Generating Evidence for Programme Planning - Rapid Assessment of Avoidable Blindness (RAAB) in Bangladesh

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Abstract (249 words)

Introduction: There is a lack of data on the prevalence and causes of blindness in Bangladesh which is important to plan effective eye health programs and advocate support services to achieve the goals of VISION 2020: the right to sight.

Methods: Between January 2010 and December 2012 we conducted a rapid assessment of avoidable blindness (RAAB) in eight districts of Bangladesh to establish the prevalence and causes of blindness in Bangladesh. People aged ≥50 years were selected and eligible participants had their visual acuity (VA) measured. Ocular examination was performed in those with VA <6/18. Additional information was collected from those with or without cataract surgeries to understand service barriers and quality of service.

Results: In total, 21,596 people were examined of which 471 (2.2%, 95% CI 2.0–2.4%) people were blind. The primary cause of blindness was cataracts (75.8%). Majority (86.2%) of the blindness was avoidable. Cataract and refractive error was the primary cause of severe visual impairment (73.6%) and visual impairment (63.6%) respectively. The cataract surgical coverage for blind person was 69.3% (76.6% for males vs. 64.3% for females, p<0.001). The magnitude of blindness among people aged ≥50 years in Bangladesh is estimated to be 563,200 people (95% CI 512,000-614,400) of whom 426,342 people have un-operated cataract.

Conclusions: In Bangladesh, majority of blindness (86.2%) among people aged ≥50 years is avoidable, and cataract is the most important cause of avoidable blindness. Improving the cataract surgical services and refraction services would be the most important step towards the elimination of avoidable blindness in Bangladesh.

INTRODUCTION

The World Health Organization (WHO) estimates that currently 285 million people (65% aged over 50 years) in the world have been suffering from visual impairment; and 39 million of these are blind [1]. According to WHO, 80% of the global visual impairment including blindness is either preventable or treatable. Uncorrected refractive errors (42%) and cataracts (33%) are the two major causes of visual impairment in the world [2].

WHO states that nearly 90% of all blind and visually impaired people are living in low and middle income countries without an access to the eye care services [3]. In the 66th World Health Assembly a new "Global Action Plan 2014–2019 for universal eye health" was endorsed by the WHO member states to strengthen eye health care and blindness prevention programmes. The overall goal of this action plan is to reduce avoidable visual impairment as a global public health problem and secure access to universal eye health care for those with visual impairment [3]. The Global Action Plan (GAP) builds upon and replaces previous initiatives including VISION 2020 and 2009 - 2013 Action Plans [4]. The Global Action Plan highlighted the "need for generating evidence on the magnitude and causes of visual impairment and eye care services and using it to advocate greater political and financial commitment by member states to eye health".

The most recent blindness and low vision survey in Bangladesh was conducted in 2000 [5]. The survey examined 11,624 eligible adults aged ≥30 years, of which 162 people were bilaterally blind (1.5% age standardised prevalence) and 1,608 subjects (13.8%) had low vision (<6/12 visual acuity (VA)) binocularly. Moreover, among the remaining 9,854 subjects with VA of >6/12 in the "better eye", 748 had low vision in the fellow eye. The main causes of low vision were cataract in majority (74.2%) of the cases [6]. There was a two-fold variation in the prevalence of blindness between the richest and the poorest divisions. Another recent study from Bangladesh used rapid assessment of avoidable blindness (RAAB) method to estimate the magnitude and causes of blindness in people aged ≥50 years a southern district of Bangladesh. This study showed the prevalence of bilateral blindness was 2.9%, in which 79.0% of those with bilateral blindness were blind due to cataract [7].

A sustainable health information system providing ongoing reliable data on blinding eye diseases would be ideal for program planning. However, eye care programmes in developing countries are limited in resources and the available funds need to be allocated efficiently. The Rapid Assessment of Avoidable Blindness (RAAB) is a simple and rapid survey

methodology that can provide data on the prevalence and causes of avoidable blindness [8]. We aimed to provide baseline data on the prevalence and causes of avoidable blindness in Bangladesh, to plan effective program and advocate support services for eye care, as well as provide evidence for future evaluations and impact assessment.

METHODS

Between January 2010 and December 2012, we conducted RAAB survey in eight districts of Bangladesh. The districts were selected from different parts of the country, providing a wide geographic spread (**Figure 1**). The districts were selected by an international eye care organisation which was planning to initiate district eye care programs in collaboration with the Bangladesh government. We aimed to provide baseline data on prevalence and causes of avoidable blindness in the selected districts to inform planning, monitoring and evaluation of eye care programs.

