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Ocular Morbidity and Associated Factors Among Garo Adults in Madhupur, Bangladesh

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Abstract

Background

Indigenous populations may experience substantial barriers to accessing eye care services, yet evidence on ocular morbidity among the Garo community in Bangladesh remains limited. This study assessed the burden and factors associated with ocular morbidity among Garo adults in Madhupur, Tangail.

Methods

A community-based cross-sectional study of 111 Garo adults aged 18 and older was conducted in Pirgacha, Madhupur, Tangail, from June 2024 to July 2025. Participants received structured interviews and ocular assessments, including visual acuity (VA), refraction, and anterior- and posterior segment examinations. Data were analyzed using descriptive statistics, and factors associated with various eye conditions were examined through bivariate and multivariable logistic regression, with Firth penalized regression used for posterior segment disease due to a small number of cases.

Results

The mean age was 39.7 years, and 58 (52.2%) participants were female. The mean VA was 0.35 ± 0.60 logarithm of the minimum angle of resolution (LogMAR) in the right eye and 0.31 ± 0.54 LogMAR in the left eye. In the better-seeing eye, 73.9% of participants had no visual impairment, while 9.0% had mild, 9.0% moderate, 4.5% severe visual impairment, and 3.6% were blind. Refractive error findings accounted for 56 (50.4%) reported responses, including myopia (28; 25.2%), hypermetropia (18; 16.2%), and astigmatism (10; 9.0%). Presbyopia was reported in 39 (35.1%) participants. Anterior segment findings accounted for 61 (55.0%) reported responses, including cataract (19; 17.1%), dry eye (9; 8.1%), and pterygium (7; 6.3%). Posterior segment disease was identified in 10 (9.0%) participants. Participants aged >49 years had higher odds of refractive error (adjusted OR (aOR) 9.875, 95% CI 2.248-51.761; p = 0.004) and anterior segment disease (aOR 18.604, 95% CI 4.224-98.943; p < 0.001). Family history of ocular disease was associated with refractive error (aOR 6.522, 95% CI 2.243-20.918; p < 0.001) and posterior segment disease (aOR 9.269, 95% CI 1.839-93.635; p = 0.005).

Conclusions

Ocular morbidity appeared substantial among Garo adults, particularly refractive and anterior segment conditions. These findings may support the strengthening of community-based eye screening, accessible refractive services, cataract detection, and timely referral within Indigenous communities in Bangladesh.

Categories: Public Health, Ophthalmology
Keywords: bangladesh , community-based eye screening, eye health, garo community, ocular morbidity, refractive error, visual impairment

Introduction

Visual impairment is a major global public health concern affecting quality of life, productivity, independence, and socioeconomic well-being [1,2]. Globally, at least 2.2 billion people experience near or distance vision impairment, with at least 1 billion cases preventable or unaddressed [3]. In 2020, approximately 596 million people had distance vision impairment, including 43 million who were blind, while 510 million had uncorrected near vision impairment due to presbyopia [2]. The burden is disproportionately greater in low- and middle-income countries and among populations facing socioeconomic and geographic barriers to eye care [2,3].

Refractive error and cataract remain the leading causes of vision impairment and blindness, with glaucoma, diabetic retinopathy, and age-related macular degeneration contributing substantially to vision loss [3,4].

Uncorrected refractive error is particularly important because it can be effectively addressed through appropriate refractive correction and accessible eye care services [3,5]. Improving access to eye care is therefore essential for reducing health inequities, particularly among disadvantaged populations [2].

Bangladesh is home to several indigenous communities, including the Garo, who have a substantial population in the Mymensingh region. Previous studies have highlighted socioeconomic and environmental differences in health outcomes across communities in Bangladesh [6], while research among the Garo has indicated the importance of accessible, community-oriented healthcare services [7]. More broadly, indigenous populations may experience persistent inequities in healthcare access and resource distribution [8].

Despite the substantial burden of visual impairment in South Asia, evidence regarding ocular health among indigenous populations in Bangladesh remains limited. In particular, information on refractive errors, anterior- and posterior segment diseases, and associated factors among Garo adults is scarce. Therefore, this study aimed to assess visual impairment, refractive status, ocular morbidity, and their associated factors among Garo adults in Bangladesh. The primary objective of this study was to assess the burden and pattern of visual impairment and ocular morbidity among Garo adults in Madhupur, Bangladesh. The secondary objective was to identify factors associated with refractive errors, anterior segment disease, and posterior segment disease. The findings may inform targeted, accessible eye care strategies for this underserved population.

