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Utilisation of eye health care services in Australia: the National Eye Health Survey

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Keywords: National survey, eye healthcare, Indigenous health, population health, eye test

ABSTRACT

Importance: National data on eye healthcare service utilisation will inform Australia's eye health policy.

Background: To investigate the utilisation of eye healthcare services by Australians.

Design: Cross-sectional survey

Participants: Indigenous Australians aged 40 years and older and non-Indigenous Australians aged 50 years and older.

Methods: 1738 Indigenous Australians and 3098 non-Indigenous Australians were recruited from 30 randomly-selected sites, stratified by remoteness.

Sociodemographic, ocular history, and eye healthcare service utilisation data were collected, and an eye examination was conducted.

Main outcome measures: Recentness of eye examinations, types of providers used, and associated risk factors.

Results: 67.0% of Indigenous Australians and 82.5% of non-Indigenous Australians underwent an eye examination within the previous two years. Indigenous status ($p<0.001$), male gender ($p<0.001$), Outer Regional ($p<0.001$) and Very Remote ($p<0.001$) residence were associated with less recent examinations. Participants with self-reported eye disease or diabetes were most likely to have been examined within the past year ($p<0.001$). For Indigenous Australians, older age was associated with recent eye testing ($p=0.001$). Those with retinal disease and cataract were more likely to see an ophthalmologist ($p<0.001$), while those with

refractive error were more likely to see an optometrist ($p < 0.001$). In Regional Australia, non-Indigenous people were more likely to see optometrists ($p < 0.001$), while Indigenous Australians were more likely to utilise other, non-specialist services ($p < 0.001$).

Conclusions and Relevance: Eye examination frequency has improved in Indigenous and non-Indigenous Australians compared to previous population-based research. Further improvements are required in risk groups including Indigenous Australians, and those living in Regional and Remote areas.

INTRODUCTION

The International Agency for the Prevention of Blindness classifies Australia as a 'Category A' country (the highest rating) for nationwide distribution of eye care services.¹ Service availability is particularly high in metropolitan areas, in which 70% of Australians reside.² Despite this, more than 500 000 Australians aged 40 years and older are estimated to have vision impairment (VI) or blindness, and vision loss persists as a public health concern.³ Almost 80% of vision loss in Australia is caused by uncorrected refractive error and cataract, both of which are readily and affordably reversible through spectacle correction or surgeries.³ The vision loss caused by other major eye conditions including diabetic retinopathy, age-related macular degeneration (AMD) and glaucoma, may be better managed through early detection, prevention and treatment strategies.⁴

Population-based studies conducted in Australia have identified insufficiencies in the availability and utilisation of eye health services. Indigenous Australians, those with diabetes, those of lower socio-economic status, men, those for whom English is not their main spoken language and individuals with eye disease are under-served.⁵⁻⁸ A disproportionately low availability of services has been noted in non-metropolitan

areas, with the number of patients per optometrist being 12,700 in remote areas compared with the national average of 1,180.^{2, 9} In 2014 the Australian Government developed the National Framework Implementation Plan (NFIP) that aimed to build on existing eye health care services and programmes to improve access for all Australians in an effort to promote eye health and reduce avoidable blindness.¹⁰ The NFIP emphasised the need for up-to-date population-based data on the prevalence of vision loss, as well as data on the utilisation of eye health services, to inform the implementation of improved eye health strategies.¹⁰

One of the aims of the National Eye Health Survey (NEHS) was to provide up-to-date population-based data on the utilisation of eye health services by both Indigenous and non-Indigenous Australians across all levels of geographic remoteness. These data will directly inform the implementation of appropriate eye health service delivery strategies. This paper investigates the utilisation of eye health care services by both Indigenous and non-Indigenous participants in the NEHS, including how recently participants underwent eye examinations, the types of healthcare providers used, and sociodemographic and clinical risk factors associated with these behaviours.