Sample size and sample selection

We followed standard RAAB methods of sample size estimation and sample selection [8]. An estimated prevalence of blindness of 5% in adults aged ≥50 years was used for the purpose of sample size calculation based on our experiences form previous national survey as well as findings from the neighbouring countries [7, 9]. Allowing for a required confidence of 95%, a worst acceptable result of 4.0%, a design effect of 1.5 and 10% non-response rate and depending on the district population size, the numbers of clusters varied from district to district. We used a stratified cluster random sampling and the 2001 national census data were used as the sampling frame [10]. We produced a list of all the enumeration areas in the selected districts with their respective populations aged ≥50 years and estimated using the population size of the enumeration areas and the population age-structure from the census data. The sampling frame was entered into specially designed spreadsheet. Using the RAAB software package (RAAB version 4.02) clusters were selected for the survey from the sampling frame. In total, 50 to 61 clusters of 50 adults aged ≥50 years were required from each district. Details of sample selection and recruitment process have been described in one of the previous publications [7].

Ophthalmic examination

A standard RAAB survey protocol (Version 4.02 for Windows®) was used for ophthalmic examination [7]. Survey records were completed for all eligible participants containing information on demographics, vision and ocular examination findings, details of visual impairments, and details of surgical management and outcomes in those who had cataract operation. Information on barriers to cataract surgeries were collected from those with untreated cataract.

Each survey team consisted of an ophthalmologist and ophthalmic assistant and there were two teams for each district. Teams were accompanied by field supervisors on every alternate day to maintain the high standard of the survey. Visual acuity (VA) was measured by an ophthalmic assistant using a Snellen simplified tumbling 'E' chart with available correction [7]. Vision was tested separately for each eye, in order from the right to left, by covering one eye with an occluder. If the examinee is able to read the 'E' optotype of size 60 at 6 meters (6/60), they are further tested to read size 18 at 6 metres (18/6). If the examinee is unable to read the 'E' optotype at 6/60, the chart is changed to size 60 at 3 metres (3/60), and subsequently size 60 at 1 metre. If they cannot read at 1 metre distance, their perception of light was examined. The optotype was rotated before each reading to prevent prediction of the direction of open ends. Additionally, any eye with a VA of <6/18 was assessed by an ophthalmologist and dilated if required, and examined for acuity with a pinhole (RAAB instruction manual Version 4.02 for Windows®).

We followed standard definitions of blindness, severe visual impairment and visual impairment as outlined below [7]:

Blindness was considered as VA < 3/60 in the better eye with available correction.

Severe visual impairment (SVI) was considered when VA was < 6/60 and ≥ 3/60 in the better eye with available correction.

Visual impairment (VI) was considered when VA was < 6/18 and ≥ 6/60 in the better eye with available correction.

The primary cause of blindness or VI was assigned based on the disorder that was easiest to treat [11]. Avoidable causes of blindness were defined as blindness which could be either treated or prevented by known, cost-effective means [4].

Statistical analysis

As per the standard RAAB protocol we used RAAB version 4.02 software for sample selection, data entry and analysis. The software package and manual was collected free of charge from www.iceh.co.uk. Prevalence was calculated with 95% confidence interval (95% CI) using standard formula. Bivariate analysis was done using chi-square test for statistical significance. A p value of <0.05 was considered significant. Cataract surgical coverage was calculated as the proportion of aphakic or pseudoaphakic eyes/persons by operable cataract eyes/persons [12].

Ethics approval

Ethical approval was obtained from the Institutional Review Board, Research, Evaluation, Advocacy and Development (READ) centre, Child Sight Foundation, Bangladesh.

RESULTS

The survey was conducted in 433 clusters in eight districts of Bangladesh. There were over 3.1 million people aged ≥50 years in the survey districts. The age and sex distribution of the population of the survey area population has been presented in **Table 1**. In total, 21,596 people were examined (response rate of 86.7%) of which 51.7% were women across eight districts (**Table 2**).

Prevalence of blindness and visual impairment

We identified 471 (2.2%, 95% CI 2.0–2.4%) blind people of which 305 (64.7%) were women (p=0.07). Another 751 people had bilateral SVI (3.5%, 95% CI 3.2-3.7%) and 3,478 had bilateral VI (16.1%, 95% CI 15.6-16.6%). **Table 3** shows the prevalence of blindness, SVI and VI by gender.