Materials And Methods

Study design and setting

A community-based, cross-sectional observational study was conducted among adults of the Garo indigenous community in Pirgacha, Madhupur, Tangail, Bangladesh. The study was overseen by the Department of Community Ophthalmology, Bangladesh Medical University (BMU), Dhaka. The overall study period extended from December 2023 to September 2025, with participant recruitment and data collection occurring from June 2024 to July 2025.

Study population and participant selection

Participants were recruited using non-probability sampling at a community eye camp in Pirgacha, Madhupur, Tangail, Bangladesh, organized with permission from the local chairman. Public-address announcements (“miking”) informed residents that participation was limited to the Garo community. At the camp, attendees were screened by ethnicity, age, and residency; Garo identity was verified using National Identity Cards. We enrolled eligible attendees who gave written informed consent. Exclusion criteria were age <18 years, non-Garo ethnicity, non-permanent residency, severe systemic illness, or inability to cooperate with ophthalmic examinations. The final analysis included 111 participants.

Sample size

The sample size was estimated using a two-population proportion formula, as described in a previous study [9], assuming proportions of 16% and 8%, a two-sided significance level of 5% ($Z = 1.96$), and 80% statistical power ($Z = 0.84$), yielding a target sample of 111 participants. However, as this was a community-based cross-sectional study without predefined comparison groups, the calculation was not specifically designed for prevalence estimation with a predetermined margin of error. A total of 111 eligible Garo adults were included. The sample size and non-probability sampling approach should be considered when interpreting the precision and generalizability of the findings.

Data collection

Data were collected through face-to-face interviews by trained interviewers using an investigator-developed, semi-structured questionnaire based on the study objectives and relevant literature [10,11]. The questionnaire covered sociodemographic characteristics, medical and ophthalmic histories, lifestyle factors, family history, and household conditions, including age, gender, education, housing, sanitation, nutritional status, systemic diseases, substance use, and previous ocular conditions. It was reviewed for content relevance and clarity and pretested to assess comprehensibility and practical applicability. Similar questionnaires have been used in population-based eye health surveys in rural Bangladesh [12]. As the questionnaire collected descriptive and clinical information rather than measuring a psychological construct, formal psychometric validation was not undertaken. Before the ophthalmic examination, participants completed a structured questionnaire about prior ocular disease. A history was defined as a self-reported condition predating the study assessment, recorded separately from examination findings and classified as present or absent. Clinical findings were assessed separately through standardized ophthalmic examinations.

The questionnaire primarily focused on sociodemographic characteristics, medical and ophthalmic histories, lifestyle factors, and household conditions. Awareness of ocular diseases, previous utilization of eye care services, and perceived barriers to seeking ophthalmic care were not systematically assessed.

Ophthalmic assessment

Distance visual acuity (VA) was measured monocularly with a Snellen chart at 6 m under good lighting. Participants wearing spectacles used their habitual correction. If VA was reduced, pinhole testing checked for correctable refractive errors; those improving with pinhole had subjective refraction and retinoscopy, with best-corrected VA recorded. Near VA was tested binocularly at 40 cm with an N-type chart. Best-corrected VA and near VA were assessed as part of the clinical examination; however, the prespecified analytical outcomes were visual impairment, refractive error findings, anterior segment findings, and posterior segment disease. VA in Snellen notation was converted to the logarithm of the minimum angle of resolution (LogMAR) for analysis. The ocular examination included Hirschberg reflex, pupillary light reactions, and anterior segment assessment with a torchlight and slit lamp. Posterior segment examination was performed using a Heine 200S ophthalmoscope (HEINE Optotechnik GmbH & Co. KG, Gilching, Germany) to identify abnormalities involving the vitreous, retina, choroid, or optic nerve. Those needing further care were referred to the Department of Community Ophthalmology, BMU.

Outcome measures and definitions

The prespecified analytical outcomes were visual impairment, refractive error, anterior segment disease, and posterior segment disease. Visual impairment was classified according to World Health Organization (WHO) criteria based on VA in the better eye [13]. Participants were categorized as having no visual impairment, mild, moderate, or severe visual impairment, or blindness, using the prespecified visual-acuity thresholds.

