ORIGINAL RESEARCH

Proportion, Causes and Associated Factors of Blindness Among Adult Patients Attending Tertiary Eye Care and Training Center in Ethiopia

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Purpose: This study aimed to estimate the magnitude of blindness, identify causes and associated factors among adult patients who visited a Tertiary Eye Care Training Center in Gondar, Ethiopia.

Methods: A hospital-based cross-sectional study was done at University of Gondar Tertiary Eye Care and Training Center. 708 participants (99.02% of invited) were recruited in this study with a systematic random sampling technique. Interviewer administered questioner and physical examination were applied to collect the data. Blindness was defined as the presenting visual acuity less than 3/60 in the better eye according to the World Health Organization criterion for visual acuity. Data was entered with Epi Info 7 and imported into SPSS for coding and analysis. Descriptive and analytical statistics were performed to analyze the entered data. Adjusted odds ratio was used to show the strength of the association and variables with a P–value of < 0.05 were considered as statistically significant.

Results: The proportion of blindness in this study was 14.3% (95% CI: 11.8–16.8). Low monthly income (AOR: 4.9; 95% CI: 1.4, 17.1), aged ≥ 60–69 (AOA: 2.9, 95% CI: 1.2, 7.6), and aged ≥ 70 years (AOR: 4.8; 95% CI: 1.9, 12.2) were positively associated with blindness. In this study, the leading cause of blindness was cataract (49.5%), followed by glaucoma (18.8%) and Age-related macular degeneration (AMD) (9.9%).

Conclusion: The proportion of blindness was 14.3%. Cataract, glaucoma and AMD were the common causes of blindness. Low monthly income and older age were significantly increased the risk of blindness.

Keywords: blindness, causes, University of Gondar, Ethiopia

Introduction

Globally, about 253 million people are living with visual impairment, of whom 36 million people are blind; 56% and 86% of blind people are females and people aged ≥50 years, respectively.[1] Approximately, 89% of visually impaired people (low vision and blindness) live in developing countries particularly Sub-Saharan Africa.[2] In Sub-Saharan Africa, the prevalence of blindness was 1.3%, which is higher in the west sub-regions of Africa.[3] Furthermore, the prevalence of blindness in Ethiopia was 1.6%, of which greater than 87.4% cases of blindness are avoidable.[4] Besides the institution-based studies done in South and West Africa revealed that the prevalence of blindness ranges from 3.7% to 28.9%.[5–8]

On the other hand, the prevalence of blindness in Ethiopia was 7.9% in the Gurage zone,[9] and 7.3% in Addis Ababa.[10] In 2015, global report showed that the top causes of

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blindness were cataract, uncorrected refractive error, and glaucoma,[11] whereas in Ethiopia; the leading causes of blindness were cataract, corneal opacity (CO), and uncorrected refractive error; which were more prevalent among rural dwellers, females and older aged individuals.[4] Despite blindness is a major ocular morbidity in Ethiopia and witnessed among the adult population in clinical practice; the actual magnitude, causes and associated factors of the condition is poorly understood in a clinical setup. Hence, studies of this nature is required to incite policies and strategies on preventive and curative eye care service for the community in the surrounding area of the hospital to reduce the avoidable causes of blindness. Therefore, this study aimed to determine the proportion, causes, and associated factors of blindness among adult patients aged ≥ 18 years visited University of Gondar Tertiary Eye Care and Training Canter.

Methods and Materials
Study Design, Area and Period
A hospital-based cross-sectional study was conducted at the University of Gondar Tertiary Eye Care and Training Center, Northwest Ethiopia on 708 adult patients who visited the eye care center from November 1 to December 30/ 2019. The University of Gondar is located in Gondar town and is far from Addis Ababa by 738 kilometers. This tertiary eye care center provides compressive clinical and community eye health services for eight zones and serves as a major referral center for 14 million people living in the Amhara region, Northwest Ethiopia. It has known sub-specialty clinics organized into anterior segment, glaucoma, retina, refraction, and pediatrics. It is estimated that a minimum of 31,200 patients utilizes eye care services per year.

Study Population and Eligibility Criteria
All-new adult patients aged 18 years and above who visited the outpatient department (OPD) in eye care center during the study period were eligible to participate in the study. However, patients presented with an ocular emergency were excluded from the study hence stable visual acuity could not reasonably be taken from these clients. Moreover, these clients would not be suitable for the interview while having these conditions.