Causes of blindness and visual impairment

Cataract was the primary cause of blindness, of the 471 blind people 357 had bilateral untreated cataract (75.8%) and only 12.9% had posterior segment disease (e.g. glaucoma, diabetic retinopathy). Overall 86.2% of blindness was either preventable or treatable (i.e. avoidable). Cataract was also the leading cause of SVI (73.6%) and the second leading cause of VI (33.3%). Refractive error was the leading cause of VI (63.6%). **Table 4** shows the distribution of main causes of bilateral blindness, SVI and VI.

Cataract surgical coverage (CSC)

The CSC for blind person was 69.3% (76.6% for males and 64.3% for females, p <0.001), for person with SVI it was 46.8% (51.1% males, 43.9% females, p <0.001) and for those with VI CSC was 32.4% (35.1% males, 30.5% females, p <0.001). The overall CSC for blind eyes was 55.1%. **Table 5** describes the CSC by person and eyes in people aged ≥50 years.

Barriers to cataract surgery and outcome of surgery

Among the blind people with untreated cataract (n=357), 54.3% stated that they could not afford the cost of the surgery. Among other barriers to cataract surgery 9.3% had no company to take them to the hospital, 7.3% were unaware of treatment, 4.9% considered themselves too old for the surgery, 4.5% had fear of operation, 3.9% did not know how to get the surgery and 2.2% considered blindness as their destiny or God's will. Among 553 people who had SVI due to untreated cataract 51.8% could not afford the surgery, 8.6% had no company to take them to the hospital, 7.3% were unaware of treatment and another 7.8% did not know how to get the surgery and 5.8% stated that there were no surgical services in their area.

Those who had cataract surgery with IOL, 78.0% had good VA (can see 6/18), and VA was improved to 88.6% after best correction. Almost one in ten (9.0%) had poor VA (could not see 6/60), and even after best correction, 7.9% still had poor VA. Among 303 persons who had non IOL surgery, 106 (35.0%) had poor VA (could not see 6/60). **Table 6** shows post-operative VA following cataract surgery by available correction and best correction.

Extrapolation of the results

From our survey in 8 districts of Bangladesh the estimated prevalence of blindness, SVI and VI among people aged ≥50 years were 2.2%, 3.5% and 16.1% respectively. According to these estimates among people aged ≥50 years in our survey districts; there are 68,333 blind and 108,712 people with SVI of which 51,728 and 80,012 respectively have cataract who will require surgery. Extrapolating the survey data to national census data, the magnitude of blindness among people aged ≥50 years in Bangladesh is estimated to be 563,200 people (95% CI 512,000-614,400) of whom 426,342 people have un-operated cataract.

DISCUSSION

To our knowledge this is one of the largest studies on avoidable blindness using the RAAB method. Our reported prevalence of blindness, SVI and VI among people aged ≥50 years in eight districts of Bangladesh is relatively low. However, most cases of blindness and SVI were due to cataract (75.8% and 73.6% respectively), whereas refractive error (63.6%) is the major cause of VI. Majority of the cases of blindness were avoidable (87.0%), and almost all the SVI (91.5%) and VI (97.9%) were due to avoidable causes.

Recent RAAB surveys in neighbouring India and Bhutan reported the prevalence of blindness as 3.6% (95% CI: 3.3–3.9) and 1.5% (95% CI 1.09-1.89) respectively [9, 13]. Among other Asian countries, the prevalence of blindness are reported as 4.4% (95% CI 2.0-6.8) in China [14], 2.6% (95% CI 2.0-3.2%) in Saudi Arabia [15] and 1.33 (95% CI 0.91-1.75) in Iran [16]. In the African region the prevalence of blindness are reported as 1.8% in Rwanda [17], 2.0% in Kenya [18], 2.3% in Zambia [19], 3.3% in Malawi [20] and 7.5% in Eritrea [21]. Our findings are consistent with other studies conducted in countries with similar economy.

According to the national blindness and low vision survey in 2000, there was an estimated 650,000 blind adults (95% CI 552,175-740,736) aged ≥ 30 years in Bangladesh, and cataract was the major cause of blindness [6]. Extrapolated data from our survey showed that among people aged ≥50 years in Bangladesh there are well over half a million (~563,200 people) who are blind, of which nearly 426,342 people are blind due to un-operated cataract. Assessment and strengthening of the available district eye care services is important to further reduce the prevalence of avoidable blindness in Bangladesh.

