Impairment (VI) is characterised by a visual acuity (VA) worse than 6/18, and or a corresponding visual field loss of less than 20 degrees around the central fixation in the better eye, with any prescribed corrective lenses. This includes low vision (VI categories 1 and 2), and blindness, which is visual acuity worse than 3/60, or a corresponding visual field loss of less than 10 degrees around the central fixation in a better eye with presenting optical correction if any [3].

Basing on Visual Acuity (VA), Visual Impairment is classified as Mild (presenting VA worse than 6/12, Moderate (presenting VA) worse than 6/18, Severe (presenting VA worse than 6/60) and Blindness (presenting VA worse than 3/60).

Worldwide, 285 million people are estimated to be visually impaired, 39 million are blind and 246 million have low vision. About 90% of the world's visually impaired live in developing countries, in which Uganda is part. Approximately 82% of people living with blindness are aged 50 years and above and 80% of all VI can be prevented or cured [9].

VI among patients with diabetes mellitus can be attributed to multiple factors with progressive Diabetic retinopathy (DR) and clinically significant macula oedema [10] being the leading causes and other identifiable causes include cataract, glaucoma and refractive errors [6] [7]. Patients with DR have about 4 times higher risk of developing visual disability compared to other forms of retinopathies [11]. A longitudinal study done in Guinea found a very high prevalence of DR among patients with DM at 37%. This was due to negligent monitoring and poor self-management of diabetes, as the researcher writes [12].

Globally, the principal causes of VI are Uncorrected Refractive Errors (43%), Cataracts (33%), Glaucoma (2%), age-related macular degeneration, diabetic retinopathy, trachoma and corneal opacities; all approximately at 1% with a significant 18% being contributed too by unknown factors based on the global estimates of 2012 [9]; these are similar to the etiological trends of VI among patients with DM [6] [7].

1.4. Visual Impairment in Sub-Saharan Africa and Uganda

In Uganda, studies on diabetic retinopathy and VI are limited but suggest a significant burden of diabetic eye complications, particularly in patients with poor glycemic control and long-standing diabetes [6] [13]. However, there remains a paucity of comprehensive data on the overall prevalence of VI and its specific causes among diabetic patients in both urban and rural settings. This lack of data presents a major barrier to developing effective eye health strategies tailored for diabetic populations.

Furthermore, the majority of diabetic patients in Uganda present late to health facilities, often after the onset of visual symptoms, due to low awareness, inadequate screening, and limited access to ophthalmic services, especially in rural areas [14]. As a result, many cases of diabetic eye disease go undiagnosed and untreated until advanced stages, when visual damage may be irreversible.

1.5. Justification for the Study

Understanding the prevalence and causes of visual impairment among diabetic patients is critical for planning effective interventions, including early screening, prompt referral, and management. It also helps inform public health policy and allocation of resources toward integrated diabetic care and ophthalmologic services.

This study, therefore, aimed to fill this gap by determining the prevalence and underlying causes of visual impairment among patients with diabetes mellitus attending the diabetic clinic at Gulu Regional Referral Hospital.

2. Methods

2.1. Study Setting

The study was carried out at Gulu Regional Referral Hospital in the Diabetes and Eye Clinics. The Hospital is located in Northern Uganda, Gulu City with coordinates of 02˚46'40.0"N, 32˚17'52.0"E (Latitude: 2.777778; Longitude: 32.297778), approximately 343 km, by road north of Kampala which is Uganda's capital and largest city. This is one of the 14 public Referral Hospitals in Uganda. The hospital serves the Acholi sub region comprised of one city and eight districts (Amuru, Agago, Gulu, Kitgum, Lamwo, Nwoya and Pader) with a catchment population of 1.6 million. The Diabetic Clinic receives a range of 50 to 60 patients with diabetes at the out-patient diabetes clinic weekly, with an annual population of about 300 registered patients.

2.2. Study Population

The study was carried out among patients with DM attending the diabetic clinic in the outpatient department at Gulu Regional Referral Hospital.

2.3. Inclusion Criteria

All patients with DM attending the diabetic clinic at GRRH and consented to participate in the study.