Sampling Size Determination and Sampling Producer
The sample was calculated by using single population proportion formula with an assumption of the proportion of blindness 7.3%, which was taken from a previous study done in Addis Ababa,[10] 95% confidence level, 2% desired precision and 10% non-response rate. Accordingly, the final calculated sample size was 715 study subjects. The study participants were chosen by applying a systematic random sampling with a sampling fraction of 3.

Operational Definitions
The World health organization (WHO) definitions' of visual impairment was used to defined blindness; Blindness was defined as presenting visual acuity of less than 3/60 in the better eye.[12] The International Society of Geographical and Epidemiological Ophthalmology classification was used to diagnose glaucoma.[13] Age-related macular degeneration (AMD) was diagnosed based on the International ARMD Epidemiological Study Group.[14] Whether the presence or absence of Diabetic retinopathy in diabetic patients was assessed based on the Early Treatment Diabetic Retinopathy Study definition.[15] Refractive error was considered when the spherical equivalent (SE) was ≥±0.50DS following full refraction. Hypertension and/or diabetes were assigned to the participants based on referring their medical folder and from their response whether confirmed diagnosis of these conditions and their respective medications are present.

Education status was categorized as non-formal education (illiterate, able to write and read with no formal schooling) and formal education (from primary school to university).

Data Collection Procedures (Personnel and Instrument)
Data was collected by 5 trained and senior experienced optometrist. The level of agreement between data collectors to label the causes of blindness among participants was assured using Cohen's kappa value which was found a score of 0.90.

Face to face interview was done using pre-tested structured questionnaire, which consists of information on socio-demographic and economic variable, behavioral factor (smoking status), ocular and medical history of the participants.

Visual acuity of study subjects was measured by using a portable tumbling E Optotypes Snellen chart with optimal illumination room and IOP was measured using I-Care Tonometer. For those who could not read letters at 6 meters, their vision was measured by making the portable chart closer to the patient at specified meters up to one meter. Finally, for those who could not see any letter on the Snellen chart at 1 meter, their vision was expressed as

counting finger, hand motion, light perception with projection and non-light perception. Pinhole visual acuity was checked for each study subject whose distance visual acuity was less than 6/18 to exclude whether the reduction of visual acuity is due to refractive error or not. Full refraction (objective and subjective refraction) was done

Table 1 Distribution of Socio-Demographic and Economic Data of Study Participants by Sex (n=708)

Variables	Proportion by Sex		Total N (Column %)
	Male n (%)	Female n (%)	
Overall	416 (58.8)	292 (41.2)	708 (100)
Age (years)			
18–40	165 (39.7)	102 (34.9)	267 (37.7)
40–49	30 (7.2)	32 (11.0)	62 (8.8)
50–59	45 (10.8)	50 (17.1)	95 (13.4)
60–69	68 (16.4)	55 (18.8)	123 (17.4)
≥70	108 (26.0)	53 (18.2)	161 (22.7)
Residence			
Rural	218 (52.4)	141 (48.3)	359 (50.7)
Urban	198 (47.6)	151 (51.7)	349 (49.3)
Marital status (currently)			
Single	108 (26.0)	77 (26.4)	185 (26.1)
Married	308 (74.0)	215 (73.6)	523 (73.9)
Education			
No formal education	239 (57.5)	198 (67.8)	437 (61.7)
Formal education	177 (42.5)	94 (32.2)	271 (38.3)
Occupation			
Farmer	213 (51.2)	51 (17.5)	264 (37.3)
House wife	0 (0.0)	128 (43.8)	128 (18.1)
Others	78 (18.8)	42 (14.4)	120 (17.0)
Government employer	125 (30.0)	71 (24.3)	196 (27.7)
Monthly income (Ethiopian Birr)			
≤ 1000	125 (30.1)	134 (45.9)	259 (36.6)
1001–1500	92 (22.1)	63 (21.6)	155 (21.9)
1501–2500	87 (20.9)	40 (13.7)	127 (17.9)
>2500	112 (26.9)	55 (18.8)	167 (23.6)
History of cataract surgery			
Yes	42 (10.1)	28 (9.6)	70 (9.9)
History of any non-surgical ocular injury			
Yes	48 (11.5)	8 (2.7)	56 (7.9)
History of diabetes mellitus			
Yes	20 (4.8)	6 (2.1)	26 (3.7)
History of hypertension			
Yes	11 (2.6)	17 (5.8)	28 (4.0)
Cigarette smoking			
Yes	9 (2.2)	0 (0)	9 (1.3)
Use of protective sunglass			
Yes	22 (5.3)	14 (4.8)	36 (5.1)

Note: Monthly income was categorized based on interquartile range.

to determine the degree of refractive error. Participants were dilated with 1% of tropicamide of eye drop and examined with slit-lamp bio-microscope and 90 diopters of Volk Lens. Bases on suggested methodology of the world health organization for surveys on blindness,[16] the most likely causes of blindness were determined by the diseases which have a profound visual reduction in the better eye at the time of data collection.