In our study we have found that CSC was 69.3%. Despite a relatively high CSC, cataract was the major cause of blindness in all districts. There were significant gender differences in CSC and we have found that women were less likely to receive surgery compared to men ($p < 0.001$). Similar differences were observed in studies conducted in other Asian and sub-Saharan African nations [17-20, 22]. Our findings highlight the need for closing the gender gap to reduce the prevalence of cataract blindness in developing countries. Gender-sensitive targeted interventions are needed to improve cataract surgical coverage among females [23].

Comparing the eight districts, our data suggests the importance of CSC (in persons with VA<6/60) in contributing to the reduction of total prevalence of blindness (**Table 2**). Satkhira and Natore districts had the highest prevalence of blindness (4.0% and 3.5% respectively)

and the lowest CSC coverage (57.9% and 53.1% respectively). Conversely, Brahmanbaria and Tangail districts had the lowest prevalence of blindness (0.5% and 1.3% respectively) with the highest CSC coverage (90.0% and 79.2% respectively). One possible reason for the disparity in CSC may be attributed to the success of a recent district cataract campaign in 2008-2009. Additionally, Wadud and colleagues [7] found the prevalence of blindness in Satkhira to be 2.9% compared to our data of 4.0%. Observing CSC in persons with VA of <3/60, the coverage was higher in Wadud's study (61%) compared to our study (57.9%). The outcomes of improving CSC have shown to be linked with effectively reducing the burden of blindness and poor vision.

Treatable blindness requires a comprehensive health system approach. In our survey we have found that visual outcomes after cataract surgeries were relatively poor with over 20% having poor outcomes even with IOL. There is no national or district level monitoring service to assess the outcomes of cataract surgeries in Bangladesh. Such services are essential to improve the quality and overall outcomes of cataract surgeries in countries like Bangladesh. Efforts in raising awareness for avoidable causes of blindness has created substantial impact on people since "unaware of treatment" did not appear as the major barrier in our survey districts. However, lack of uptake of surgical treatment due to financial constraints, remains the major reason for cataract still being the principal cause of avoidable blindness in Bangladesh.

Despite our best effort there are some limitations in our study. The primary cause of blindness or VI was assigned based on the disorder that was easiest to treat. However, in some cases cataract due to other causes (e.g. due to glaucoma) might have been misclassified as cataract. This might have overestimated the prevalence of cataract in our study.

CONCLUSION

Our survey provides most recent and comprehensive information on the burden of avoidable blindness and visual impairment in Bangladesh from a representative population. In Bangladesh, majority of blindness (86.2%) among people aged ≥50 years is avoidable, and cataract is the most important cause of avoidable blindness. Improving the cataract surgical services and refraction services would be the most important step towards the elimination and reduction of avoidable blindness and visual impairment in Bangladesh respectively.

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Author Contributions

MM, ZW, JI conceived and designed the study. MM, ZW, BRS was involved in study implementation. GK, JI, MM, JJ analysed the data. GK, BRS, MM contributed to study materials/analysis tools. MM, GK, JJ wrote the first and subsequent version of the manuscript and all authors approved the final version of the manuscript.

