The prevalence and causes of vision loss in Indigenous Australians: the National Indigenous Eye Health Survey

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In 1980, the National Trachoma and Eye Health Program (NTEHP) gave the first national data on eye health and vision loss in Australian Aboriginal and Torres Strait Islander peoples.[1] At that time, rates of blindness in Indigenous Australians were 10 times higher than in other Australians, which is a striking paradox, as Aboriginal people have the best recorded visual acuity.[2,3]

There have been several national programs to improve the delivery of eye care to Indigenous Australians,[4-6] and there are ongoing efforts by committed individuals and groups. Occasional reports underscore the ongoing presence of trachoma and the dramatic increase in diabetic eye disease.[7-13] However, since the 1980 report, there have been no further national surveys on the status of Indigenous eye health to assess the adequacy of current services and for future planning.

We report the results of a national population-based survey of vision and eye health in Indigenous children and older adults performed in 2008. It redefines the gap in eye health between Indigenous and other Australians.

ABSTRACT

Aim: To determine the prevalence and causes of vision loss in Indigenous Australians.

Design, setting and participants: A national, stratified, random cluster sample was drawn from 30 communities across Australia that each included about 300 Indigenous people of all ages. A sample of non-Indigenous adults aged ≥ 40 years was also tested at several remote sites for comparison. Participants were examined using a standardised protocol that included a questionnaire (self-administered or completed with the help of field staff), visual acuity (VA) testing on presentation and after correction, visual field testing, trachoma grading, and fundus and lens photography. The data were collected in 2008.

Main outcome measures: VA; prevalence of low vision and blindness; causes of vision loss; rates of vision loss in Indigenous compared with non-Indigenous adults.

Results: 1694 Indigenous children and 1189 Indigenous adults were examined, representing recruitment rates of 84% for children aged 5–15 years and 72% for adults aged ≥ 40 years. Rates of low vision (VA < 6/12 to ≥ 6/60) were 1.5% (95% CI, 0.9%–2.1%) in children and 9.4% (95% CI, 7.8%–11.1%) in adults. Rates of blindness (VA < 6/60) were 0.2% (95% CI, 0.04%–0.5%) in children and 1.9% (95% CI, 1.1%–2.6%) in adults. The principal cause of low vision in both adults and children was refractive error. The principal causes of blindness in adults were cataract, refractive error and optic atrophy. Relative risks (RRs) of vision loss and blindness in Indigenous adults compared with adults in the mainstream Australian population were 2.8 and 6.2, respectively. By contrast, RRs of vision loss and blindness in Indigenous children compared with mainstream children were 0.2 and 0.6, respectively.

Conclusion: Many causes of vision loss in our sample were readily avoidable. Better allocation of services and resources is required to give all Australians equal access to eye health services.

METHODS

Sample selection

Data from the June 2006 national census were used to delineate 30 geographic areas that each included about 300 Indigenous people.[14] The sampling method has been described in detail elsewhere.[15] Data collection was undertaken in 2008.

Sample size

The sample size was determined to detect a doubling in the rate of presenting vision impairment in Indigenous Australians compared with the rate in the Australian population as a whole ("mainstream" Australia). Rates of vision impairment in mainstream Australia have been reported as 4.2% for the better eye in adults[16] and 5% in the worse eye for 12-year-old children.[17]

Sample sites were selected using the Australian Indigenous Geographical Classification. The classification is based on census collection districts, which are aggregated into Indigenous Locations, which in turn are combined into Indigenous Areas and then Indigenous Regions (each of these categories comprising a progressively larger geographical area). Indigenous Areas were grouped according to the Accessibility/Remoteness Index of Australia into five strata: major city, inner regional, outer regional, remote and very remote. The very remote stratum was divided into very remote coastal and very remote inland. Within each stratum, five sample areas were randomly selected (with probability of selection being proportional to community size and some smaller communities being combined to make a larger group) to yield geographic areas containing about 300 Indigenous people.

Recruitment

The survey team worked with existing Aboriginal Medical Services and community members. Promotional material included word of mouth, telephone calls, posters, flyers, radio messages and local media.

An informal census was undertaken using all available community data to establish the size of the eligible population of Indigenous adults and children. Sources included community and local council housing lists, health service and hospital lists, Aboriginal housing or legal aid records, and local informants.

At the completion of the eye examination, children were given a pair of sunglasses and adults were given a pair of reading glasses.

