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National survey of blindness and visual impairment in Guatemala, 2015

Pesquisa nacional sobre cegueira e deficiência visual na Guatemala, 2015

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ABSTRACT | Purpose: To estimate the prevalence of blindness and visual impairment in older adults living in Guatemala. **Methods:** Participants ≥50 years of age were selected using random cluster sampling and evaluated using the Rapid Assessment of Avoidable Blindness method. Visual acuity was measured, and the lens was examined. If presenting visual acuity was <20/60, it was also tested with a pinhole and fundoscopy was performed. Blindness and visual impairment were classified as moderate visual impairment (presenting visual acuity <20/60 to 20/200), severe visual impairment (presenting visual acuity <20/200 to 20/400), or blindness (presenting visual acuity <20/400). The primary cause of blindness or visual impairment in each eye was determined, and if the cause was cataracts, the barriers to treatment were assessed. **Results:** The study included 3,850 people ≥50 years of age, of whom 3,760 (97.7%) were examined. The age- and sex-adjusted prevalence of blindness was 2.9% (95% confidence interval, 2.0%-3.8%), while 5.2% (4.0%-6.4%) presented with severe visual impairment, and 27.6% (23.3%-32.0%) presented with moderate visual impairment. Cataracts were the leading cause of blindness (77.6%), followed by other posterior segment diseases (6.0%). Cataracts caused 79.4% of cases of severe visual impairment, while uncorrected refractive errors caused 67.9% of cases of moderate visual impairment. Following cataract surgery, 75% of participants had a presenting visual acuity of 20/200 or better, and in 19.0% of participants, visual acuity was not better than 20/200 with correction. Cost was the main barrier to cataract surgery (56.7%). **Conclusions:** The prevalence of blindness in older adults is higher in Guatemala than in most Central American countries. Most cases of blindness and visual impairment were either preventable or treatable. Increased availability of affordable, high-quality cataract treatment would have a substantial impact on blindness prevention.

Keywords: Blindness/epidemiology; Prevalence; Vision, low/epidemiology; Cataract extraction

RESUMO | Objetivo: Estimar a prevalência de cegueira e deficiência visual em idosos que vivem na Guatemala. **Métodos:** Indivíduos com idade ≥50 anos foram selecionados por amostragem aleatória por conglomerados, e os participantes do estudo foram avaliados pelo método de Avaliação Rápida da Cegueira Evitável. A acuidade visual foi medida e o cristalino foi examinado. Se a acuidade visual apresentada fosse <20/60, então também foi testada com um buraco estenopeico e a fundoscopia realizada.

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A cegueira e a deficiência visual foram classificadas como deficiência visual moderada com acuidade visual <20/60-20/200; deficiência visual grave com acuidade visual <20/200-20/400; ou cegueira com acuidade visual <20/400. A principal causa de cegueira ou deficiência visual em cada olho foi determinada, e naqueles com catarata, as barreiras ao tratamento foram avaliadas. **Resultados:** O estudo incluiu 3.850 pessoas com ≥50 anos de idade; 3.760 (97,7%) foram examinadas. A prevalência de cegueira ajustada à idade e ao sexo foi de 2,9% (intervalo de confiança de 95%, 2,0-3,8%), 5,2% (4,0-6,4%) deficiência visual grave e 27,6% (23,3-32,0%) deficiência visual moderada. A catarata foi a principal de cegueira (77,6%), seguida de outras doenças do segmento posterior (6,0%). Catarata causada por 79,4% de deficiência visual grave, enquanto erros refrativos não corrigidos causaram 67,9% de deficiência visual moderada. Após a cirurgia de catarata, 75% dos participantes tiveram uma acuidade de 20/200, ou melhor, e 19,0% a deficiência visual não foi melhor do que 20/200 com a correção. O custo foi a principal barreira à cirurgia de catarata (56.7%). **Conclusões:** A prevalência de cegueira em idosos é maior na Guatemala do que na maioria dos outros países da América Central. A maioria dos casos de cegueira e deficiência visual era evitável ou tratável. O aumento da disponibilidade de tratamento de catarata a preços acessíveis e de alta qualidade teria um impacto substancial na prevenção da cegueira.