Figure 1. Eight districts in Bangladesh where RAAB was carried out

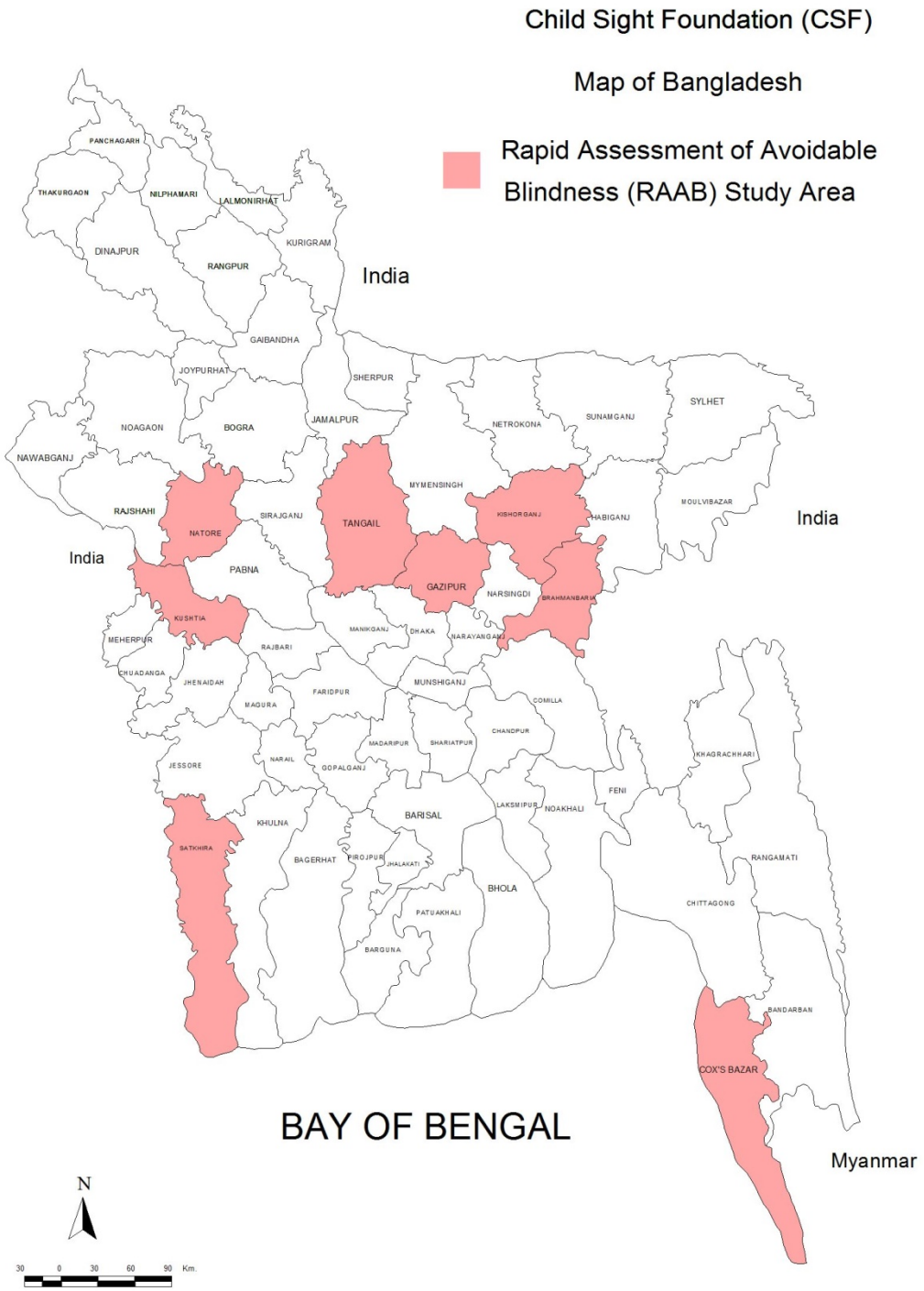

Table 1. Age and sex distribution of sample and district population

	Male		Female	
Age (years)	**Census estimates**	**Sample**	**Census estimates**	**Sample**
50 - 54	412,326 (29.4)	1,516 (15.6)	346,286 (29.6)	4,870 (33.1)
55 - 59	342,366 (18.8)	2,175 (22.1)	290,154 (22.8)	3,295 (21.8)
60 - 64	328,042 (18.0)	2,390 (23.8)	277,716 (18.4)	3,009 (19.7)
65 - 69	220,604 (12.1)	1,535 (15.4)	179,618 (11.9)	1,650 (10.6)
≥ 70	393,930 (21.7)	2,188 (22.4)	315,014 (20.9)	2,287 (14.8)
Total	**1,697,268**	**9,804**	**1,408,788**	**15,111**

Table 2. District-wise distribution data on total adult population examined, number of blindness with proportion of avoidable causes

District	**Total cluster**	**Adult pop Examined**	**Gender % (female)**	**Blind**	**Prev. of Blind % (≥50 yrs)**	**Avoidable Cause of blindness %**		
						Blind	**SVI**	**VI**
Brahmanbaria	61	3050	45.7	14	0.5	78.6	100.0	99.1
Satkhira	50	2485	43.9	99	4.0	91.9	96.7	99.3
Gazipur	50	2500	50.6	46	1.9	71.7	77.6	94.6
Kishoreganj	61	3050	54.1	68	2.25	82.4	90.8	94.6
Cox's Bazar	50	2500	52.2	77	3.02	92.2	96.9	99.7
Tangail	61	3049	55.0	38	1.25	86.8	98.8	99.1
Kushtia	50	2476	55.1	43	1.74	83.7	88.7	97
Natore	50	2486	56.6	86	3.46	97.7	93.5	97.5
Total	**433**	**21,596**	**51.7**	**471**	**2.2**	**85.6**	**92.9**	**97.6**