Examination procedures

Standardised demographic data were collected by means of a written questionnaire (self-administered or completed with the help of field staff and an interpreter if necessary).[18-20] A standardised eye examination was carried out on all participants. This included measurement of distance and near presenting visual acuity (VA),[19,21] pinhole testing if VA was < 6/12, or autorefraction and testing with correction if indicated, and visual

field assessment with a Humphrey frequency doubling technology (FDT) test (Zeiss, Jena, Germany). Appropriate arrangements were made for treatment or referral.

All participants with VA of <6/12 were defined as having vision impairment. VA of <6/12 but ≥6/60 was defined as low vision, and VA <6/60 as blindness. Vision impairment was attributed to refractive error when VA improved to ≥6/12 with either the pinhole test or after refraction.

Trachoma was graded in each eye, using a ×2.5 magnifying loupe, according to the World Health Organization simplified grading system.[22] Digital photographs of the everted left tarsus were graded independently.[23]

Fundal photographs of each eye were taken using a Canon CR-DGi retinal camera (Canon, Tokyo, Japan). Anteriorly focused, retroillumination photographs of the lens were taken in eyes with VA of <6/12 to assess cataract.[24] Pupil-dilating drops were used when needed. Retinal photographs were assessed in a masked fashion (ie, with the grader blinded to the clinical condition or previous clinical grading of the patient) for diabetic retinopathy,[25] macular changes[26] or optic disc cupping.[27]

A diagnosis of glaucoma was made if the cup-to-disc ratio (CDR) (ie, the ratio comparing the diameter of the "cup" portion of the optic disc with the total diameter of the optic disc) was greater than 0.8 or if two or more points on FDT testing were missed in an eye with a CDR of greater than 0.7.[19,28] To determine the distribution of optic disc diameters and CDRs in Indigenous Australians, 816 consecutive optic disc photographs were measured (data not presented here): 0.7 was 2 SD from the mean and 0.9 was 3 SD from the mean.[29]

Non-Indigenous sample

As population-based data on eye health for non-Indigenous Australians in remote areas were not available, a sample of non-Indigenous adults aged 40 years and over was sought at six remote sites. However, in two of the selected sites, the Aboriginal Medical Service considered it inappropriate to also examine non-Indigenous subjects. The size of each site was adjusted by adding or deleting adjacent census collection districts until it included 300–400 non-Indigenous adults. The recruitment and examination protocol for non-Indigenous people was the same as the protocol for Indigenous people.

Data analysis

Data were entered into an electronic database using Access 2000 (Microsoft Corp, Redmond, Wash, USA). For categorical variables, the χ^2 test was used to test for significant differences in participants' characteristics by group. For continuous variables, significant differences between strata were evaluated by the Mann–Whitney–Wilcoxon test or Student t-test. P values of <0.05 were taken to indicate statistical significance. All statistical analysis was done using STATA software, version 10.2 (Stata Corporation, College Station, Tex, USA).

Ethics approval

Primary ethics approval was obtained from the Human Research Ethics Committee of the Royal Victorian Eye and Ear Hospital. However, separate formal ethics approval was also required and obtained from the human research ethics committees of the Aboriginal Health and Medical Research Council of New South Wales, the Aboriginal Health Council of South Australia, the Menzies School of Health Research and the Australian Capital Territory Department of Health (approved 12 November 2007), as well as the Central Australian Human Research Ethics Committee, the Western Australian Aboriginal Health Information and Ethics Committee, the Tasmanian Scientific Research Advisory Committee, the Tasmanian Health and Medical Human Research Ethics Committee and the Queensland Aboriginal and Islander Health Council.

The protocol was also reviewed and approved by the board of the National Aboriginal Community Controlled Health Organisation and the appropriate organisation in each community. Permission was obtained as needed at the local, regional or state level to examine children in schools. Our research was conducted in accordance with the tenets of the Declaration of Helsinki as revised in 2000. Written, informed consent was obtained for all participants before examination.

RESULTS

The target population included 2007 Indigenous children and 1655 adults. Of these, 1694 children (84.4%) and 1189 adults (71.8%) were examined (Box 1). Of 163 non-Indigenous adults in four communities, 136 (83.4%) were examined.

Additionally, in 26 communities, 402 Indigenous children who lived outside the sample area (and were thus ineligible for the study) were examined, as were 425 ineligible adults in 19 communities. Children living within or outside the sample area were generally similar demographically, although the ineligible children were more likely to speak English (Box 2). The ineligible adults differed in several ways from adults in the sample, reflecting self-selection for an eye examination.