Refractive error was defined as VA ⩽6/9 (20/25) in either eye that improved with correction, or ametropia on retinoscopy [14]. Reduced acuity alone was insufficient for diagnosis, as cataract, corneal abnormalities, and posterior segment disorders can also impair vision. Pinhole testing, subjective refraction, and retinoscopy assessed refractive abnormalities; anterior- and posterior segment examinations identified other causes. Refractive errors and other ocular abnormalities were distinct findings but could coexist.

Anterior segment disease was defined as any pathological condition affecting the cornea, anterior chamber, iris, lens, or other anterior ocular structures. Posterior segment disease was defined as any pathological condition involving the vitreous, retina, choroid, or optic nerve.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 27.0 (released 2019; IBM Corp., Armonk, NY, USA). Continuous variables were summarized using means and SDs, whereas categorical variables were presented as frequencies and percentages. The potential influence of skewed distributions on the interpretation of continuous variables was considered; however, the descriptive statistics were reported in accordance with the analyses performed.

Bivariate logistic regression analyses were conducted separately for refractive error, anterior segment disease, and posterior segment disease. Crude ORs (CORs) with 95% CIs were calculated. Variables associated with the respective outcomes in bivariate analyses or considered clinically relevant were considered for multivariable modelling. Age and sex were retained a priori. Variables demonstrating exact collinearity were not included simultaneously in the models; therefore, proper nutrition was excluded because of its exact collinearity with sanitary latrine use. History of ocular surgery was excluded from the final multivariable models because the small number of participants reporting previous ocular surgery could produce unstable adjusted estimates.

Multivariable logistic regression was performed to identify factors associated with each ocular outcome, and adjusted ORs (aORs) with 95% CIs were reported. Because posterior segment disease occurred in only 10 participants, Firth's penalized logistic regression was used to reduce small-sample estimation bias. Given the limited number of outcome events, estimates with exceptionally wide CIs were interpreted cautiously because of their substantial statistical uncertainty. Statistical significance was defined as a two-sided p-value < 0.05.

Results

Table *1* shows that 111 Garo adults participated, with a mean age of 39.7 ± 15.4 years. The largest age group was 18-30 years, with 44 (39.6%) participants, and 58 (52.2%) participants were female. The most common education level was intermediate/diploma (33; 29.7%), followed by high school (27; 24.3%), while 22 (19.8%) participants were illiterate. Hypertension and diabetes mellitus were reported in 15 (13.5%) and seven (6.3%) participants, respectively. Previous ocular surgery, ocular disease, and ocular injury were reported by 12 (10.8%), nine (8.1%), and nine (8.1%) participants, respectively. Alcohol consumption, smoking, and betel nut/leaf use were reported by 74 (66.7%), 34 (30.6%), and 32 (28.8%) participants, respectively. A family history of ocular disease was reported by 43 (38.7%) participants.

Characteristics	Number of participants (n)	Percentage (%)

Age group (years)		
18-30	44	39.6
31-49	37	33.4
>49	30	27
Age (years), mean ± SD	39.7 ± 15.4	
Gender		
Male	53	47.8
Female	58	52.2
Educational attainment		
Illiterate	22	19.8
Primary school	9	8.1
Middle school	7	6.3
High school	27	24.3
Intermediate/diploma	33	29.7
Graduate	13	11.7
Professional degree	0	0
Systemic comorbidities		
Hypertension	15	13.5
Diabetes mellitus	7	6.3
Previous ocular history		
Ocular disease	9	8.1
Ocular surgery	12	10.8
Ocular injury	9	8.1
Lifestyle factors		
Current smoking	34	30.6
Alcohol consumption	74	66.7
Betel nut/leaf consumption	32	28.8
Family history		
Ocular disease	43	38.7
Hypertension	28	25.2
Diabetes mellitus	4	3.6
Fatty liver disease	1	0.9
Living conditions (housing type)		
Brick	85	76.6
Bamboo	12	10.8
Wood	14	12.6
Sanitary latrine use	96	86.5
Adequate nutrition	94	84.7

TABLE 1: Sociodemographic, clinical, and lifestyle characteristics of the study participants (N =

111).

Data are presented as frequencies (n) and percentages (%). Lifestyle characteristics were assessed independently, and participants could report more than one behavior. Therefore, percentages for these characteristics are not mutually exclusive and may exceed 100% when summed. Percentages were calculated using the total sample (N = 111).