2.4. Exclusion Criteria

Diabetic patients who were mentally and critically ill and could not follow the specifications of the study; and those who declined to consent were excluded.

2.5. Sampling Procedure

Consecutive sampling method was employed to obtained the desired sample size.

2.6. Sample Size

Gulu Regional Referral Hospital had a total of diabetic patients amounting to 300 during the time of the study; this was based on the estimates from the local registry at the diabetic clinic, based on a study done from Mbarara regional referral hospital [6] which estimated a prevalence of 28.6%; Applying the Kish–Leslie formula with this 28.6% prevalence, a 5% margin of error, and 95% confidence level; then adjusting for a finite population of 300; yielded a minimum sample size of 170 participants. 181 participants were included.

2.7. Data Collection and Study Variables

Sociodemographic characteristics, clinical data were collected using a structured questionnaire, fasting blood sugar was measured using an On-Call plus Glucometer machine following standard guidelines by qualified personnel.

All study participants had visual acuity testing using the Snellen Chart. All those found to have visual acuity of 6/12 or worse were categorized as having VI and

therefore underwent detailed ophthalmic assessment for causes VI by qualified eye health workers; Ophthalmic Clinic Officers and Ophthalmologists. The assessment included: torch, Slit Lamp and Fundoscopy examination. The WHO classification of Visual Impairment was applied to categorized them and all those who needed treatment were managed accordingly.

2.8. Data Management and Analysis

Collected data were first checked for completeness, and both hard and soft copies were securely stored to ensure confidentiality. Hardcopy records were kept in a locked cupboard, while soft copies were protected with password-restricted access.

Data were entered and analyzed using Statistical Package for Social Sciences (SPSS) Version 16. Descriptive statistics were used to summarize participant characteristics and clinical findings. Frequencies and percentages were generated for categorical variables such as gender and causes of visual impairment, and means with standard deviations were calculated for continuous variables where applicable.

The prevalence of visual impairment was determined by calculating the proportion of participants with visual acuity below 6/18 in the better-seeing eye. Visual data were further categorized by cause, and the distribution of each cause was analyzed. Results were presented in frequency tables and bar graphs for ease of interpretation.

3. Results

3.1. Characteristics of the Study Participants

A total of 181 respondents participated in the study, with the majority being female (n = 108, 59.7%). Most participants were aged above 50 years, accounting for 62.4% of the sample, with a mean age of 52.3 years. Majority of the respondents (n = 166, 91.7%) had Type II diabetes and the duration of diabetes among participants varied: 57 (31.5%) had lived with diabetes for less than 3 years, 59 (32.6%) for 4 - 6 years, 14 (7.7%) for 7 - 9 years and 51 (28.2%) for more than 9 years as shown in Table 1.

Table 1. Characteristics of study participants.

Variable	Description	Frequency	Percentage (%)
Gender	Male	73	40.3
	Female	103	59.7
Age	11 - 20	3	1.7
	21 - 30	16	8.8
	31 - 40	23	12.7
	41 - 50	26	14.4
	51 - 60	54	29.8
	>60	59	32.6

Continued

Residence	Urban	75	41.4
	Rural	106	58.6
Marital status	Single	24	13.3
	Married	152	84
	Widowed	2	1.1
	Divorced	3	1.7
Type of DM	1	15	8.3
	11	166	91.7
Duration of DM (years)	0 - 3	57	31.5
	4 - 6	59	32.6
	7 - 9	14	7.7
	>9	51	28.2

3.2. Prevalence of Visual Impairment

Among the 181 study participants, only 45 had visual impairment yielding a prevalence of 24.9%, majority of the study participants with VI were aged 61 years and above (n = 26, 57.8%) and no cases were recorded below the age of 20 years (See Table 2).

Table 2. Age distribution among the study participants with Visual impairment.