Distance VA data on presentation were missing for six children and six Indigenous adults, all of whom were believed to have normal vision. Near VA data were missing for 12 Indigenous adults and one non-Indigenous adult.

Retinal images were available for 1057/1189 Indigenous adults (89%) and 132/136 non-Indigenous adults (97%). Photographs were gradable for both eyes in 82% of participants, gradable for one eye and partially gradable for the other in 7%, and partially gradable for both eyes in 5%. FDT test results were obtained for 1136 Indige-

1 Age distribution of participants in the National Indigenous Eye Health Survey

Age group (years)	Indigenous children
5	154
6	166
7	185
8	198
9	180
10	172
11	164
12	174
13	121
14	111
15	69
Total	1694

Age group (years)	Indigenous adults	Non-Indigenous adults
40–44	255	19
45–49	252	23
50–54	235	30
55–59	166	11
60–64	118	17
65–69	81	14
70–74	45	8
75–79	22	6
80–84	12	6
85–89	3	2
Total	1189	136

2 Demographic characteristics of participants in the National Indigenous Eye Health Survey*

Characteristic	Indigenous children				Indigenous adults				Non-Indigenous adults		
	Eligible (n = 1694)	Ineligible (n = 402)	$\chi^{2 \text{ (or } z^{\dagger})}$	P	Eligible (n = 1189)	Ineligible (n = 425)	χ^2	P	Eligible (n = 136)	$\chi^{2\ddagger}$	$P^{\ddagger}$
Female	49%	49%	0.007	0.94	61%	59%	0.30	0.58	62%	0.05	0.83
Median age in years (IQR)§	9 (7–12)	9 (7–12)	− 1.26†	0.21	51 (45–59)	52 (47–60)	1.71†	0.08	54 (48–66)	− 3.73†	< 0.001
English spoken at home	66%	52%	25.8	< 0.01	59%	75%	33.9	< 0.001	97%	76.1	< 0.001
Education higher than secondary school level	na	na	na	na	12%	18%	142.4	< 0.001	20%	26.3	0.001
Self-reported diabetes	1.3%	0.5%	1.80	0.18	37%	37%	7.51	0.006	12%	35.4	0.001
Current smoker	na	na	na	na	67%	60%	0.01	0.92	57%	4.57	0.03
History of eye problems	19%	20%	0.15	0.70	78%	84%	5.38	0.02	84%	1.93	0.17
Distance glasses normally worn	8%	7%	0.64	0.42	26%	32%	4.99	0.03	49%	31.0	< 0.001
Reading glasses normally worn	na	na	na	na	61%	68%	5.16	0.02	74%	8.97	0.003

IQR = interquartile range. na = not applicable. * "Ineligible" participants were those who lived outside the sample areas. † z scores given for median age. ‡ Comparison was between eligible Indigenous adults and non-Indigenous adults. § Based on Wilcoxon rank sum test. ◆

nous adults (96%) and for all non-Indigenous adults. Trachoma grading was available for 98% of participants.

Ninety-six per cent of responses to questionnaire items were complete.

Visual acuity on presentation

For both children and adults, there were no statistically significant differences in presenting binocular distance vision between eligible and ineligible groups (χ^2 test P values were between 0.3 and 0.9) (Box 3).

Overall, 1.5% of eligible Indigenous children had low vision (VA < 6/12) and 0.2% were blind (VA < 6/60). Of the eligible Indigenous adults, 9.4% had low vision and 1.9% were blind.

Rates of vision loss were weighted for the sampling rate from different strata. Weighted rates for eligible Indigenous children were 2.0% (95% CI, 1.3%–2.9%) for low vision and 0.2% (95% CI, 0.01%–0.7%) for blindness. Weighted rates for eligible Indigenous adults were 8.6% (95% CI,

6.9%–10.7%) for low vision and 1.8% (95% CI, 0.1%– 3.3%) for blindness.

