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Prevalence and Causes of Blindness and Vision Impairment in the State of Qatar: Results of a Population-Based Cross-Sectional Study

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Keywords
Qatar · Population-based investigation · Avoidable blindness · Vision impairment

Abstract

Introduction: This study is a population-based investigation into the prevalence and causes of blindness and vision impairment (VI) among people aged 50 years and older living in the State of Qatar. ***Methods:*** A Rapid Assessment of Avoidable Blindness (RAAB) methodology, applied from May 2022 to June 2023, utilized stratified two-stage cluster random sampling to select 5,060 persons aged 50 years and older resident in Qatar from 145 communities chosen by probability proportional to size. Communities were stratified by Qatari and non-Qatari nationality. Participants were examined by ophthalmologists in primary health centers. Data collection was through the RAAB7 Android application and supervised by a trainer using secure, encrypted cloud storage. ***Results:*** Of the 3,206 participants examined, 14 (0.4%) had blindness and 10 (0.3%) had severe VI. Compared to a previous RAAB study in 2009, the prevalence of blindness (presenting visual acuity [VA] <3/60) decreased from 1.28% to 0.4% (95% confidence interval (CI): 0.2–0.7%). The age-sex-adjusted prevalence of all VI (presenting VA <6/12-NPL) was 9.7% (95% CI: 8.3–11.1), higher among females 12.6% (95% CI: 10.5–14.6), and Qataris 16.7% (95% CI: 14.4–19.1), compared to males 7.6% (95% CI: 6.3–9.0), and non-Qataris 6.3% (95% CI: 5.1–7.5). The principal causes of blindness included diabetic retinopathy (DR) (33.3%), cataract (20%), glaucoma (13%), and other posterior segment diseases (13%). All VI was mainly attributed to uncorrected refractive errors at 58% and cataract at 17%, with the former being more common among non-Qataris and cataract more prevalent among Qataris. ***Conclusion:*** Our findings show a low prevalence of VI compared with many countries that have published VI data. VI was mainly caused by DR, cataract, and uncorrected refractive error. Further reduction in vision loss can be achieved with early detection and improved access using innovation and technology.

Introduction

Worldwide, there are 2.2 billion people with vision impairment (VI) or blindness, 400 million with distance VI, and a further 1.8 billion with near VI due to presbyopia [1–3]. In 2020, the population of Qatar was

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2,846,000, made up of Qatari nationals and non-Qataris who are typically working age group expatriates. Based on the 2020 Census, a total of 164,962 people aged 50 years and older were living in Qatar, divided into 51,550 Qataris and 113,412 non-Qataris. Notably, females comprised 54% of the Qatari group and only 38% of the non-Qatari group. Qatar's rapid economic growth has led to a dynamic and complex migration landscape, where the non-Qatari population is largely transient, with many expatriates returning home after retirement. However, some long-term residents remain due to family or personal ties, reflecting the evolving nature of migration patterns in the region. Eye care services in Qatar are provided by public, private, and semi-government entities [4]. The two main public providers are Hamad Medical Corporation (HMC) and Qatar Primary Health Care Corporation (PHCC). The Ministry of Public Health (MOPH) in Qatar and the PHCC recognized the urgency of a population eye health study to meet international health mandates, underscoring Qatar's dedication to ensuring the well-being and eye health of its population [5, 6], and aligning with global eye health priorities [4, 7]. This is in response to the recommendations of the 74th World Health Assembly [8] and in line with the 75th United Nations General Assembly Resolution [9]. RAAB is a cross-sectional population-based survey used for evidence-based eye care planning and evaluation of universal health coverage. It provides candidate indicators for assessing the achievements of the United Nations 2030 Sustainable Development Goals [10]. RAAB focuses on VI in the population aged 50 years and older, because over 90% of blindness was found in this age group allowing for a smaller sample size with the ability to estimate the magnitude and causes of VI RAAB focuses on VI in the population aged 50 years and older. After all, over 90% of blindness were found in this age group allowing for a smaller sample size with the ability to estimate the magnitude and causes of VI [11, 12]. The survey's objectives were (1) to estimate the prevalence and causes of blindness, (2) measure the effective coverage of cataract and refractive error services, (3) determine barriers to accessing cataract surgery, and (4) estimate the prevalence of diabetes mellitus and diabetic retinopathy (DR) in the State of Qatar. This manuscript discusses only the first objective. In 2009, Qatar conducted a modified RAAB revealing significant risk factors for visual disabilities, with cataract and glaucoma emerging as the main causes [5]. Thus, researchers aimed to compare the results of the 2009 RAAB survey with the current study.