Data Processing and Analysis

After checking completeness and consistency of the data; it was coded and entered into EPI info version 7, and then exported into Statistical Package for Social Science (SPSS) version 20 software for analysis. Descriptive and analytical statistics were performed for analysis of the entered data. Binary logistic regression was used to determine the significance of socio-demographic and economic factors associated with blindness. The strength of association was expressed by using an adjusted odds ratio at a 95% confidence interval. The model of fitness was assured using Hosmer and Lemeshow goodness of fit. A variable with a P-value of less than 0.05 was considered as statistically significant. Finally, the analyzed data was organized and presented with tables and text form as necessary.

Ethical Consideration

Ethical approval was obtained from the University of Gondar, College of Medicine and Health Sciences, School of Medicine, Ethical Review Committee. Furthermore, administrative permission was obtained from the clinical directorate of eye care service. After a full explanation of the objective of the study, written informed consent was obtained from each study participant during data collection. The right of discontinuing or refuse to participate in the study was informed for all study subjects. Confidentiality was maintained by omitting any personal identifier. Generally, the study was conducted in tenet of the Principle of Declaration of Helsinki. Individuals presented with blindness in the outpatient department were directly linked to required sub-specialty clinics.

Results
Socio-Demographic Data of Study Participants

This study enrolled 708 adult patients with a response rate of 99.02%. The median age of study subjects was 50.0 (interquartile range=38) years. Out of 708 study subjects, 264 (37.3%) were farmers and 437 (61.7%) had no formal education (Table 1).

The Proportion of Presenting Blindness

In the current study, the proportion of blindness was 14.3% (95% CI: 11.8–16.8) (Table 2). The study showed that, the proportion of blindness was more prevalent among study subjects aged ≥ 70 (50.5%), and who were rural dwellers (74.3%) (Table 3).

Cause of Presenting Blindness

In the present study, almost fifty percent of blindness was contributed by cataracts (49.5%) followed by glaucoma 18.8% and Age-related macular degeneration (AMD) (9.9%) (Table 4).

Effect of Demographic and Socio-Economics Variables on Blindness

In the present study, demographic and socio-economic variables were associated with blindness in bivariable logistic regression, whereas of those variables only low monthly income and older age were remained significantly associated with blindness in a multivariable binary logistic regression. Compared to high monthly income, those participants with low monthly income were 4.9 times more likely to be blind (AOR=4.9 (95% CI: 1.4–17.1). The risk of developing blindness for those study participant whose age 60–69 and ≥ 70 years were 2.9 times (AOR=2.9 (95% CI: 1.2–7.6) and 4.8 times (AOR=4.8 (95% CI: 1.9–12.2) higher than those age 18–40 years, respectively (Table 5).

Table 2 Visual Status of Adults Patients Aged ≥ 18 Years at the University of Gondar Tertiary Eye Care and Training Center (n=708)

Visual Status	Number of Participant (%)	95% of Confidence Interval
Normal vision	267 (37.7)	34.3–41.2
Mild visual impairment	79 (11.2)	9.0–13.6
Moderate visual impairment	142 (20.1)	17.2–23.2
Severe visual impairment	119 (16.8)	14.4–19.5
Blindness	101 (14.3)	11.8–16.8

Table 3 Distribution of Presenting Blindness in Different Socio-Demographic and Economic Data of Study Subject (n=708)