Age Group (years)	Frequency (n)	Percentage (%)
11 - 20	0	0.0
21 - 30	1	2.2
31 - 40	5	11.1
41 - 50	5	11.1
51 - 60	8	17.8
61 and above	26	57.8
Total	**45**	**100.0**

The most common cause was cataract, affecting 20 individuals (44.4%). This was followed by refractive error in 9 (20.0%), maculopathy (all forms) in 6 (13.3%), and diabetic retinopathy in 3 (6.7%). Of the six cases of Maculopathy, three are Age Related Macular Degeneration, one was a macular scar of unknown cause while two were Macular oedema, which is usually related to DM.

The two cases with macular oedema had had DM for more than nine years. Other less common causes included optic atrophy, glaucoma, and corneal scars, each accounting for 2 cases (4.4%), while chorioretinopathy was reported in 1 respondent (2.2%) (See Table 3).

Majority of the participants with VI had a moderate type affecting 36 (80%), 7(15.5%) were blind and 2 (4.5%) had severe visual impairment as noted in (See Table 4).

Table 3. Causes of visual impairment.

Cause of Visual Impairment	Frequency (n)	Percentage (%)
Cataract	20	44.4
Optic Atrophy	2	4.4
Maculopathy	6	13.3
Diabetic Retinopathy	3	6.7
Refractive Error	9	20.0
Glaucoma	2	4.4
Corneal Scars	2	4.4
Chorioretinopathy	1	2.2
Total	**45**	**100.0**

Table 4. Category of visual impairment.

Category of Visual Impairment	Frequency (n)	Percentage (%)
Moderate	36	80.0
Severe	2	4.5
Blindness	7	15.5
Total	**45**	**100.0**

3.3. Glucose and VI

The fasting blood sugar (FBS) levels of the 45 participants with diabetes were classified into four categories based on severity. Approximately one-fifth of the participants (n = 10, 22.2%) had controlled FBS levels (<7 mmol/L). The majority (n = 21, 46.6%) fell within the mild hyperglycemia range (7 - 10 mmol/L). Moderate hyperglycemia (10.1 - 14 mmol/L) was observed in 5 participants (11.1%), while 9 participants (20.0%) exhibited severe hyperglycemia with FBS levels greater than 14 mmol/L (See Table 5). These findings indicate that over three-quarters of the respondents had suboptimal glycemic control despite being on diabetes treatment.

Table 5. Glycemic control in patients with VI.

FBS Category	Range (mmol/L)	Frequency (n)	Percentage (%)
Controlled	<7	10	22.2
Mild Hyperglycemia	7 - 10	21	46.6
Moderate Hyperglycemia	10.1 - 14	5	11.1
Severe Hyperglycemia	>14	9	20.0
Total	—	**45**	**100.0**

3.4. Diabetes and Diabetic Retinopathy

Diabetic retinopathy was observed in three (6.7%) of the respondents with VI. The prevalence of DR amongst the study group was 1.7%. Of the three patients with

DR, two had non-proliferative DR (NPDR) and one was proliferative DR. Two of the patients had lived with DM for not more than six years while one had had it for eleven years. All the respondents with DR had elevated FBS (>7 mmoles).

4. Discussion

The prevalence of Visual Impairment in this study was 24.9%. This is similar to studies done in Mbarara Regional Referral Hospital, Uganda; and in Tunisia which showed a prevalence of VI to be 26.8% [6] and 22.2% [15] respectively. The three studies have to similar methodological designs and relatively similar patient characteristics. Studies done in German [16], China [17] and Ghana [18] demonstrated lower prevalence ranging between 4% - 18%. This is attributed to early screening, methodological differences (excluded patients with refractive errors) and a smaller sample size respectively. However, a study done in Ethiopia showed a higher prevalence of VI among patients with diabetes of 37.6% [19]; the study had a different operational definition for VI; Visual acuity of less than 6/12 compared to our study which was less than 6/18.

In this study, the commonest cause of VI was Cataract with 44.4%, followed by Refractive Error (20%), maculopathy (13.3%), and Diabetic retinopathy (6.7%). This is similar to a study done in Mbarara Regional Referral Hospital which showed that Cataract as the commonest cause of VI (34.5%) followed by Refractive Error (20.8%), Glaucoma (16.8%) and Diabetic Retinopathy was 12.5% [6].