Table 3. Distribution of survey VA results by VA category and gender

	Male (examined = 10,442)		Female (examined = 11,154)		Total (examined = 21,596)	
VA with available correction	**N**	**Prevalence % (95% CI)**	**N**	**Prevalence % (95% CI)**	**N**	**Prevalence % (95% CI)**
Blindness: VA <3/60						
Bilateral blindness	166	1.6 (1.4-1.8)	305	2.7 (2.4-3.1)	471	2.2 (2.0-2.4)
Unilateral blindness	743	7.1 (6.6-7.6)	1,091	9.8 (9.2-10.3)	1834	8.5 (8.1-8.9)
SVI: VA < 6/60-≥3/60						
Bilateral SVI	304	2.9 (2.6-3.3)	447	4.0 (3.7-4.4)	751	3.5 (3.2-3.7)
Unilateral SVI	764	7.3 (6.8-7.8)	1,051	9.4 (8.9-10.0)	1,815	8.4 (8.0-8.8)
VI: VA < 6/18-≥6/60						
Bilateral VI	1728	16.5 (15.8-17.3)	1750	15.7 (15.0-16.4)	3478	16.1 (15.6-16.6)
Unilateral VI	3658	35.0 (34.1-36.0)	3633	32.6 (31.7-33.4)	7291	33.8 (33.1-34.4)
Bilateral aphakia	164	1.6 (1.3-1.8)	169	1.5 (1.3-1.8)	333	1.5 (1.4-1.7)
Unilateral aphakia	283	2.7 (2.4-3.0)	313	2.8 (2.5-3.1)	596	2.8 (2.5-3.0)
Aphakic eyes	611	5.8 (5.4-6.3)	651	5.8 (5.4-6.3)	1,262	5.8 (5.5-6.2)

VA: visual acuity, SVI: severe visual impairment, VI: visual impairment

Table 4. Distribution of main causes of bilateral blindness, severe visual impairment and visual impairment

Cause	Blind		SVI		VI	
	N	%	N	%	N	%
Refractive error	5	1.1	105	14.0	2213	63.6
Cataract, untreated	**357**	**75.8**	**553**	**73.6**	**1160**	**33.3**
Aphakia, uncorrected	6	1.3	19	2.5	13	0.4
Surgical complications	13	2.8	6	0.8	9	0.2
Phthisis	6	1.3	0	0	0	0
Other corneal scar	19	4.0	4	0.5	8	0.2
Globe abnormalities	4	0.8	1	0.1	2	0.1
Posterior segment *	**61**	**13.0**	**63**	**8.5**	**73**	**2.1**
Total	**471**	**100.0**	**751**	**100.0**	**3478**	**100.0**

* Glaucoma, diabetic retinopathy and age-related macular degeneration

Table 5. Cataract surgical coverage (CSC) by person and eyes in people aged ≥50 years

Persons	Male %	Female %	Total %
VA < 3/60	76.6	64.3	69.3
VA < 6/60	51.1	43.9	46.8
VA < 6/18	35.1	30.5	32.4
Eyes			
VA < 3/60	61.5	49.7	55.1
VA < 6/60	38.2	30.9	33.9
VA < 6/18	20.1	21.3	22.9

VA: visual acuity

Table 6. Post-operative visual acuity following cataract surgery, by IOL status

Correction	Visual acuity	IOL (n =1010)		Non IOL eyes (n =303)		All eyes (n =1313)	
		N	%	N	%	N	%
Available correction	Can see 6/18	788	78.0	151	49.8	939	71.5
	Can't see 6/18 but can see 6/60	131	13.0	46	15.2	177	13.5
	Can't see 6/60	91	9.0	106	35.0	197	15.0
Best correction	Can see 6/18	895	88.6	202	66.7	1097	83.5
	Can't see 6/18 but can see 6/60	35	3.5	39	12.9	74	5.7
	Can't see 6/60	80	7.9	62	20.5	142	10.8

IOL: intra-ocular lens

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