Table 2 shows that the mean VA was 0.35 ± 0.60 logMAR in the right eye and 0.31 ± 0.54 logMAR in the left eye. A VA of 0.00 logMAR was recorded in 54 (48.6%) right eyes and 56 (50.5%) left eyes. The most common non-normal VA values were 0.17 logMAR in 21 (18.9%) right eyes and 0.30 logMAR in 14 (12.6%) left eyes. A VA of 2.00 logMAR was observed in 11 (9.9%) right eyes and eight (7.2%) left eyes.

VA (LogMAR)	Right eye, n (%)	Left eye, n (%)
0	54 (48.6)	56 (50.5)
0.17	21 (18.9)	16 (14.4)
0.3	11 (9.9)	14 (12.6)
0.47	4 (3.6)	7 (6.3)
0.6	3 (2.7)	2 (1.8)
0.77	3 (2.7)	3 (2.7)
1	4 (3.6)	5 (4.5)
2	11 (9.9)	8 (7.2)
Mean ± SD	0.35 ± 0.60	0.31 ± 0.54
Range (min-max)	0-2.00	0-2.00

TABLE 2: Distribution of VA among the study participants (N = 111).

Data are presented as n (%) unless otherwise indicated.

LogMAR, logarithm of the minimum angle of resolution; VA, visual acuity

In Table 3, among the 111 participants, 82 (73.9%) had no visual impairment; 10 (9.0%) had mild, 10 (9.0%) had moderate, five (4.5%) had severe visual impairment, and four (3.6%) were blind.

Visual impairment category	VA in better-seeing eye	n (%)
No visual impairment	≥6/12	82 (73.9)
Mild visual impairment	<6/12 to ≥6/18	10 (9.0)
Moderate visual impairment	<6/18 to ≥6/60	10 (9.0)
Severe visual impairment	<6/60 to ≥3/60	5 (4.5)
Blindness	<3/60	4 (3.6)

TABLE 3: Distribution of participants according to WHO visual impairment categories based on VA in the better-seeing eye (N = 111).

Values are presented as n (%). Visual impairment categories were assigned at the participant level according to VA in the better-seeing eye.

VA, visual acuity

Table 4 summarizes the reported ocular findings among the 111 Garo adults. Refractive error findings accounted for 56 reported responses (50.4%), including myopia (28; 25.2%), hypermetropia (18; 16.2%), and

astigmatism (10; 9.0%). Presbyopia was reported in 39 (35.1%) participants and emmetropia in 31 (27.9%). Anterior segment findings accounted for 61 reported responses (55.0%), including cataract (19; 17.1%), dry eye (9; 8.1%), and pterygium (7; 6.3%). Posterior segment disease was identified in 10 (9.0%) participants, most commonly myopic fundus (5; 4.5%) and glaucoma (3; 2.7%).

Characteristics	Frequency of reported findings (n)	Percentage (%)
Refractive and visual findings		
Refractive error	56	50.4
Myopia	28	25.2
Hypermetropia	18	16.2
Astigmatism	10	9
Presbyopia	39	35.1
Emmetropia	31	27.9
Vision not improved with correction	6	5.4
Anterior segment disease	61	55
Cataract	19	17.1
Dry eye	9	8.1
Pterygium	7	6.3
Ocular growth	5	4.5
Pseudophakia (bilateral)	4	3.6
Pseudophakia, unilateral	4	3.6
Corneal opacity	3	2.7
Conjunctivitis	3	2.7
Chronic dacryocystitis	2	1.8
Strabismus	2	1.8
Pinguecula	1	0.9
Blepharitis	1	0.9
Chalazion	1	0.9
Posterior segment disease	10	9
Myopic fundus	5	4.5
Glaucoma	3	2.7
Diabetic retinopathy	1	0.9
Age-related macular degeneration	1	0.9

TABLE 4: Distribution of refractive, anterior segment, and posterior segment ocular findings among Garo adults (N = 111).

Data are presented as frequency (n) and percentage (%). Multiple responses were permitted; therefore, percentages may not sum to 100%.

Figure *1* summarizes major ocular findings from Table *4*, showing distribution. Anterior segment findings are most common, followed by refractive error; posterior segment findings are less frequent. While Figure *1* compares the three categories, Table *3* details their distribution.