Methods

Sampling Design

The study was conducted between May 2022 and June 2023 (excluding the period between October and December). A minimum sample size of 5,060 persons was calculated using the RAAB7 sample size calculator based on the previously reported blindness prevalence of 1.28% (2009 RAAB study) [5], a precision of 0.4%, a design effect of 1.4, a 95% confidence level, and a 10% nonresponse rate. Participants were selected using a stratified two-stage cluster random sampling technique. To conduct household surveys stratified by Qatari and non-Qatari (expatriate residents) nationality status, the Qatar Planning and Statistics Authority (PSA) has developed two sets of primary sampling units (PSUs) that are distinct by nationality but cover the entire population, excluding the collective housing quarters of short-term workers. PSUs were constructed by combining adjacent 2020 Census enumeration areas, nationally, there were 581 Qatari PSUs and 1,678 non-Qatari PSUs [13]. PSU selection was divided proportionally between Qataris and non-Qataris in an approximately 1–2.2 ratio. Therefore, out of 145 PSUs required for the study, 100 non-Qatari PSUs and 45 Qatari PSUs were selected from their respective sampling frames with probability proportionate to population size. In a departure from the typical RAAB sampling approach, in the second stage, 35 eligible persons were randomly selected from an individual-level list of residents in the chosen PSUs by simple random selection after generating random numbers. PSA used the 2020 Census to select individuals at the second stage. Eligibility was defined as aged 50 years and above, resident in a selected PSU for at least the past 6 months, excluding visitors or migrant laborers with short-term contracts (typically residing in camps for less than 6 months) and individuals recently exposed to COVID-19.

Participant Enrollment

Instead of employing the typical door-to-door approach of a standard RAAB survey, each selected participant was contacted by telephone by appointment schedulers from MOPH and invited to participate in the study, after which they were assigned to the closest of the 10 health centers (HCs) used by the survey for ophthalmic examinations. Participants' electronic medical records were used to schedule appointments at the assigned HCs for the selected and consented participants. On the appointment day, each selected

participant was verified at the HC using their ID card and signed a written consent form. Participants were designated as not enrolled if their telephone number was inactive or after three unsuccessful attempts to contact them by telephone.

Survey Team Training

All 10 ophthalmologists and 10 nurses involved in the study were trained by a qualified RAAB trainer in two batches. The training, conducted over 7 days for each batch, consisted of survey design, mobile data entry, examination protocol, and operational definitions. It also involved interobserver variation among the teams for VA testing, lens assessment, causes(s) of vision loss, and grading of DR to ensure optimal agreement in attainment of Kappa coefficients >0.60.

Examination

Each of the HCs had one trained ophthalmologist and two nurses who recorded participant demographic details by using the RAAB7 Android application on Samsung tablets. All participants underwent visual acuity (VA) testing, i.e., uncorrected, corrected (aided), and pinhole vision of each eye, using the Peek Vision acuity test in the RAAB7 application. The examination included direct and indirect ophthalmoscopy and slit lamp examination. All participants received lens assessment using a slit lamp to determine if an eye had the natural lens, intraocular lens or aphakic, and a random blood glucose test was done. Pupil dilation was done to only diabetics or those with a presenting VA of <6/12 to determine the cause of VI for each eye and for the person. Where there was more than one possible cause of VI in any eye, the cause more responsible for vision loss was chosen, or the cause more curable or preventable if this could not be determined. For each person, the cause of VI was determined by considering the causes in the two eyes and selecting the cause that was more curable or preventable. Where participants were physically unable to attend a HC, the examination team arranged to visit them at their homes with a similar examination process, protocol, and tools.