Rates of blindness in eligible Indigenous adults and children did not vary significantly by state or remoteness category. Rates of low vision in adults tended to be lower in major city and regional areas (range, 6.6%–7.8%) than in remote and very remote areas (range, 9.5%–12.7%), but the difference was not statistically significant ($\chi^2 = 8.3$; P = 0.60). However, the opposite was true in children. Compared with children in major cities,

3 Binocular presenting distant visual acuity among participants in the National Indigenous Eye Health Survey*

Presenting distant visual acuity	Eligible Indigenous		Ineligible Indigenous		Non-Indigenous adults (n = 136)
	Children (n = 1694)	Adults (n = 1189)	Children (n = 402)	Adults (n = 425)	
Normal vision (VA ≥ 6/12)	1659 (97.9% [97.3%–98.6%])	1052 (88.5% [86.7%–90.3%])	388 (96.5% [94.7%–98.3%])	381 (89.4% [86.4%–92.3%])	122 (89.7% [84.6%–94.9%])
Bilateral vision loss					
VA < 6/12 to ≥ 6/18	17 (1.0% [0.5%–1.5%])	75 (6.3% [4.9%–7.7%])	5 (1.1% [< 0.1%–2.5%])	24 (5.7% [3.4%–7.8%])	9 (6.6% [3.0%–12.6%])
VA < 6/18 to ≥ 6/60	8 (0.5% [0.2%–0.9%])	37 (3.1% [2.1%–4.1%])	3 (0.6% [< 0.1%–1.8%])	10 (2.3% [0.9%–3.8%])	5 (3.7% [1.1%–8.6%])
VA < 6/60 to > PL	3 (0.2% [< 0.1%–0.5%])	19 (1.6% [0.9%–2.3%])	1 (0.2% [< 0.1%–1.2%])	3 (0.7% [0.1%–2.1%])	na
PL or NPL†	na	3 (0.3% [0.1%–0.7%])	0	2 (0.5% [0.1%-1.7%])	na
Not recorded	7 (0.4% [0.2%–0.9%])	3 (0.3% [0.1%–0.7%])	25 (5.3% [3.4%–7.8%])	5 (1.2% [0.4%–2.8%])	na
Low vision (VA < 6/12 to ≥ 6/60)	25 (1.5% [0.9%–2.1%])	112 (9.4% [7.8%–11.1%])	5 (1.2% [0.2%–2.3%])	34 (8.0% [5.4%–10.6%])	14 (10.3% [5.1%–15.5%])
Blindness (VA < 6/60)	3 (0.2% [< 0.1%–0.5%])	22 (1.9% [1.1%–2.6%])	1 (0.2% [< 0.1%–1.4%])	6 (1.4% [0.5%–3.1%])	na

na = not applicable. VA = visual acuity. * Figures represent number (% [95% CI]). † These blind people either had perception of light (PL) (could tell light from dark) or no perception of light (NPL) (could not tell light from dark). ◆

those in all other regions had less vision impairment (both low vision and blindness): odds ratio (OR) (inner regional), 0.58 (95% CI, 0.20–1.64); OR (outer regional), 0.33 (95% CI, 0.08–1.27); OR (remote), 0.21 (95% CI, 0.05–0.80); OR (very remote coastal), 0.25 (95% CI, 0.07–0.85); OR (very remote inland), 0.06 (95% CI, 0.01–0.49). There were no state-based differences seen among children. However, rates of vision impairment in adults were higher in several other states/territories than in NSW: Northern Territory OR, 1.68 (95% CI, 0.85–3.32); Queensland OR, 2.19 (95% CI, 1.19–4.03); South Australia OR, 1.72 (95% CI, 0.80–3.67); Western Australia OR, 2.29 (95% CI, 1.26–4.16). (Tasmania and Victoria were omitted because of small numbers.)

Weighted rates of vision loss were age-standardised to the Australian population.[14] The relative risks (RRs) of low vision and blindness in Indigenous adults compared with mainstream adults were 2.8 and 6.2, respectively (Box 4).[16] By contrast, in Indigenous children compared with mainstream children the RRs of low vision and blindness were 0.2 and 0.6, respectively (Box 4).[17,30,31]

Both low vision and blindness in adults increased markedly with age (Box 5). Among Indigenous adults over the age of 80 years, 53% had low vision and 13% were blind.

Causes of vision loss

The most common cause of bilateral blindness in Indigenous adults was cataract and the most common cause of low vision was uncorrected refractive error (Box 6). In Indigenous children, uncorrected refractive error was the cause of blindness in one of three children and of low vision in 14 of 25 children. Refractive error was the most common cause of monocular low vision in all groups (Box 7). Ocular trauma was the leading cause of monocular blindness in Indigenous adults.