Descritores: Cegueira/epidemiologia; Prevalência; Baixa visão/epidemiologia; Extração de catarata

INTRODUCTION

Despite the efforts of the VISION 2020 Initiative, more than 2 million people in the Latin American and Caribbean region are blind, and 14 million have moderate or severe visual impairment[1,2]. Most cases are treatable. Recent nationwide population-based studies of blindness and visual impairment conducted in Latin America using the Rapid Assessment of Avoidable Blindness (RAAB) methodology[3] found that cataracts were the primary cause of blindness and uncorrected refractive errors were the leading cause of moderate visual impairment.

The Republic of Guatemala is a Central American country of 108,889 km^2 bordered by Mexico, Belize, Honduras, El Salvador, the Pacific Ocean, and the Caribbean Sea[4]. The country is divided into eight regions and 22 departments. The estimated total population in 2015 was 16,342,897, with about one-third living in the capital, Guatemala City[5]. Approximately 13% of the population is ≥50 years of age[6], which is among the lowest percentage for this age group in Latin America. The World Bank classifies Guatemala as a lower-middle-income country. It is one of the poorest countries in Latin America, with 11.5% of its population living under the poverty line of USD 1.90/day and large urban and rural inequalities. The country has an estimated 1.3 ophthalmologists per 100,000 people, and most opthalmologists practice in Guatemala City. The average for Latin America is 5.2 ophthalmologists per 100,000 people[7].

Little is known about the causes of eye disease in Guatemala. The only population-based data are from 2004 and were collected in only four departments[8]. Trachoma and trachomatous trichiasis are endemic[9], but onchocerciasis was recently considered eliminated as a result of a large ivermectin distribution program carried out in previously endemic areas[10]. Using the RAAB methodology[11], we investigated the prevalence and causes of blindness and visual impairment in Guatemala in people ≥50 years of age. Cataract surgical coverage, visual outcomes after cataract surgery, and barriers to cataract surgical services were assessed.

METHODS

The entire country was selected as the survey area. The 2012 national census estimated that the total population at the time of the study was 14,938,645 people, with 12.4% (1,852,392) ≥50 years of age. Informed consent was obtained from eligible subjects who agreed to participate. The study was performed following the ethical guidelines of the Declaration of Helsinki. All individuals needing medical assistance were either treated or referred to the nearest medical unit. As there have been no previous nationwide population-based studies of blindness in Guatemala, the prevalence of blindness in participants ≥50 years of age was estimated as 2.6% based on data from studies in neighboring Central American countries. For an estimated prevalence of 2.6% and a study noncompliance rate of 10%, a sample size of 3,850 was calculated to be powerful enough to detect a variation of 25% around the estimated prevalence with 95% probability. The Instituto Nacional de Estadística de Guatemala provided the list of 15,511 census enumeration areas (EAs) and their population used in the 2012 national census, which was used as a sampling frame. Seventy-seven EAs were selected by systematic sampling using the RAAB software module, which allows a random selection of clusters. EAs with larger populations had higher odds of selection; probability was proportional to size. In each of the randomly selected EAs, 50 residents ≥50 years of age were selected for ocular examination by compact segment sampling.

Four data collection teams, each including a third-year ophthalmology resident or senior ophthalmologist, an

ophthalmic assistant, and a local guide, conducted the study and were trained by a certified RAAB trainer (ED) just before the fieldwork. Prior to data collection, interobserver variations in measurement of visual acuity (VA), lens evaluation, and determination of the primary cause of a presenting visual acuity (PVA) <20/40, were assessed to ensure standardization and quality of the ocular examination. All teams achieved a good kappa ≥0.60. The fieldwork was conducted between June and December 2015.