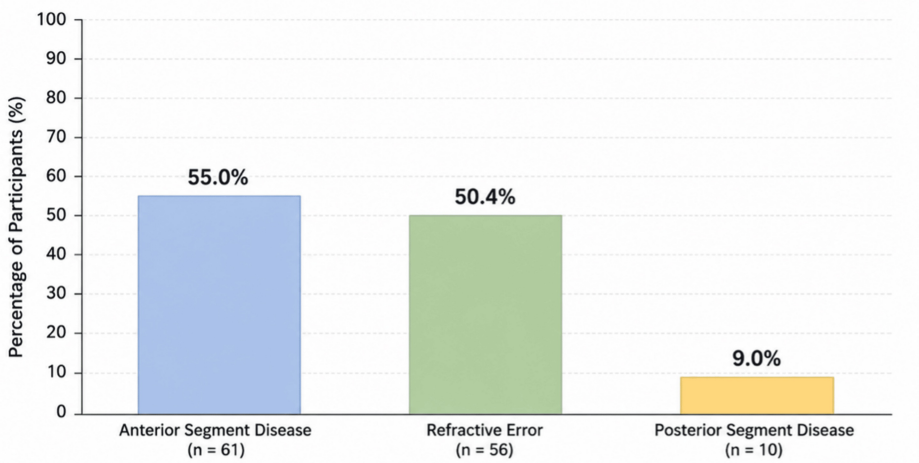


FIGURE 1: Distribution of major ocular findings among study participants.

Multiple ocular findings could be reported in the same participant; therefore, the frequencies are not mutually exclusive.

Table 5 shows that increasing age was associated with higher odds of refractive error (COR 1.037, 95% CI 1.010-1.064; p = 0.006), anterior segment disease (COR 1.064, 95% CI 1.033-1.095; p < 0.001), and posterior segment disease (COR 1.047, 95% CI 1.006-1.090; p = 0.023). Refractive error was also associated with a history of ocular disease, previous ocular surgery, family history of ocular disease, and systemic disease. Anterior segment disease was associated with previous ocular injury and bamboo housing, whereas sanitary latrine use and adequate nutrition were associated with lower crude odds. Posterior segment disease was associated with a history of ocular disease, previous ocular surgery, family history of ocular disease, and systemic disease.

Variable	Refractive error crude COR (95% CI)	p-value	Anterior segment disease COR (95% CI)	p-value	Posterior segment disease COR† (95% CI)	p-value
Age, per year	1.037 (1.010-1.064)	0.006	1.064 (1.033-1.095)	<0.001	1.047 (1.006-1.090)	0.023
Gender						
Male	Reference	-	Reference	-	Reference	-
Female	0.639 (0.300-1.359)	0.245	0.597 (0.279-1.278)	0.184	0.872 (0.248-3.059)	0.830
History of ocular disease						
No	Reference	-	Reference	-	Reference	-
Yes	11.902 (1.434-98.785)	0.022	1.143 (0.290-4.509)	0.849	21.667 (4.501-104.304)	<0.001
History of ocular surgery						
No	Reference	-	Reference	-	Reference	-
Yes	7.564 (1.572-36.399)	0.012	2.211 (0.654-7.468)	0.202	12.467 (2.969-52.346)	<0.001
History of ocular injury						
No	Reference	-	Reference	-	Reference	-
Yes	1.648 (0.418-6.497)	0.476	5.654 (1.117-28.610)	0.036	0.464 (0.022-9.944)	0.623
Family history of ocular disease						
No	Reference	-	Reference	-	Reference	-
Yes	4.178 (1.856-9.402)	<0.001	0.543 (0.245-1.204)	0.133	12.391 (2.080-73.805)	0.006

Systemic disease						
No	Reference	-	Reference	-	Reference	-
Yes	2.837 (1.033-7.793)	0.043	2.515 (0.934-6.770)	0.068	5.581 (1.489-20.909)	0.011
Family history of systemic disease						
No	Reference	-	Reference	-	Reference	-
Yes	1.790 (0.761-4.212)	0.182	1.505 (0.640-3.540)	0.349	2.050 (0.559-7.518)	0.279
Housing status						
Brick	Reference	-	Reference	-	Reference	-
Bamboo	1.412 (0.437-4.560)	0.564	6.667 (1.698-26.174)	0.007	1.449 (0.210-10.015)	0.707
Wood	0.484 (0.141-1.668)	0.25	2.667 (0.843-8.435)	0.095	3.676 (0.839-16.098)	0.084
Use of sanitary latrine						
No	Reference	-	Reference	-	Reference	-
Yes	0.889 (0.298-2.648)	0.833	0.081 (0.017-0.379)	0.001	0.184 (0.046-0.730)	0.016
Proper nutrition						
No	Reference	-	Reference	-	Reference	-
Yes	0.923 (0.309-2.753)	0.886	0.083 (0.018-0.391)	0.002	0.187 (0.047-0.769)	0.020

TABLE 5: Bivariate logistic regression analysis of factors associated with refractive error, anterior segment disease, and posterior segment disease among Garo adults (N = 111).