Near vision

A third of adults in each of the groups (eligible Indigenous, ineligible Indigenous and non-Indigenous) were unable to read normal-sized print (N8) with their near vision on presentation (Box 8). More non-Indigenous than Indigenous participants wore reading glasses during testing ($\chi^2 = 19.0$; $P < 0.001$). There was no significant difference in near vision or the use of reading glasses between the three groups. (χ^2 test P values were between 0.2 and 0.3).

4 Age-adjusted* prevalence of vision loss

Vision loss	National survey	Mainstream Australia	Relative risk
Low vision			
Children[†]	1.40% (1.38–1.44)	6.36 (6.27–6.45)[†]	0.2
Adults	14.42 (14.39–14.43)	5.19 (5.17–5.20)[‡]	2.8
Blindness			
Children	0.18 (0.17–0.18)	0.28 (0.26–0.30)	0.6
Adults	2.79 (2.78–2.81)	0.45 (0.44–0.46)[‡]	6.2

* Age-adjusted to the Australian population.[14] † From data provided by the Sydney Myopia Study.[17,30,31] ‡ From data synthesised from the Melbourne Visual Impairment Project and the Blue Mountains Eye Study.[16] ◆

Visual field loss

Of 1052 participants with presenting VA of ≥ 6/12, 39 (3.7%) missed one FDT point and 96 (9.1%) missed two or more points. In 134 with presenting VA of < 6/12, 8 (6.0%) missed one FDT point and 27 (20.1%) missed two or more points. The correlation between FDT testing and visual function is not well established, and the prevalence of visual field loss detected by FDT testing has not been determined.[32]
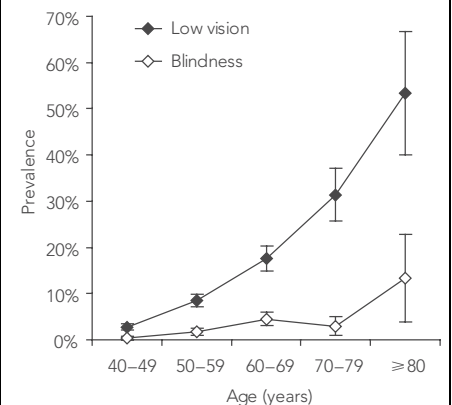
DISCUSSION

This is the first national report on the vision status of Australian Aboriginal and Torres Strait Islander people for 30 years. Our results confirm the good vision enjoyed by Indigenous children, particularly those in more remote or traditional areas, and reconfirm the high level of avoidable blindness found in adults.

The strengths of our study included its national scope, study design and sampling framework, and the use of a standardised methodology. Its weaknesses included a relatively small sample size, the limited number of sites sampled and somewhat variable participation rate. The absence of a comprehensive ophthalmic examination also limited the ability to establish a definitive diagnosis in every case. In spite of this, there was only one case of vision impairment out of 15 in which a diagnosis could not be reached, and most of these 15 were children for whom retinal photography was not performed.

We were unable to include eligible non-Indigenous adults in all remote and very remote communities. In most very remote communities, the non-Indigenous population was small and transient and, in two remote communities, it was considered inappropriate to examine non-Indigenous subjects. With the very small sample of non-Indigenous adults, only limited comparisons

5 Age-specific prevalence of visual impairment in eligible Indigenous adults*

* Bars indicate 95% confidence intervals. ◆

could be made, and no significant differences were found between non-Indigenous adults in our sample and adults in mainstream Australia.[16]

The good vision of Indigenous children can be accounted for by the relative infrequency of myopia,[2] although the prevalence of myopia may have increased recently.[33] Nevertheless, uncorrected refractive error was responsible for vision loss in 15/28 Indigenous children (54%), and only 8% of Indigenous children wore glasses. Of the 15 Indigenous children with vision impairment due to refractive error, four (27%) were wearing glasses that were not appropriate and reduced their vision to < 6/12. By comparison, the Sydney Myopia Study found that refractive error caused at least 74% and possibly 96% of vision impairment in 6-year-olds[30] and 75% in 12-year-olds,[17,31] and that spectacles were worn by 4% of younger children and 19% of older children.[17,31] A detailed comparison between these studies and ours of the prevalence and