The survey protocol used the RAAB methodology (RAAB ver. 5), and a Spanish version of the standard RAAB survey form was completed for each eligible subject. VA was measured in daylight in the participant's residence with a Snellen tumbling "E" chart at distances of 20 and 10 feet. The VA of each eye was measured, and a pinhole was used when the PVA was <20/60. The presence of lens opacification was assessed with distant direct ophthalmoscopy (red reflex) with the participant in a (semi) dark room. Lens status was scored as normal (no or minimal opacification), obvious opacification, aphakia, or pseudophakia with or without posterior capsule opacification (PCO). When needed, direct ophthalmoscopy was conducted after pupil dilatation. Blindness and PVA in the eye with better vision were classified as follows: PVAs from <20/60 to 20/200 were classified as moderate visual impairment (MVI), and those from <20/200 to 20/400) were classified as severe visual impairment (SVI). A PVA of <20/400 was scored as blindness. The primary cause of blindness or visual impairment was assessed in each eye. If there were two or more causes and it could not be determined which was the primary cause of vision loss, then, following the World Health Organization (WHO) guideline, the cause that was easiest to treat or to prevent was chosen[11].

Cataract surgery coverage (CSC) was defined as the number of eyes or individuals with operable cataract divided by the number of eyes or individuals with pseudophakia, aphakia, or operable cataracts and was reported as a percentage[12]. Visual outcomes after cataract surgery were rated as good (PVA ≥20/60), borderline (PVA <20/60-20/200), or poor (PVA <20/200). The causes of poor visual outcome included selection, which entailed participants presenting with vision-impairing conditions other than cataracts, such as glaucoma or age-related macular degeneration; surgical (e.g., vitreous loss); optical (e.g., postoperative astigmatism); or late surgical complications (e.g., retinal detachment or PCO). In those with the best corrected visual acuity (BCVA) <20/200 and operable cataracts, the barriers to cataract services were assessed. The reasons included "need not felt," "fear of surgery or a poor result," "cannot afford surgery," "treatment denied by health care provider," "unaware that treatment is possible," and "no access to treatment."

Statistical analysis

The overall and age- and sex-adjusted prevalence of blindness and visual impairment were calculated with 95% confidence intervals (CIs) for cluster sampling. The RAAB software program was used for data entry and automatic data analysis. The data were double-entered into RAAB software and checked for consistency and potential entry errors.

RESULTS

The study included 3,850 people ≥50 years of age. Of the 3,760 (97.7%) who were evaluated, 1,527 (40.61%) were men and 2,233 (59.38%) were women. Thirty-one subjects (0.8%) could not be contacted, 49 (1.3%) refused to participate, and 10 (0.3%) were not capable of participation. The age- and sex-adjusted prevalence of blindness (Table 1) was 2.9% (95% CI, 2.0%-3.8%); 5.2% (4.0%-6.4%) presented with SVI, and 27.6% (23.3%-32.0%) presented with MVI. Cataracts were the leading cause of blindness (77.6%), followed by other posterior segment diseases (6.0%) and nontrachomatous corneal opacity (4.5%) (Table 2). Cataracts were also the primary cause of SVI (79.4%), while uncorrected refractive errors were the primary cause of MVI (67.9%).

In Guatemala, only 24.3% of all eyes that are blind (VA <20/400) because of cataracts have been treated surgically; that is, only 2.4 of every 10 eyes with cataract-caused blindness. Of all individuals with bilateral blindness caused by cataracts, 29.5% (29.3% of men and 29.6% of women) have had surgery on one eye (Table 3). In cases of visual impairment <20/200, the CSC of eyes was thus 13.7% and that of people was 17.4%.