† Firth's penalized logistic regression was used for posterior segment disease because of the small number of events.

Univariable logistic regression was used. $p < 0.05$ was considered statistically significant.

COR, crude OR

Table 6 shows that participants aged >49 years had higher odds of refractive error (aOR 9.875, 95% CI 2.248-51.761; p = 0.004), and family history of ocular disease was also associated with refractive error (aOR 6.522, 95% CI 2.243-20.918; p < 0.001). For anterior segment disease, participants aged 31-49 years (aOR 6.681, 95% CI 1.831-27.665; p = 0.005) and >49 years (aOR 18.604, 95% CI 4.224-98.943; p < 0.001) had higher odds than those aged 18-30 years. Family history of ocular disease was associated with lower odds of anterior segment disease (aOR 0.231, 95% CI 0.058-0.774; p = 0.025), whereas family history of systemic disease was associated with higher odds (aOR 6.164, 95% CI 1.496-30.230; p = 0.016). No other variables were significantly associated with either outcome after adjustment. The association between previous ocular disease and refractive error was estimated with considerable uncertainty (aOR 4.291, 95% CI 0.406-109.708; p = 0.273).

Variable	Refractive error aOR (95% CI)	p-value	Anterior segment disease aOR (95% CI)	p-value
Age group (years)				
18-30	Reference	-	Reference	-
31-49	1.104 (0.328-3.782)	0.872	6.681 (1.831-27.665)	0.005
>49	9.875 (2.248-51.761)	0.004	18.604 (4.224-98.943)	<0.001
Gender				
Male	Reference	-	Reference	-
Female	0.297 (0.075-1.053)	0.069	1.256 (0.332-4.942)	0.738
History of ocular disease				
No	Reference	-	Reference	-

Yes	4.291 (0.406-109.708)	0.273	1.154 (0.124-14.823)	0.904
History of ocular injury				
No	Reference	-	Reference	-
Yes	2.750 (0.372-27.300)	0.343	2.810 (0.267-50.399)	0.433
Smoking				
No	Reference	-	Reference	-
Yes	0.255 (0.055-1.048)	0.066	3.252 (0.759-16.058)	0.126
Alcohol consumption				
No	Reference	-	Reference	-
Yes	0.415 (0.106-1.511)	0.19	0.911 (0.213-3.915)	0.898
Betel nut/leaf consumption				
No	Reference	-	Reference	-
Yes	3.042 (0.783-13.253)	0.117	0.873 (0.211-3.273)	0.844
Family history of ocular disease				
No	Reference	-	Reference	-
Yes	6.522 (2.243-20.918)	<0.001	0.231 (0.058-0.774)	0.025
Family history of systemic disease				
No	Reference	-	Reference	-
Yes	0.847 (0.248-2.829)	0.787	6.164 (1.496-30.230)	0.016
Housing status				
Brick	Reference	-	Reference	-
Bamboo	0.772 (0.051-11.025)	0.848	4.884 (0.491-50.414)	0.170
Wood	0.165 (0.012-1.260)	0.114	3.466 (0.558-22.019)	0.179
Use of sanitary latrine				
No	Reference	-	Reference	-
Yes	1.216 (0.070-20.993)	0.892	0.975 (0.080-9.822)	0.983

TABLE 6: Multivariable logistic regression analysis of factors associated with refractive error and anterior segment disease among Garo adults (N = 111).

Multivariable logistic regression models were fitted separately for refractive error and anterior segment disease. Age and sex were retained a priori, while other variables were selected based on bivariate associations and clinical relevance. Proper nutrition was excluded because of exact collinearity with sanitary latrine use, and previous ocular surgery was excluded because of sparse data and potential model instability. Reference categories are indicated in the table. A two-sided p-value <0.05 was considered statistically significant.

aOR, adjusted OR

Table 7 presents the multivariable analysis of factors associated with posterior segment disease. Of 111 participants, 10 had posterior segment disease; therefore, Firth's penalized logistic regression was used. A history of ocular disease was significantly associated with posterior segment disease (Firth aOR 32.885, 95% CI 2.437 to >1000; p = 0.006), as was a family history of ocular disease (Firth aOR 9.269, 95% CI 1.839-93.635; p = 0.005). A reported family history of ocular disease was associated with lower adjusted odds of anterior segment disease (aOR = 0.231), but interpret this cautiously due to the small sample and possible residual confounding.