6 Causes of bilateral vision loss among participants in the National Indigenous Eye Health Survey

Cause of vision loss	Eligible Indigenous		Ineligible Indigenous		Non-Indigenous
Low vision (VA < 6/12 to ⩾ 6/60)	Children (n = 25)	Adults (n = 112)	Children (n = 5)	Adults (n = 34)	Adults (n = 14)
Refractive error	14 (56%)	60 (54%)	1 (20%)	18 (53%)	5 (36%)
Cataract	0	30 (27%)	0	12 (35%)	6 (43%)
Diabetic retinopathy	0	13 (12%)	0	0	1 (7%)
AMD	0	2 (2%)	0	0	0
Glaucoma	0	1 (1%)	0	0	1 (7%)
Trachoma	0	2 (2%)	0	0	0
Corneal scar	0	1 (1%)	0	0	0
Retinitis pigmentosa	0	1 (1%)	0	0	1 (7%)
Optic atrophy	0	1 (1%)	0	0	0
Retinal vascular occlusion	0	0	0	1 (3%)	0
Congenital nystagmus	1 (4%)	0	1 (20%)	0	0
Unknown	10 (40%)	1 (1%)	3 (60%)	3 (9%)	0
Blindness (VA < 6/60)	Children (n = 3)	Adults (n = 22)	Children (n = 1)	Adults (n = 6)	Adults (n = 0)
Refractive error	1 (33%)	3 (14%)	1 (100%)	1 (17%)	0
Cataract	0	7 (32%)	0	3 (50%)	0
Diabetic retinopathy	0	2 (9%)	0	0	0
AMD	0	0	0	1 (17%)	0
Glaucoma	0	0	0	1 (17%)	0
Optic atrophy	0	3 (14%)	0	0	0
Ocular trauma	0	1 (5%)	0	0	0
Trachoma	0	2 (9%)	0	0	0
Retinal detachment	0	1 (5%)	0	0	0
Unknown	2 (67%)	3 (14%)	0	0	0

AMD = age-related macular degeneration. VA = visual acuity. ◆

causes of blindness in children cannot be made because of the very small numbers involved.

Although our study showed that vision impairment was less common in Indigenous than non-Indigenous children, low vision and blindness were much more frequent in Indigenous adults than in mainstream Australian adults, and were the result of different causes. In mainstream Australia, age-related macular degeneration (AMD) causes 48% of blindness.[16] AMD was not seen in our sample population, although one ineligible Indigenous adult was blind from AMD. Similarly, glaucoma, which causes 14% of blindness in mainstream Australia,[16] was not seen in our sample population, although one ineligible Indigenous adult was blind from glaucoma. However, optic atrophy and trachoma were common in our study. Our results showed that unoperated cataract was a much more important cause of blindness in Indigenous adults (32%) than in mainstream Australian adults (12%),[16] as was refractive error (14% in Indigenous adults compared with 4% in the mainstream).[16]

Similar differences between Indigenous adults and mainstream adults in the causes of low vision were seen. Cataract was a much more common cause of low vision in Indigenous adults (27%) than in mainstream adults (14%).[16] The pattern was similar for diabetic retinopathy (12% v 2%).[16] On the other hand, AMD was a less common cause of low vision in Indigenous adults than in mainstream adults (2% v 10%).

In 1980, the NTEHP reported 871 blind Aboriginal people out of 10 601 over the age of 40 years (8.2%),[1] a rate about 10 times higher than the rate in non-Aboriginal people. The NTEHP rate is much higher than the 2.8% we found. Detailed comparisons of our study with the NTEHP study are difficult, as their sample was predominantly

from more remote areas, their data were aggregated, and their non-Aboriginal sample was self-selected. Nevertheless, some comparison can still be made. In the NTEHP study,[1] among Aboriginal people aged over 40 years, blindness was caused by corneal disease in 52% of subjects (84% of which was due to trachoma [ie, 44% of the total]); by cataract in 40%; by diabetes, AMD and other retinal causes in 4%; and by glaucoma in 0.7%. The corresponding data from our study were 9% for corneal disease (all due to trachoma), 32% for cataract, 14% for retinal causes (9% due to diabetes), and no bilateral blindness due to glaucoma.

Clearly, there has been a major reduction in blindness due to corneal scarring among Indigenous adults since 1980. As there has been no major corneal transplantation program in the intervening years, the reduction in blindness is probably due to the passing of one or more generations of people who were blind from corneal scarring. Rates of cataract-related blindness (40% in 1980 v 32% in our study) have not changed significantly.