After cataract surgery, 42% of evaluated eyes had a VA of 20/60 or better and 25.0% could not see at 20/200 with available correction (Table 4). With the best correction, the results improved to 66.0% with a good outcome and 19.0% with a poor outcome. As expected, visual outcomes were better in eyes that had been operated on within 3 years before the study (82.9% good/borderline and 17.1% poor) than in those that had been operated on within 4 to 6 years (65.3% good/borderline,

34.6% poor) or 7 or more years (74.4% good/borderline and 25.6% poor) before the study. Intraocular lenses were present in 91% of all operated eyes; 43.0% of the surgeries were conducted in voluntary or charity hospitals, 29% in private hospitals, and 28% in government hospitals. Uncorrected postoperative refractive errors (which included incorrectly powered intraocular lenses and surgically induced astigmatism) were the major cause of borderline/poor outcomes (57.1%), followed by selection (30.9%), sequelae (28.6%), and surgery

Table 1. Adjusted results for all causes of blindness, SVI, and MVI, Guatemala, 2015

	Males			Females			Total		
	n	%	(95% CI)	*n*	%	(95% CI)	*n*	%	(95% CI)
Blindness (VA <20/400 in the better eye with best correction or pinhole)									
All bilateral cases	16,853	1.9	(0.8-3.1)	31,074	3.2	(2.3-4.1)	47,927	2.6	(1.8-3.4)
All eyes	84,147	4.8	(3.3-6.3)	109,301	5.6	(4.5-6.7)	193,448	5.2	(4.3-6.2)
Blindness (VA <20/400 in the better eye with available correction [presenting VA])									
All bilateral cases	18,426	2.1	(0.9-3.3)	35,146	3.6	(2.6-4.6)	53,572	2.9	(2.0-3.8)
All eyes	93,838	5.4	(3.8-6.9)	118,871	6.1	(5.0-7.2)	212,709	5.8	(4.7-6.8)
SVI (VA <20/200-20/400 in the better eye with available correction)									
All bilateral cases	41,379	4.7	(3.3-6.1)	54,881	5.6	(4.3-7.0)	96,260	5.2	(4.0-6.4)
All eyes	94,571	5.4	(3.9-6.9)	125,097	6.4	(5.2-7.7)	219,668	5.9	(4.8-7.1)
MVI (VA <20/60-20/200 in the better eye with available correction)									
All bilateral cases	236,239	27.0	(22.2-31.8)	274,767	28.2	(23.7-32.7)	511,006	27.6	(23.3-32.0)
All eyes	485,707	27.8	(23.3-32.3)	572,563	29.4	(25.2-33.6)	1,058,270	28.6	(24.6-32.7)

SVI= severe visual impairment; MVI= moderate visual impairment; EVI= early visual impairment; VA= visual acuity; CI= confidence interval.

Table 2. Principal causes of blindness, SVI, MVI, and EVI in persons (PVA)

	Blindness		SVI		MVI	
Cause	*n*	%	*n*	%	*n*	%
1. Refractive error	3	2.2%	15	6.6%	723	67.9%
2. Aphakia uncorrected	0	0.0%	0	0.0%	0	0.0%
3. Cataract untreated	104	77.6%	181	79.4%	278	26.1%
4. Cataract surgical complications	3	1.1%	2	0.9%	2	0.2%
5. Trachomatous corneal opacity	2	1.1%	1	0.4%	2	0.2%
6. Nontrachomatous corneal opacity	6	4.6%	8	3.5%	20	1.9%
7. Phthisis	0	0.0%	0	0.0%	0	0.0%
8. Onchocerciasis	0	0.0%	0	0.0%	0	0.0%
9. Glaucoma	3	2.3%	5	2.2%	10	0.9%
10. Diabetic retinopathy	2	1.5%	6	2.6%	13	1.2%
11. AMD	1	0.7%	0	0.0%	1	0.1%
12. Other posterior segment disease	8	6.0%	7	3.1%	13	1.2%
13. All other globe/CNS abnormalities	2	1.5%	3	1.3%	3	0.3%
Total	**134**	**100.0%**	**228**	**100.0%**	**1,065**	**100.0%**
Blindness, SVI, and MVI in persons by intervention category						
A. Treatable (1, 2, 3)	107	79.9%	196	86.0%	1,001	94.0%
B. Preventable (PHC/PEC services) (5, 6, 7, 8)	8	6.0%	9	4.0%	22	2.1%
C. Preventable (ophthalmic services) (4, 9, 10)	8	6.0%	13	5.7%	25	2.4%
D. Avoidable (A + B + C)	123	91.8%	218	95.6%	1,048	98.4%
E. Posterior segment causes (8, 9, 10, 11, 12)	14	10.5%	18	7.9%	37	3.5%

SVI= severe visual impairment; MVI= moderate visual impairment; EVA= early visual impairment; PVA= presenting visual acuity; AMD= age-related macular degeneration; CNS= central nervous system; PHC/PEC.