Data Monitoring, Management, and Analysis

Upon completing the examinations and synchronizing the data with the cloud server, the RAAB7 trainer and principal investigator (PI) remotely monitored the data. They carried out regular progress evaluations and quality tests accompanied by immediate notifications regarding potential errors or deviations from the set protocols, alerting the survey coordinators and the involved ophthalmologists. For data analysis, separate datasets were defined for Qataris and non-Qataris by PSU (cluster) identifiers, alongside the total sample. Qatar 2020 Census data were used with the RAAB7 automated analysis to calculate age- and sex-adjusted prevalence with 95% confidence intervals [14].

Ethical Considerations and Data Security

The study received ethical approval from Qatar MOPH (Ref. PHCC/DCR/2022/04/023). During data collection, participants' names, ages, and genders were recorded on encrypted, password-protected mobile data collection devices, each equipped with GPS to log the location of survey completion, followed by a secure upload directly to Peek Vision's encrypted server. Data access was limited to the PI, co-PI, survey coordinators, RAAB trainer, and selected Peek technical staff. Following the completion of the survey, identifiable participant data were permanently deleted from the dataset.

Definitions

All VI was defined as a combination of mild, moderate, SVI, and blindness [15]. Mild VI = presenting VA (PVA) <6/12 but ≥6/18 in the better eye, moderate VI = PVA <6/18 but ≥6/60 in the better eye, severe vision impairment (SVI) = PVA <6/60 but ≥3/60 in the better eye, and blindness = PVA <3/60 in the better eye.

Results

There were 4,064 out of the target sample size of 5,060 (80.3%) who were enrolled in the survey, and of those enrolled, 3,206 were examined, a response rate of 78.9%. Enrollment and examination rates and reasons for nonparticipation are shown in Figures 1 and 2, and Table 1. The Qatari and non-Qatari proportions were 35% and 65%, respectively. Overall, the age-sex-adjusted prevalence of blindness was 0.4% (95% CI: 0.2–0.7%), higher among Qataris than non-Qataris (1.2% [95% CI: 0.7–1.8%] vs. 0.1% [95% CI: 0.0–0.3]) (Table 2). Extrapolated to the 2020 population of people aged 50 years and older, there were 732 people blind in the country, and about two-thirds were Qataris. The age-sex-adjusted prevalence of all VI was 9.7% (95% CI: 8.3–11.1), SVI prevalence was 0.3% (95% CI: 0.1–0.5), while moderate and mild VI prevalence were 3.8% and 5.2%, respectively. For all VI, Qataris had more than