Globally, including Uganda, cataract is the leading cause of VI amongst people age above 50 years, Cataract and Refractive Errors are consistently among the leading causes of VI in diabetic populations, a pattern that is well-supported by both epidemiological evidence [20]-[22] and pathophysiological understanding. The incidence gets higher amongst diabetic patients due to hyperglycemic factors. In this study 62% of the respondents were 50 years or more.

Cataract formation in diabetic individuals is significantly accelerated compared to non-diabetics, primarily due to chronic hyperglycemia. Elevated blood glucose levels lead to the accumulation of sorbitol in the lens via the aldose reductase pathway. Sorbitol is osmotically active and causes water retention in lens fibers, resulting in lens swelling, disruption of fiber architecture, and eventual opacification [23]-[25]. Additionally, chronic hyperglycemia promotes non-enzymatic glycation of lens proteins and increases oxidative stress [26] [27], both of which contribute to lens protein denaturation and the formation of advanced glycation end-products (AGEs), further driving cataract genesis. These mechanisms explain the earlier onset and increased severity of cataracts observed in diabetic individuals, especially those with poor glycemic control.

Refractive errors, particularly transient myopic shifts, are another common visual issue in people with diabetes [28]. The pathophysiology behind this lies in the osmotic and biochemical changes occurring in the lens during episodes of hyperglycemia. As glucose diffuses into the aqueous humor and into the lens, it is metabolized to sorbitol, leading to lens swelling and a change in its curvature and

refractive index [29] [30]. This alters the eye's focusing power, often manifesting as blurred vision or sudden changes in spectacle prescription. These refractive fluctuations are typically reversible once blood glucose levels are stabilized. However, if diabetes remains poorly controlled over time, structural changes in the lens and cornea may become more permanent, potentially leading to sustained refractive error. In both cases, the underlying metabolic disturbances of diabetes; particularly persistent hyperglycemia; play a central role. Furthermore, the high prevalence of cataract and refractive error as causes of VI among diabetic patients may also reflect gaps in healthcare access, such as delayed cataract surgery and limited availability of refractive services, particularly in low-resource settings. These findings highlight the importance of routine ophthalmic screening and strict glycemic control in the prevention and early management of diabetic eye complications.

These mechanisms align closely with our study findings, where over 77% of the participants with VI exhibited suboptimal glycemic control. This metabolic dysregulation likely underlies the high prevalence of cataract and refractive errors observed, reinforcing the central role of hyperglycemia in the pathogenesis of these conditions. Furthermore, the persistence of these visual complications may also reflect systemic barriers to timely eye care; such as delayed cataract surgery or limited access to refractive services; particularly in low-resource settings.

Cataract and uncorrected refractive errors present the leading causes of avoidable visual impairment. Good glycemic control, followed by appropriate intervention such as optical correction with spectacles and cataract surgery, will reduce the magnitude of these two disorders.

The low prevalence of diabetic retinopathy (DR) observed in this study (1.67%) may be partly explained by the glycemic control profile of the participants, duration of DM, low socioeconomic status and small sample size. Of the three patients with DR, the two cases with NPDR have had DM for less than six years, while the only one with Proliferative DR had had it for eleven years but all high blood sugar level. The occurrence of DR is more common amongst those who have had DM for a longer duration and are persistently poorly controlled. In this study, 31.1% had moderate to severe hyperglycemia (FBS > 10 mmol/L) and all the respondents with DR fall in this category.

This suggests that nearly 69% of the participants with VI had either controlled or minimally elevated glucose levels, which may reduce the risk or progression of DR. Chronic hyperglycemia is a well-established risk factor for microvascular complications such as DR, and better glycemic control has been shown to delay its onset [31] [32]. The relatively low proportion of participants with moderate (11.1%) and severe hyperglycemia (20.0%) supports the idea that the cohort had generally favorable glycemic profiles. Furthermore, this may reflect good access to diabetes care services, early diagnosis, or better adherence to treatment in this group.