(21.4%) (Table 5). Subjects with bilateral cataracts and a BCVA <20/200 said that cost was the main barrier to cataract surgery (56.7%), followed by an unawareness of treatment (18.3%).

DISCUSSION

This is the first nationwide population-based study of the prevalence and causes of blindness in Guatemala. The age- and sex-adjusted prevalence of blindness and visual impairment of 2.9% (95% CI, 2.0%-3.8%) was higher than the estimated values in other Central American countries, such as Costa Rica (1.7%; 95% CI, 1.2%-2.2%)[13], El Salvador (2.4%; 95% CI, 2.2%-2.6%)[14], and Honduras (1.9%; 95% CI, 1.4%-2.4%)[15], and similar to that in Panama (3.0%; 95% CI, 2.3%-3.6%)[16]. In consistency with the results of most population-based studies of blindness in Latin America, unoperated cataract was the primary cause of blindness[1,3]. Beltranena et al. previously highlighted the importance of unoperated cataracts as a cause of blindness in four Guatemalan provinces, but data from other regions were not available[8].

Guatemala has one of the lowest percentages of elderly people among Latin American countries, and this helps to account for a lower prevalence of bilateral blindness caused by posterior pole diseases such as diabetic retinopathy and age-related macular degeneration compared with other Latin American countries and regions[3], especially those with a different age structure, such as Uruguay[17], Argentina[18], and southeastern Brazil[19,20]. Other variables not evaluated in this study include eating habits and differences in ethnic composition.

The estimated CSC in people with PVA <20/400 in this study is the lowest reported from studies in Latin America using the RAAB methodology in the last decade[3]. Pongo-Aguila et al. in Piura, Northern Peru, in 2002[21], Duerksen et al. in Asunción, Paraguay, in 1999,[22] and Beltranena et al. in Southern Guatemala in 2004[8] all reported lower CSC rates than those in the present study, ranging from 23.1% to 38%, and more recent studies in Peru and Paraguay have shown increased coverage of 66.9% and 90%[23,24]. In our study population, fewer than half of the participants with blindness caused by cataracts had received surgery. The low CSC also accounts for the importance of cataracts as a cause of MSI and SVI. The cataract surgery rate (CSR), the number of cataract surgeries performed per million population per year[25], in Guatemala is one of the lowest in the region. It is below the target CSR, even for a country with a

Table 3. Cataract surgical coverage, Guatemala, 2015

	Males	Females	Total
Cataract surgical coverage (eyes) - percentage			
VA <20/400	21.6	25.8	24.3
VA <20/200	11.3	15.3	13.7
VA <20/60	5.5	8.4	7.2
Cataract surgical coverage (persons) - percentage			
VA <20/400	29.3	29.6	29.5
VA <20/200	14.4	19.1	17.4
VA <20/60	7.1	10.5	9.1

VA= visual acuity.

Table 4. Outcome after cataract surgery with available correction (eyes), Guatemala, 2015

	Males		Females		Total	
	n	%	*n*	%	*n*	%
Good: can see 20/60	13	40.6%	29	42.6%	42	42.0%
Borderline: can see 20/200	13	40.6%	20	29.4%	33	33.0%
Poor: cannot see 20/200	6	18.8%	19	27.9%	25	25.0%
Total	**32**	**100.0%**	**68**	**100.0%**	**100**	**100.0%**

Table 5. Causes of PVA <20/60 (good, borderline, and poor outcomes) after cataract surgery, Guatemala, 2015