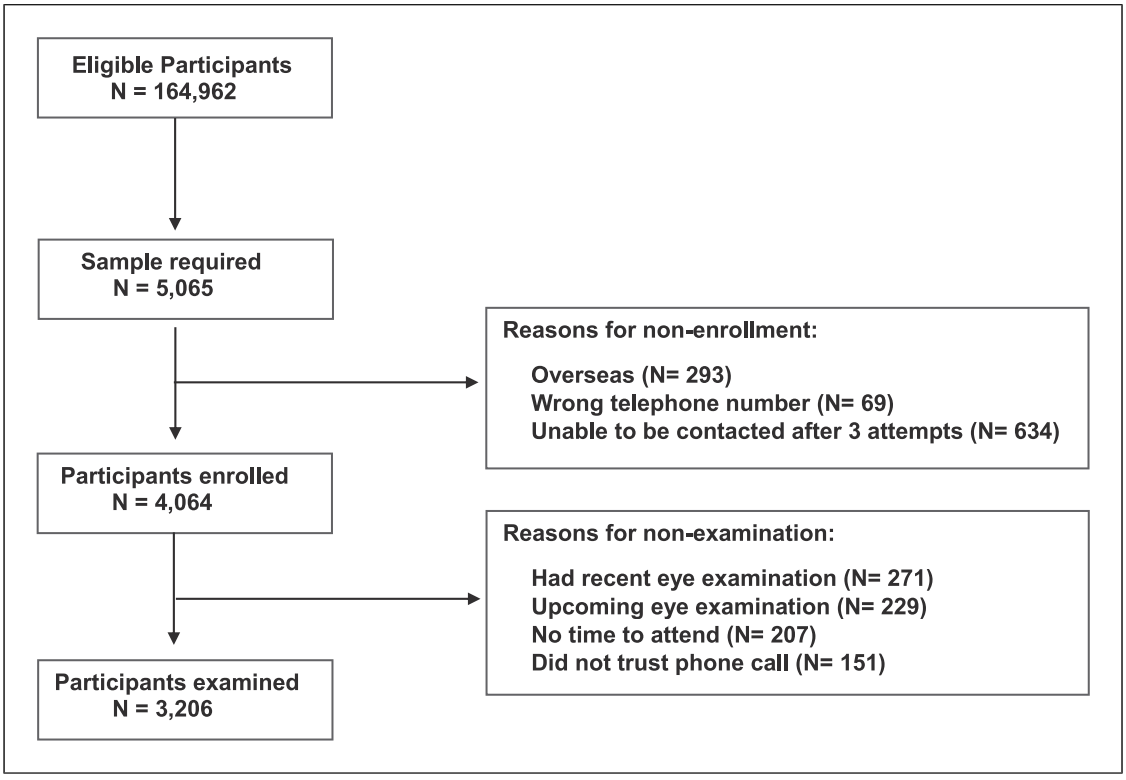

Fig. 1. Flow diagram describing number of participants enrolled and examined and reasons for non-enrollment and non-examination.

double that of the non-Qataris (16.7% vs 6.3%) (Table 2). Figures 3 and 4 compare the prevalence and causes of blindness and SVI between the current survey and the 2009 survey [5] and among the total sampled population and the Qatari and non-Qatari sampled strata. Blindness prevalence reduced from 1.3% (95% CI: 1.2–1.4) in 2009 to 0.4% (95% CI: 0.2–0.7) in this study. Non-Qataris prevalence decreased from 1.0% (95% CI: 0.4–1.5) to 0.1% (95% CI: 0.0–0.3), and the Qataris became 1.2% (95% CI: 0.7–1.8) instead of 2.0% (95% CI 1.3%–2.8%). The causes of blindness (n = 14) were DR (33.3%), cataract (20%), glaucoma (13%), and other posterior segment diseases (13%). Additionally, cataract surgery complications, corneal opacity, and URE each accounted for 7% (one case) of blindness. The main causes of all VI were URE (58%), cataract (17.5%), and DR (7%), with some variation as non-Qataris exhibited a higher rate of URE, whereas cataract condition was more prevalent among Qataris (Table 3). About 39% (1,269) of all examined participants were diabetic and they received fundus examination after pupil dilatation. There were 211 participants who offered home examinations.

Discussion

Qatar has carried out a modified RAAB survey, estimating the age-sex-adjusted prevalence of bilateral blindness among people aged 50 years and older at 0.4%, with Qatari communities (1.2%) having a higher prevalence than non-Qatari communities (0.1%). This difference could be attributed to the fact that Qataris have a higher proportion of elderly (who are more vulnerable to vision loss) in the overall population of Qatar. In this study, 13% of Qataris sampled were 70 years and over, while only 4% of the non-Qatari sample was in this age category. Since May 2009, despite the population growth from 1,652,608, with non-Qataris (82%) and Qataris (18%), to 2,773,598 in 2022, non-Qataris (79%) and Qataris (21%), there has been a ninefold increase in the population of people above 50 years in the last 3 decades [13]. The comparison between the RAAB studies of 2023 and 2009 also reveals a decline in VI prevalence. In 2009, VI was defined as VA <6/18–3/60, with an age-sex-adjusted prevalence of 5.3%. In 2023, using a similar definition, the prevalence dropped to 4.1%, marking a 23% decline over the period. A significant progress in reducing blindness prevalence from 1.3% (95% CI:

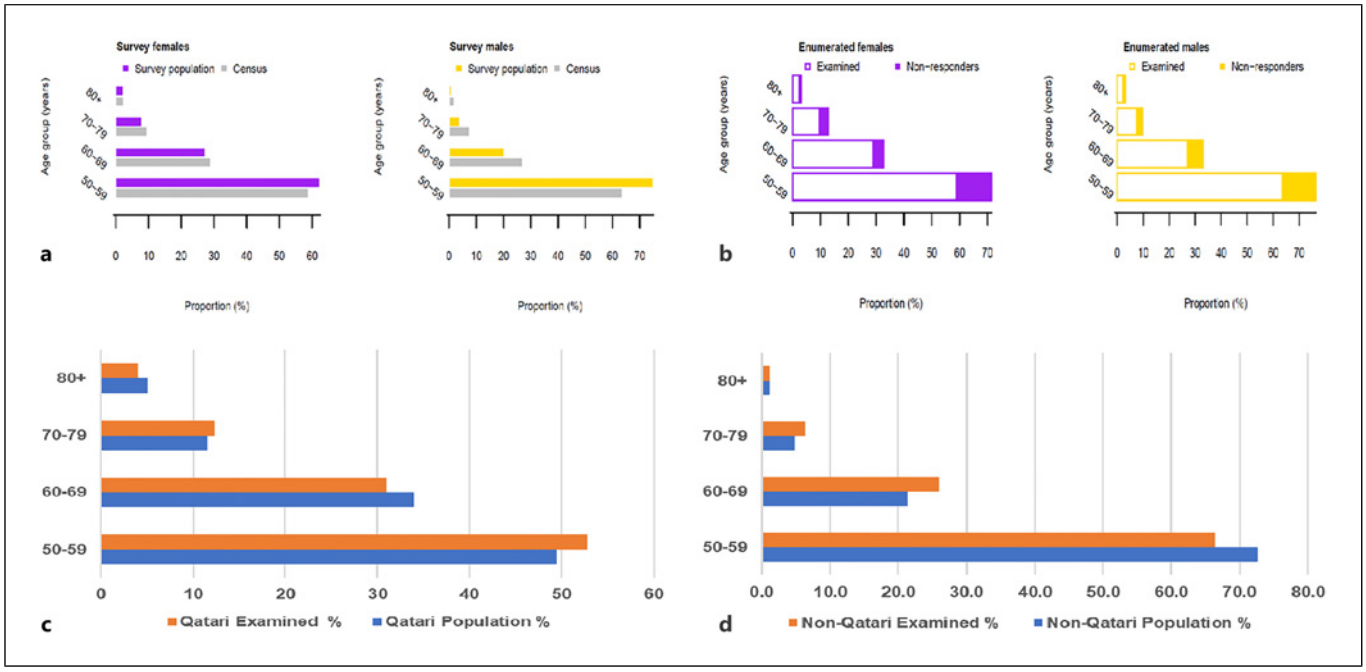

Fig. 2. a The age-sex pyramid of males and females for the total sample population. **b** Bar charts of examined participants among the enrolled study participants for males and females. **c** The percentage of population and examined participants by age group for the Qatari stratum. **d** The percentage of population and examined participants by age group for the non-Qatari stratum.

Table 1. Response rate among enrolled participants

Examination status	Qatari						Non-Qataris						Total		
	male		female		total		male		female		total		male	female	total
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	%	%	*N*
Examined[a]	500	44.5%	624	55.5%	1,124	100.0	1,386	66.5%	696	33.5%	2,082	100.0	58.8%	41.2%	3,206
Not examined	150	47%	169	53%	319	100.0	370	68.7%	169	31.3%	539	100.0	60.6%	39.4%	858
Total	650	100.0	793	100.0	1,443	100.0	1,756	100.0	865	100.0	2,621	100.0	59.2%	40.8%	4,064
Response rates, %	76.9		78.7		77.9		78.9		80.5		79.4				78.9

[a]Percentage examined indicates the response rate for each group among those enrolled.

1.2–1.4%) to 0.4% (95% CI: 0.2–0.7%) and an SVI prevalence from 1.67% to 0.3% [5]. A comparison with RAAB studies in Middle East countries revealed that Qatar had lower estimates in 2023, with prevalence of blindness (0.4%) and SVI (0.3%). In contrast, Palestine (2018) [16] reported blindness (2.6%) and SVI (1.4%) and KSA-Taif (2011) with blindness (1.9%) and SVI (1.4%) [17]. Hungary (2018) [18] displayed moderate prevalences, with blindness (0.9%) and SVI (0.5%). Barrenechea et al. [19] estimated a low prevalence of blindness (0.7%) in Argentina but a higher prevalence of SVI (2.6%). A potential way to notice changes in eye care services in Qatar is to study the trend in causes of blindness and VI in the country over time. An improved eye care service may result in not only lowering the magnitude of blindness and VI but also altering the distribution of the causes as readily treatable and preventable causes like cataract diminish, while the less preventable causes like DR assume more prominence. The number of elderly people in