This study was done amongst a population of low socioeconomic status, which

have lower onset and incidence of Diabetes Mellitus and development of DR. DM is commonly regarded a lifestyle non-communicable disease.

5. Study Limitations

Hospital based design and selection bias: The study was conducted at a single regional referral hospital and included only patients attending the diabetic clinic. This may introduce selection bias, as the findings may not reflect the prevalence or causes of visual impairment (VI) among diabetic patients in the broader community, especially those who are undiagnosed, do not attend regular follow-up, or access care from lower-level health facilities.

Limited diagnostic tools: Although clinical eye examinations were performed using slit-lamp and ophthalmoscopy, access to more advanced diagnostic tools such as optical coherence tomography (OCT), fluorescein angiography, and visual field testing was not available. This may have led to underdiagnosis or misclassification of conditions like early maculopathy, glaucoma, or mild diabetic retinopathy.

Glycemic control assessment: Glycemic control was assessed using a single fasting blood sugar (FBS) measurement. This may not reflect long-term glycemic control as accurately as glycated hemoglobin (HbA1c) levels. Consequently, associations between glycemic control and visual outcomes may be less reliable.

Small subgroup sample size: Although the overall sample was adequate, the number of participants with certain conditions (e.g., diabetic retinopathy or maculopathy) was small. This limited the ability to perform subgroup analysis or detect statistically significant differences across certain variables.

6. Conclusion

The Prevalence of Visual Impairment among DM patients at Gulu Regional Referral Hospital was 24.9%. The leading causes of VI were Cataract, Refractive Error and Maculopathy due to age degeneration and macular oedma. The prevalence of Diabetic Retinopathy was low (1.7%).

7. Recommendations

Prioritize management of cataract and refractive errors: Given that cataract and uncorrected refractive errors were the most prevalent causes of visual impairment in this study, their management should be the top priority in efforts to reduce vision loss among diabetic patients. Investments should focus on improving access to affordable spectacles and timely cataract surgery, especially in underserved regions. Community-based outreach programs, mobile clinics, and strengthening the referral systems can enhance coverage. Scaling up the training and deployment of eye care professionals is also crucial to meet this need.

Strengthen routine eye examination for diabetic patients: Regular and comprehensive ophthalmic evaluations should be integrated into diabetes care services. Annual eye exams—including visual acuity testing, fundoscopy, and, where

possible, retinal imaging—should be provided to all diabetic patients. This facilitates early detection of not only diabetic retinopathy but also cataracts and refractive errors, allowing for timely intervention.

Improve public awareness and health education: Public health campaigns should focus on educating diabetic individuals about the risk of visual impairment and the importance of regular eye checkups. Messaging should emphasize the preventable nature of many visual disorders, the role of glycemic control, and the availability of corrective and surgical treatments. Leveraging community health workers and media platforms can enhance reach and impact, particularly in rural areas.

Promote and monitor glycemic control: Persistent hyperglycemia is a major driver of both diabetic retinopathy and lens-related complications such as cataracts and refractive changes. Healthcare providers should prioritize consistent glycemic monitoring and promote adherence to dietary and pharmacologic interventions. Where available, HbA1c testing should be used to assess long-term glycemic control. Integrating diabetes education and glucose monitoring into routine clinical care is essential to prevent or delay vision-threatening complications.

Declarations

Ethics Approval and Consent to Participate

Ethical approval was obtained from the Gulu University: ADM/2017-18/001. Written informed consent was obtained. Participants with VI were referred for clinical management. All procedures were conducted in accordance with the Declaration of Helsinki.

Availability of Data and Materials

Data are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no competing interests.

Authors' Contributions

BRO, JB, MN, TBK conceptualized and designed the study, collected data. DN, BBO, analyzed data and drafted the manuscript, BW; supervised the whole process from proposal development to manuscript writing. All authors approved the final manuscript.

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List of Abbreviations

VI	Visual impairment
DM	Diabetes mellitus
GRRH	Gulu regional referral hospital
DR	Diabetic retinopathy
FBS	Fasting blood sugar
HbA1c	Glycated hemoglobin