Variable	COR (95% CI)	p-value	Firth-aOR (95% CI)	p-value
Age group (years)				
18-30	Reference	-	Reference	-
31-49	0.781 (0.099-4.968)	0.793	0.704 (0.107-4.012)	0.690
>49	2.733 (0.617-14.270)	0.193	0.332 (0.002-4.228)	0.440
Gender				
Male	Reference	-	Reference	-
Female	0.870 (0.229-3.307)	0.834	0.907 (0.199-4.220)	0.897
History of ocular disease				
No	Reference	-	Reference	-
Yes	24.250 (5.063-130.780)	<0.001	32.885 (2.437 to >1000)	0.006
Family history of ocular disease				
No	Reference	-	Reference	-
Yes	17.735 (3.145-333.880)	0.007	9.269 (1.839-93.635)	0.005

TABLE 7: Multivariable logistic regression analysis of factors associated with posterior segment disease (N = 111).

Data are presented as CORs and Firth-aORs with 95% CIs. Reference categories are indicated in the table. Firth's penalized logistic regression was used because of the small number of posterior segment disease events. A two-sided $p < 0.05$ was considered statistically significant.

The exceptionally wide CI for previous ocular disease indicates substantial uncertainty in the magnitude of the estimated association. The upper confidence limit is presented as >1000 in the available statistical output and should not be interpreted as a precisely estimated upper bound.

aOR, adjusted OR; COR, crude OR

Discussion

This community-based study indicates a significant burden of ocular morbidity among Garo adults, with refractive and anterior segment findings more common than posterior segment issues. Since multiple responses were allowed, these frequencies reflect reported ocular findings rather than mutually exclusive participant-level prevalence. Blindness was identified in 3.6% of participants, compared with a reported national prevalence of 1.53% in Bangladesh. However, differences in age distribution, sampling methods, and study populations limit direct comparison. Despite these limitations, the findings highlight the need for accessible community-based eye screening and referral services among Garo adults. Refractive errors accounted for 56 findings (50.4%), while anterior- and posterior segment findings comprised 61 (55.0%) and 10 (9.0%), respectively. This aligns with global evidence that uncorrected refractive error and cataract are primary causes of preventable vision impairment [15-17].

Myopia was the most common refractive error (28; 25.2%), followed by hypermetropia (18; 16.2%), and astigmatism (10; 9.0%), with presbyopia also prevalent (39; 35.1%). These findings highlight the need for accessible refraction and spectacle services in Garo communities. The high proportion of presbyopia emphasizes the importance of including near-vision assessment in adult eye screening. Uncorrected refractive error remains a major cause of visual impairment worldwide, particularly in low- and middle-income countries [16,18]. This burden is also relevant to Bangladesh, where improving access to refractive assessment and affordable spectacles is important for reducing avoidable visual impairment. The high proportion of refractive errors in our study (50.4%) further highlights the need for these services among participating Garo adults, although this finding may be influenced by self-selection of individuals with visual complaints attending the eye camp.

The mean VA was 0.35 ± 0.60 logMAR in the right eye and 0.31 ± 0.54 logMAR in the left eye. Approximately half of the eyes had a VA of 0.00 logMAR: 54 (48.6%) right eyes and 56 (50.5%) left eyes. However, a VA of 2.00 logMAR was observed in 11 (9.9%) right eyes and eight (7.2%) left eyes, indicating that preserved VA does not rule out ocular abnormalities and underscoring the importance of combining VA testing with ocular examinations. Anterior segment issues were common, especially cataract (19; 17.1%), dry eye (9; 8.1%), and

pterygium (7; 6.3%). Cataract remains a major contributor to visual impairment and blindness globally [19]. In the present study, cataract was identified in 19 participants (17.1%). Although cataract represents an important cause of ocular morbidity in Bangladesh, this proportion cannot be directly compared with national prevalence estimates because of differences in age distribution, sampling methods, and study populations. Furthermore, the cross-sectional design does not establish whether cataract develops at an earlier age among Garo adults. Pterygium frequently occurs in rural populations and is associated with age and environmental exposure [20,21]. These findings emphasize the importance of cataract detection, refractive assessment, and comprehensive anterior segment evaluation in community-based eye care services.