Variables	Blindness n (%)	95% of Confidence Interval	P-value
Age (years)			<0.001
18–40	9 (8.9)	3.9–15.0	
40–49	4 (4.0)	0.9–7.9	
50–59	14 (13.9)	7.8–20.8	
60–69	23 (22.8)	15.6–31.6	
≥ 70	51 (50.5)	40.9–59.8	
Sex			0.466
Male	56 (55.4)	45.9–65.5	
Female	45 (44.6)	34.50–5.1	
Residence			<0.001
Rural	75 (74.3)	65.7–82.9	
Urban	(25.7)	17.1–34.3	
Marital status (currently)			0.042
Single	18 (17.8)	11.0–25.5	
Married	83 (82.2)	74.5–89.0	
Education			<0.001
No formal education	93 (92.1)	86.9–97.1	
Formal education	8 (7.9)	2.9—13.1	
Occupation			<0.001
Farmer	59 (58.4)	48.9–68.3	
House wife	(20.8)	13.2–28.6	
Others	17 (16.8)	9.3–23.7	
Government employer	4 (4)	0.8–8.0	
Monthly income (Birr)			<0.001
≤ 1000	54 (53.5)	43.2–62.4	
1001–1500	26 (25.7)	17.5–34.8	
1501–2500	18 (17.8)	11.3–25.8	
>2500	3 (3)	0.0–6.1	
History of cataract surgery			0.157
Yes	6 (5.9)	2.0–11.6	
History of any non-surgical ocular injury			0.694
Yes	7 (6.9)	2.6–12.3	
History of diabetes mellitus			0.463
Yes	5 (5)	1.0–9.5	
History of hypertension			0.998
Yes	4 (4)	0.9–8.1	
Cigarette smoking			0.786
Yes	1 (1)	0.0–3.3	
Use eye protective sunglass			0.143
Yes	2 (2)	0.0–5.2	

Discussion

The proportion of presenting blindness in this study was 14.3% (95% CI: 11.8–16.8). The finding of this study is lower compared to Nigeria 28.5%,[7] and Ghana 28.9%,[8] whose blind patients were predominately female differing from our patients. Females have a higher risk to develop blindness than males.[1,3,4] Due to their longer life expectancy, they are more vulnerable to develop

Table 4 Principal Causes of Presenting Blindness Among Adults Aged ≥ 18 Years (n=708)

Ocular Abnormality	Frequency (%)			Blindness n (%)		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**
Cataract	131 (31.5)	105 (36.0)	236 (33.3)	30 (53.5)	20 (44.4)	50 (49.5)
Glaucoma	36 (8.7)	34 (11.6)	70 (9.9)	9 (16.1)	10 (22.2)	19 (18.8)
ARMD	15 (3.6)	9 (3.1)	24 (3.0)	6 (10.7)	4 (8.9)	10 (9.9)
Refractive error	48 (11.5)	42 (14.4)	90 (12.7)	3 (5.4)	4 (8.9)	7 (6.9)
Corneal opacity	38 (9.1)	22 (7.5)	60 (8.5)	3 (5.4)	2 (4.4)	5 (5.0)
Diabetic retinopathy	15 (3.6)	5 (1.7)	20 (2.8)	3 (5.4)	1 (2.2)	4 (4.0)
Others	133 (32.0)	75 (25.7)	208 (29.4)	2 (3.5)	4 (8.9)	6 (5.9)
Total	416 (100)	292 (100)	708 (100%)	56 (100)	45 (100)	101 (100)

Note: n= Sample Size.
Abbreviation: ARMD, age-related macular degeneration.

Table 5 Bivariable and Multivariable Binary Logistic Regression Analysis for Blindness Among Adult Aged ≥ 18 Years at University of Gondar Tertiary Eye Care and Training Center (n=708)

Variables	Blindness		COR (95% CI)	AOR (95% CI)	P-value
	Yes	**No**			
Age (years)					
18–40	9	258	1.00	1.00	
40–49	4	58	2.0 (0.6, 6.6)	1.3 (0.3, 4.9)	0.707
50–59	14	81	5.0 (2.7, 11.9)	2.4 (0.9, 6.9)	0.095
60–69	23	100	6.6 (3.0, 14.7)	2.9 (1.2, 7.6)	0.035
≥ 70	51	110	13.3 (6.3, 27.9)	4.8 (1.9, 12.2)	0.001
Residence					
Rural	75	284	3.3 (2.0, 5.3)	1.3 (0.7, 2.3)	0.350
Urban	26	323	1.00	1.00	
Marital status (currently)					
Single	18	167	0.6 (0.3, 1.0)	1.3 (0.6, 2.6)	0.515
Married	83	440	1.00	1.00	
Education					
No formal education	93	344	8.9 (4.2, 18.6)	1.6 (0.5, 5.2)	0.407
Formal education	8	263	1.00	1.00	
Occupation					
Farmer	59	205	13.8 (4.9, 38.8)	2.24 (0.5, 10.6)	0.309
House wife	21	107	9.4 (3.2, 28.2)	1.58 (0.7, 4.7)	0.583
Others	17	103	7.9 (2.6, 24.2)	1.74 (0.4, 7.5)	0.459
Government employee	4	192	1.00	1.00	
Monthly income (ETB)					
≤ 1000	54	205	14.4 (4.4, 46.9)	4.9 (1.4, 17.1)	0.014
1001–1500	26	129	11.0 (3.3, 37.2	3.5 (0.9, 12.7)	0.062
1501–2500	18	109	9.03 (2.6, 31.4)	3.0 (0.8, 11.3)	0.100
>2500	3	164	1.00	1.00	