Table 2. Age-sex-adjusted prevalence of blindness and VI by sex and nationality

VI category	Males % (95% CI)	Females % (95% CI)	Qataris % (95% CI)	Non-Qataris (95% CI)	Total % (95% CI)
Blindness	0.3 (0.0–0.6)	0.6 (0.2–1.0)	1.2 (0.7–1.8)	0.1 (0.0–0.3)	0.4 (0.2–0.7)
SVI	0.3 (0.0–0.7)	0.3 (0.0–0.6)	0.9 (0.3–1.4)	0.2 (0.0–0.3)	0.3 (0.1–0.5)
Moderate VI	2.9 (2.0–3.7)	5.0 (3.8–6.1)	6.5 (5.0–7.9)	2.5 (1.7–3.3)	3.8 (3.0–4.5)
Mild VI	4.0 (3.1–4.9)	6.8 (5.3–8.2)	8.2 (6.6–9.8)	3.5 (2.7–4.3)	5.2 (4.3–6.1)
Prevalence of all VI (<6/12-NPL)	7.6 (6.3–9.0)	12.6 (10.5–14.6)	16.7 (14.4–19.1)	6.3 (5.1–7.5)	9.7 (8.3–11.1)

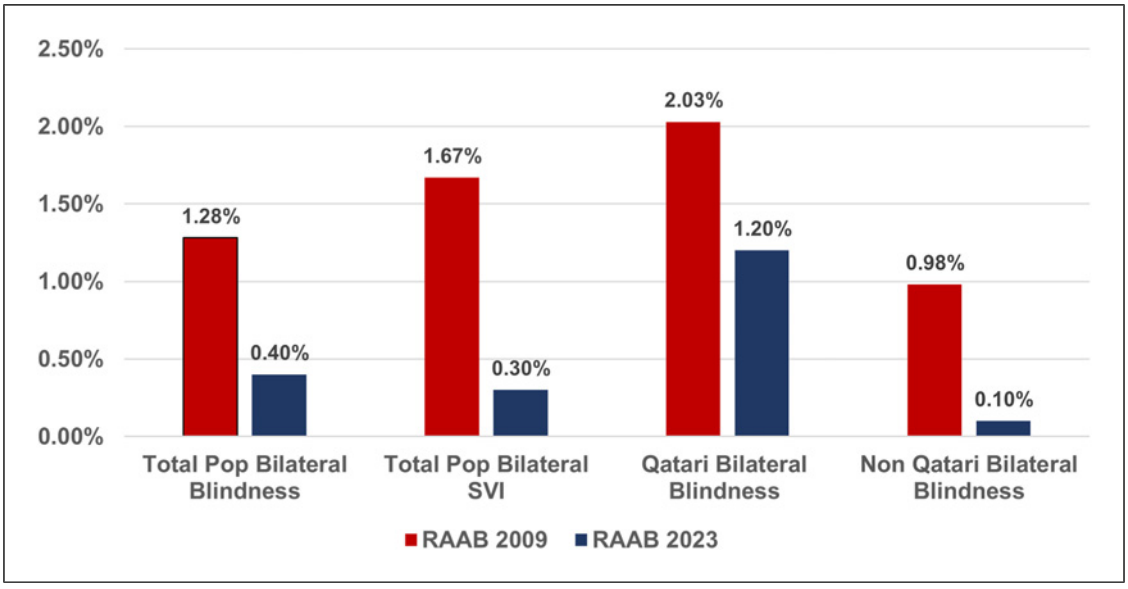

Fig. 3. Comparison of blindness and SVI between 2009 and 2023 national surveys among Qatari, non-Qatari, and total sampled population. Pop, population; SVI, severe vision impairment.