Posterior segment findings were rare, mainly myopic fundus changes (5; 4.5%) and glaucoma (3; 2.7%). Only 10 participants had posterior segment disease, making estimates potentially imprecise; Firth's penalized logistic regression was used. Adjusted analysis showed previous ocular disease (aOR 32.885, 95% CI 2.437 to >1000; p = 0.006) and family history (aOR 9.269, 95% CI 1.839-93.635; p = 0.005) were associated with higher odds, though estimates should be interpreted cautiously due to small event numbers and wide CIs. The co-occurrence of myopic fundus changes and glaucoma is plausible, as myopia is linked to glaucoma [22], with recent evidence further clarifying the relationship [23].

Although previous ocular disease was associated with posterior segment disease (aOR = 32.885), the exceptionally wide 95% CI (2.437 to >1000) indicates substantial uncertainty regarding the magnitude of this association. Similarly, another regression estimate had a wide 95% CI (0.406-109.708), indicating uncertainty regarding both the direction and magnitude of the association. These imprecise estimates likely reflect the small sample size, limited number of posterior segment disease cases (n = 10), and sparse observations in certain predictor categories. Although Firth's penalized logistic regression was used to reduce small-sample estimation bias, these findings should be considered exploratory and interpreted cautiously. Larger studies with sufficient outcome events are needed to obtain more precise and reliable estimates.

Age appeared to be the most consistent factor associated with ocular morbidity. In bivariate analysis, increasing age was linked to higher odds of refractive, anterior-, and posterior segment findings. After adjustment, individuals over 49 had significantly higher odds of refractive error than those aged 18-30 (aOR 9.875, 95% CI 2.248-51.761; p = 0.004). Similarly, anterior segment disease was more common in those aged 31-49 (aOR 6.681, 95% CI 1.831-27.665; p = 0.005) and over 49 (aOR 18.604, 95% CI 4.224-98.943; p < 0.001). This age gradient aligns with evidence that ocular morbidity and vision loss increase with age [15,24]. Family history of ocular disease was independently associated with refractive error (aOR 6.522, 95% CI 2.243-20.918; p < 0.001), reflecting known familial risk [25,26]. It was inversely associated with anterior segment disease (aOR 0.231, 95% CI 0.058-0.774; p = 0.025), but this likely does not indicate protection and may be due to chance or confounding.

These findings suggest that community-based eye screening may be warranted for Garo adults, particularly older adults, incorporating VA, refraction, presbyopia assessment, cataract detection, and referral for suspected posterior segment disease. Indigenous populations can experience substantial barriers to eye care access and remain underrepresented in eye health research [27,28]. In Bangladesh, limited awareness of treatable eye conditions and available services may further discourage the uptake of spectacles and cataract surgery. Therefore, community-based interventions should prioritize culturally appropriate awareness-raising alongside accessible screening, affordable treatment, and strengthened referral pathways. Engagement with local community representatives may also help improve awareness, service utilization, and continuity of eye care.

The strengths of this study include community-based assessment, standardized ocular examination, evaluation of multiple ocular conditions, and use of Firth regression for the sparse posterior outcome. However, the cross-sectional design prevents causal inference, purposive sampling may limit generalizability, and the small sample may have produced imprecise estimates for uncommon outcomes. Multiple-response outcomes also require cautious interpretation, while self-reported ocular and family histories may be affected by recall or reporting bias. Furthermore, the study did not assess participants' awareness of ocular diseases, prior use of eye care services, or barriers to ophthalmic care, factors that may affect detection and management, especially in underserved communities. Thus, the findings cannot link ocular morbidity to limited awareness, use of services, or access to care. Future community-based studies should measure these factors to clarify eye care needs and healthcare-seeking behaviors among Garo adults.

Despite these limitations, the study may provide useful community-level evidence on ocular morbidity among Garo adults and may underscore the need to prioritize refractive correction, cataract detection, and age-focused eye care services.

Conclusions

Ocular morbidity represents an important eye health concern among Garo adults. Strengthening community-based eye care services, including routine visual assessment, accessible refractive correction, early identification of cataract and other ocular conditions, and appropriate referral, may improve access to

essential eye care in this underserved population. Further population-based and longitudinal studies are warranted to better characterize ocular morbidity and its determinants among Indigenous communities in Bangladesh.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

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