The rate of self-reported diabetes in Indigenous adults was 0.03% in the NTEHP study[1] compared with 37% in our study. Changes in both lifestyle and diet have been implicated in this increase.[34] In the NTEHP study, diabetic retinopathy was not separated as a cause of blindness, and all retinal causes, including diabetic retinopathy, caused only 4% of blindness. We found two out of 22 cases of blindness (9%) to be due to diabetic retinopathy.

Vision loss in Indigenous adults is predominantly from preventable or treatable causes, and the higher rate of vision loss among Indigenous people reflects a profound underutilisation of eye care services. Without wanting to overinterpret our data, age-specific rates suggest that cataract-related blindness in adult Indigenous Australians is about 12 times higher than in the mainstream, diabetes-related blindness is over 14 times higher, and blindness due to uncorrected refractive error is over five times higher. Each of these causes of vision loss is readily treatable and preventable.

CONCLUSION

Over the past 30 years, overall rates of blindness in Aboriginal and Torres Strait Islander people have fallen, especially for blindness due to corneal scarring. However, blindness rates in Indigenous Australians are still much higher than in other Australians,

7 Causes of monocular vision loss among participants in the National Indigenous Eye Health Survey

Cause of vision loss	Eligible Indigenous		Ineligible Indigenous		Non-Indigenous
Low vision (VA < 6/12 to ≥ 6/60)	Children (n = 32)	Adults (n = 152)	Children (n = 5)	Adults (n = 56)	Adults (n = 19)
Refractive error	15 (47%)	89 (59%)	2 (40%)	29 (52%)	12 (63%)
Cataract	0	28 (18%)	1 (20%)	9 (16%)	5 (26%)
Diabetic retinopathy	0	10 (7%)	0	4 (7%)	0
Amblyopia	6 (19%)	4 (3%)	0	3 (5%)	2 (10%)
AMD	0	3 (2%)	0	2 (4%)	0
Glaucoma	0	2 (1%)	0	0	0
Ocular trauma	0	2 (1%)	0	1 (2%)	0
Optic atrophy	0	1 (1%)	0	0	0
Macular scar	0	1 (1%)	0	0	0
Climatic droplet keratopathy	0	1 (1%)	0	0	0
Corneal scarring	0	0	0	1 (2%)	0
Retinal detachment	0	0	0	1 (2%)	0
Congenital coloboma	0	1 (1%)	0	0	0
Retinal vascular occlusion	0	0	0	1 (2%)	0
Unknown	11 (34%)	10 (7%)	2 (40%)	5 (9%)	0
Blindness (VA < 6/60)	Children (n = 5)	Adults (n = 32)	Children (n = 2)	Adults (n = 16)	Adults (n = 2)
Refractive error	1 (20%)	3 (9%)	0	0	0
Cataract	0	7 (22%)	1 (50%)	5 (31%)	0
Diabetic retinopathy	0	4 (13%)	0	0	0
Amblyopia	2 (40%)	1 (3%)	0	3 (19%)	0
AMD	0	3 (9%)	0	0	0
Ocular trauma	0	9 (28%)	0	6 (38%)	0
Corneal scarring	0	1 (3%)	0	1 (6%)	1 (50%)
Retinal detachment	0	1 (3%)	0	0	1 (50%)
Pterygium/keratoconus	0	1 (3%)	0	1 (6%)	0
Unknown	2 (40%)	2 (6%)	1 (50%)	0	0

AMD = age-related macular degeneration. VA = visual acuity. ◆

8 Near vision on presentation among adult participants in the National Indigenous Eye Health Survey

Presenting near vision	Eligible Indigenous adults (n = 1189)	Ineligible Indigenous adults (n = 425)	Non-Indigenous adults (n = 136)
Normally wears reading glasses	725 (61%)	253 (60%)	101 (74%)
Tested with reading glasses	515 (43%)	230 (54%)	84 (62%)
Near vision			
≥ N8*	709 (60%)	247 (58%)	95 (70%)
< N8 to ≥ N20	436 (37%)	155 (36%)	38 (28%)
< N20 to ≥ N48	24 (2%)	11 (3%)	2 (1%)
< N48	8 (1%)	2 (< 1%)	0
Missing values	12 (1%)	10 (2%)	1 (1%)

* N8 means person is able to read normal-sized print with near vision. Higher N numbers indicate poorer vision (ie, larger type size required to distinguish letters clearly). ◆

and most blindness is due to readily preventable or treatable causes of vision loss: cataract, diabetes, refractive error and trachoma. Adequate provision of accessible eye care services is required to redress this inequality and "close the gap" for vision loss in Australia.

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