	Selection[a]		Surgery[b]		Spectacles[c]		Sequelae[d]		Can see 20/60	
Outcome	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Good: can see 20/60	0	0.0%	0	0.0%	0	0.0%	0	0.0%	42	100.0%
Borderline: can see 20/200	4	30.8%	2	22.2%	23	95.8%	4	33.3%	0	0.0%
Poor: cannot see 20/200	9	69.2%	7	77.8%	1	4.2%	8	66.7%	0	0.0%
Total	13	100.0%	9	100.0%	24	100.0%	12	100.0%	42	100.0%

PVA= presenting visual acuity.
[a]= Patients selected for surgery had other pathologies causing visual impairment (e.g., glaucoma, age-related macular degeneration, diabetic retinopathy); [b]= Surgical complication or immediate postsurgical complication; [c]= Prescription not correcting postoperative refractory problem (e.g., astigmatism) or wrong power intraocular lens; [d]= Late postoperative complications (e.g., posterior capsule opacification).

young age structure, and it decreased from 2005 to 2012 at a time when a majority of Latin American countries experienced an increase in CSR[26].

Most subjects with cataract-caused blindness mentioned cost as a major barrier to cataract surgery, followed by an unawareness of possible treatment. Currently, voluntary and charity hospitals play an important role in cataract treatment in Guatemala, performing approximately 4 of every 10 cataract surgeries. Fewer than one-third of cataract surgeries were performed in public hospitals. The number and availability of ophthalmologists is an issue in Guatemala[7]. Not only is the number of ophthalmologists per capita considerably below the Latin American average, but they are highly concentrated in the wealthiest areas of the country. Since most cases of blindness can be prevented by increasing access to high-quality cataract surgery, we recommend implementation of national policies that encourage the creation of more residency services that focus on cataract surgery skills, especially in poorer areas. The visual outcomes reported in this study are worse than those reported in previous RAAB studies conducted in Central America[3]; 42% of operated eyes had PVAs ≥20/60, and there is still room for improvement to achieve WHO vision goals[27]. Since uncorrected postoperative refractive error was the leading cause of poor cataract surgery outcome, a comprehensive postoperative evaluation with provision of spectacles would improve outcomes in a significant proportion of individuals.

The study limitations include not estimating the prevalence of childhood blindness, but that was not possible because the RAAB methodology does not include those <50 years of age. Also, near vision impairment was not assessed. Ramke et al.[28] recently developed a novel indicator to assess CSC and good visual outcome after cataract surgery. Effective cataract surgical coverage (eCSC) is an indicator of the level of care, using BCVA <20/200 as a cutoff to determine coverage and VA >20/60 as the definition of good outcome, following WHO recommendations[28]. Considering the WHO outcome and coverage targets, Ramke et al. defined eCSC ≥ 90 as excellent, 80-89 as very good, 70-79 as good, and 60-69 as satisfactory. The eCSC (VA <3/60) for Guatemala is 12.3%, meaning that of all people with bilateral cataracts and BCVA < 20/400 in the better eye, 12.3% had surgery in one or both eyes and had a presenting VA of 20/60 or better in the better eye. This rate is considered low. As expected, uncorrected refractive errors were the leading cause of MVI (67.9%) in this survey; a similar trend was observed in other population-based studies in Latin America.

To conclude, the availability of high-quality, affordable cataract surgery for visually impaired and blind people is a public health priority in Guatemala. Affordable cataract surgery should be provided not only in the wealthiest areas of the country, but also in poor rural communities. The number of ophthalmologists in Guatemala is considered low, and cataract is the leading cause of blindness. We recommend the creation of more residency programs with appropriate cataract surgery training. It is important to note that life expectancy at birth in Guatemala is expected to increase from 72 years in 2015 to 79 years in 2050. The number of individuals >50 years of age will more than triple by then[6], leading to an increased need for cataract surgery and treatment of other sight-threatening conditions. Finally, as cost is a major barrier for cataract surgery, manual, small-incision surgery, which is less expensive than phacoemulsification and has comparable outcomes, is an alternative[29]. It is already available in some institutions in Latin America[30] and might be a good alternative for those Guatemalans in need.

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