Qatar has increased nine times in the last 3 decades. Indeed, the life expectancy at birth for Qataris increased from 76.7 years in 2009 to 81 years in 2019 [13]. Thus, comparing the causes of blindness in 2009 with the current 2023 study (Fig. 4) demonstrates the changes in the eye disease pattern. DR has been propelled to be the main cause (33.3%), while it was the fifth largest cause (3%) a decade and half ago [5, 6]. Corneal pathology was the second leading cause of blindness, but it is now much lower in ranking, suggesting improvement in the control and prevention of corneal infection and trauma [5]. Another encouraging insight is that over 86% of the causes of blindness were preventable or treatable. The proportion of blindness due to glaucoma was lower in 2023 than in 2009, possibly due to the enhancement of early detection and treatment of the disease [5]. However, the change is likely due to the different operational definitions used in the two studies, potentially resulting in under estimation of the contribution of glaucoma to VI in the current study. Cataract, responsible for 51% of global blindness [20], represented only 20% based on the current study. However, cataract and retinal diseases other than DR maintained similar proportions, indicating an increasing incidence of age-related vision-impairing diseases because of the growing aging population. URE, the commonest cause of all VI, affected 71% of non-Qataris in contrast to 48% of Qataris. This difference may be explained by the fact that the non-Qatari population are younger, while Qataris with more elderly population had higher proportion of cataract related VI (21%) compared to non-Qataris (13%). The current pattern of VI is more in line with

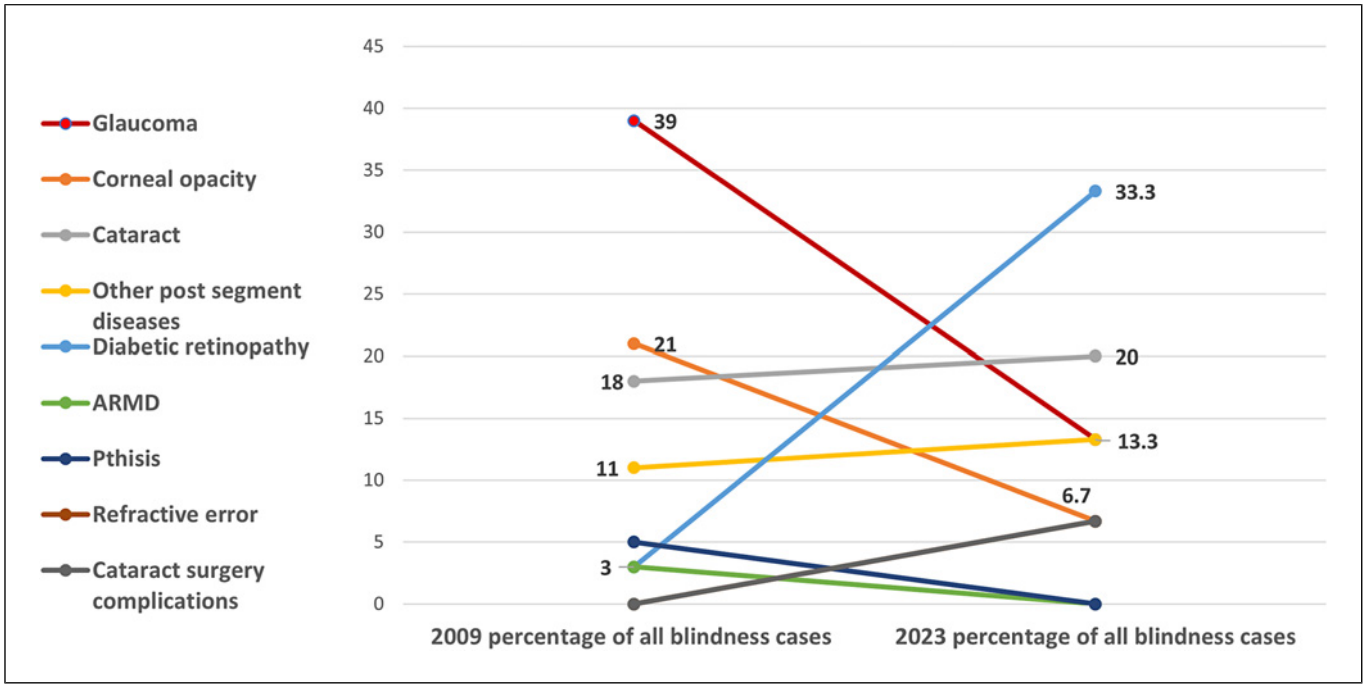

Fig. 4. Comparison of principal causes of bilateral blindness between 2009 and 2023.