Note: n= sample size.
Abbreviations: ETB, Ethiopian Birr; CI, confidence interval; COR, crude odds ratio; AOR, adjusted odds ratio.

Table 6 Comparison of the Main Causes of Blindness in Selected Countries

Country (Reference)	Study Setting and Design	Main Causes of Blindness (%)		
		First	Second	Third
Yemen[17]	Hospital-based cross-sectional	Cataract (46.3)	Glaucoma (10.4)	Diabetic retinopathy (8.6)
South Jordan[18]	Hospital-based cross-sectional	Cataract (49.83)	Glaucoma (15.68)	Diabetic retinopathy (13.6)
Cameroon[19]	Hospital-based cross-sectional	Cataract (50.1)	Glaucoma (19.7)	Diabetic retinopathy (7.8)
Nigeria[7]	Hospital-based cross-sectional	Cataract (50.0)	Glaucoma (20.5)	Corneal opacity (7.9)
South Africa[6]	Hospital-based cross-sectional	Cataract (34.1)	Glaucoma (31.7)	Corneal opacity (17.1)
Ghana[8]	Hospital-based cross-sectional	Cataract (15.3)	Glaucoma (9.1)	Corneal opacity (2.6)

age-related ocular conditions which contribute to blindness.[20] Additionally, females could be exposed to blindness due to poor utilization of eye care services and the social stigma of wearing spectacles.[21]

However, the results of this study are higher from findings in Addis Ababa, Ethiopia 7.3%,[10] Ghana 3.7%,[5] and South Africa 10.9%.[6] This discrepancy could be attributed to the variation in the sampling technique, data collection methods, and sample size.

The present study found that almost fifty percent of blindness was contributed by cataract (49.5%) and glaucoma accounted for 18.8% of blindness. This result is similar to others hospital-based studies in Yemen,[17] South Jordan,[18] Cameroon,[19] Nigeria,[7] South Africa,[6] and Ghana[8] (Table 6). The possible reason for these avoidable conditions as the leading causes of blindness worldwide particularly in developing countries might be due to the nature of the condition is age related.[8,22] Besides, lack of awareness of conditions/treatment, cost of treatment, fear of the outcome of treatment, availability of eye care service, and waiting for maturity were the most common reasons for the increment of blindness due to cataract.[22–26]

On the other hand, this study showed that, out of 70 individuals who received cataract surgery in both or either of the eye, 6 (8.6%) of the individual were blind after surgery. This might be due to the presence of posterior (retinal/macular) pathology in the operating eye and possible postoperative complications.[27,28]

As compared to having a high monthly income, the study participants who have low monthly income were 4.9 times vulnerable to develop blindness. This finding agreed with research done in Nigeria,[29] Iran,[30] and China.[31] The possible reason for more blindness in lower monthly income may be due to limited access to eye care service.

In this study, participants whose age 60–69 were 2.9 times more likely to have blindness, whereas those aged ≥70 were 4.8 times risk to develop blindness than those aged 18–40-year-old; this result is similar to studies done in the Gurage Zone of Ethiopia,[9] Afghanistan,[32] India,[33] and Nepal.[21] The possible explanation for this association might be due to the most common causes blindness are age-related eye diseases. The limitation of our study includes: Cross-sectional hospital-based nature of the study did not allow us to know the most important predictors of blindness and the finding of our study may not be generalizable for the community as a whole.

Conclusion

The proportion of blindness was 14.3%. Cataract, glaucoma and AMD were the common causes of blindness. Low monthly income and older age were significantly increased the risk of blindness. A large-scale study was recommended to know the prevalence of blindness in the community.

Data Sharing Statement

All the necessary data are included in the manuscript, and if needed, the supporting data are available.

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Disclosure

The authors declare that no conflict of interest in this work.

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