Table 3. VI causes among Qataris, non-Qataris, and total population

Causes of VI	Qatari number	Qatari, %	Non-Qatari number	Non-Qatari, %	TP number	TP, %
URE	89	48	96	71	185	58
Cataract	38	21	18	13	56	17
DR	15	8	6	4	21	7
OPSD	9	5	6	4	15	5
Globe/CNS diseases	9	5	2	1	11	3
ARMD	8	4	4	3	11	3
Corneal opacity	8	4	4	3	12	4
Cataract surgery complications	5	3	1	0.7	6	2
Glaucoma	2	1.1	0	0.0	2	0.6
Trachoma	1	0.5	0	0.0	1	0.3
Phthisis	1	0.5	0	0.0	1	0.3
Total	176	100.0	133	100.0	321	100.0

URE, uncorrected refractive errors; TP, total population; DR, diabetic retinopathy; OPSD, other posterior segment diseases (excluding DR); CNS, central nervous system; ARMD, age-related macular degeneration.

global trends, where URE and cataract are the predominant causes at 42% and 33%, respectively [20]. The limitations of this study include the less-than-optimal response rate, despite an extension of data collection for 9 months. RAAB surveys are typically done in low- and middle-income settings with enrollment and examination of participants on the same day at the participants' household. Due to the high accessibility of primary care in Qatar, where

individuals can reach their centers within minutes, a unique protocol for the RAAB study was implemented. Participants were recruited from a list of individuals per cluster and invited to a central location for examination. However, 20% of the selected sample were unable to be contacted by telephone either because their number was inactive or there was no response after three attempts. All citizens in Qatar are required to update their phone number, but documentation appears to lag population movement and use of an increased anticipated nonresponse rate in the sample size calculation would be advisable for future studies considering this approach. A further 20% of the selected sample who were contacted and enrolled refused to attend the examination. These individuals had no interest in the survey or had recent or upcoming appointments with their ophthalmologist. In settings where potential survey participants already have good access to eye care, considerable resources may be required to sensitize communities about the societal value of participating in research. Despite the low response rate, the age-sex distribution of the those examined was comparable with the population, suggesting the sample is reasonably representative of the Qatar population as percentages in the sample compares well with the percentages in the population as such estimates are applicable to the overall population aged 50+. The sample sizes for each of the strata do not provide the same precision as the overall sample. Estimates at the level of strata should be interpreted with caution; however, there was a difference in blindness prevalence between them. The operational definitions used in the determination of causes of blindness and VI in standard RAAB methodology do not include the use of the visual field, underestimating the contribution of glaucoma to the magnitude of VI.

Conclusion

This study revealed a threefold reduction in blindness prevalence in Qatar over the last decade. The prevalence of blindness and VI in Qatar was lower than that found in recent RAAB surveys in other countries. The causes of blindness and VI have changed with DR and URE becoming the main causes; however, it should be acknowledged that the importance of glaucoma as a cause of vision loss is likely underestimated here and additional research into glaucoma prevalence would be beneficial. The Qatari government could further reduce the magnitude of vision loss by increasing the accessibility for public eye care services including the different ophthalmic subspecialties. A national eye health plan can be commissioned to develop an appropriate service delivery model for the eye health needs of the population.

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Statement of Ethics

The study received ethical approval from Qatar MOPH (Ref. PHCC/DCR/2022/04/023). Almost all participants provided verbal consent during initial phone scheduling, followed by written informed consent upon their arrival at the study centers. Seven severely ill and bedridden participants were randomly selected. Verbal and written informed consents were obtained from their legally authorized representatives.

Conflict of Interest Statement

None of the authors have any proprietary interests or conflicts of interest related to this submission.

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Author Contributions

AlThani M.: writing – original draft preparation, conceptualization, and methodology. Abdulmalik M.: writing – original draft preparation and data curation. AlAbdulla S.: supervision and editing: AlMotawaa K.: writing, reviewing, and supervision. Algadi H.: visualization and investigation. Rabiu M. and McCormick I.: writing – reviewing and editing. AlAshwal S.: writing – reviewing, software, and editing.

Data Availability Statement

The data that support the findings of this study are openly available on the RAAB data repository at https://www.raab.world/survey/qatar-2023/data.

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