METHODS

Study design

The NEHS was a cross-sectional, nationwide population-based study conducted from March 2015 to April 2016. The methods used to sample participants and select survey sites have been described elsewhere.¹¹ In brief, cluster sampling was used to select 30 geographic areas stratified by remoteness to provide a sample of Indigenous Australians aged 40 years and older and non-Indigenous Australians aged 50 years and older. A younger age criterion was selected for Indigenous Australians as this group has been shown to have earlier onset and more rapid

progression of eye disease and diabetes.¹² Sites were selected using 2011 Australian Census data and were grouped according to the Accessibility/Remoteness Index of Australia (ARIA+) into five Remoteness Areas; Major City, Inner Regional, Outer Regional, Remote and Very Remote.¹³

Recruiters went door-to-door in each survey site and recruited Indigenous Australians aged 40 years or older and non-Indigenous Australians aged 50 years or older. Minor methodological adjustments were made in the recruitment of Indigenous participants, to adapt to local circumstances within diverse communities, including the use of telephone recruitment from Aboriginal Health Services community directories, word-of-mouth and recruitment from concurrent health services. Recruiters recorded reasons for non-participation provided by residents who declined to be surveyed. This study was approved by the Royal Victorian Eye and Ear Hospital Human Research Ethics Committee (HREC-14/1199H). Additional state-level ethical approvals were obtained to conduct the survey within Indigenous communities. This research was conducted in accordance with the tenets of the Declaration of Helsinki.

Participant questionnaire and examinations

Participants provided informed consent and underwent a series of eye examinations described in detail elsewhere¹⁴ and a standardised interviewer-administered questionnaire. Using the questionnaire, participants were asked if they had ever had their eyes examined, and if so, how many years and months ago, and who had performed the examination. Responses were recorded against a standardised list defined *a priori*: 1) Optometrist, 2) Ophthalmologist, 3) GP/local doctor, 4) Nurse, 5) Health worker, 6) Ophthalmic nurse/technician, 7) Other. Socio-demographic data including age, gender, education, country of birth, main language and Indigenous/non-Indigenous status were obtained. History of stroke, diabetes, glaucoma, AMD, cataract, refractive error and diabetic retinopathy (DR) were

recorded. A history of refractive error was determined by asking participants if they wore distance glasses. These data were used to determine the following outcomes: 1) the proportion of participants who had undergone an eye examination in each of four time categories prior to participation (≤ 1 year, $1 <$ to 2 years, $2 <$ to 5 years and >5 years or never) as well as sociodemographic and self-reported clinical risk factors associated with time since last eye examination; 2) The proportion of participants who visited an optometrist, an ophthalmologist or other types of eye health service providers for their last eye examination, as well as sociodemographic and self-reported clinical risk factors associated with the type of provider used.

Statistical analysis

Descriptive statistics including age, number of years of education, gender, language, and country of birth were calculated for Indigenous and non-Indigenous participants separately in the following groups based on time since last eye examination (four groups): ≤ 1 year, $1 <$ to 2 years, $2 <$ to 5 years and >5 years or never.

Multinomial logistic regression analysis was conducted to identify associations between the time since last eye examination and the following explanatory variables: Indigenous status, age, education, gender, geographic remoteness, and self-reported conditions including glaucoma, AMD, diabetic retinopathy, cataract, refractive error and diabetes. The referent group (more than 5 years and Never) was compared with two or more groups (within 1 year, 1-2 years, 2-5 years) allowing the logits to be calculated simultaneously for each comparison. Due to the small sample of non-Indigenous Australians with histories of AMD and glaucoma, these groups were combined for regression analysis to detect an effect of retinal disease. The association between self-reported DR and the time since examination was not tested in non-Indigenous Australians due to insufficient sample size. The sample size in this model included 1731 Indigenous Australians and 3098 non-Indigenous Australians.

Logistic regression analysis was conducted to identify associations between the outcome variable of the types of eye healthcare provider most recently visited. Excluding 'optometrist' and 'ophthalmologist', the list of eye health care providers was collapsed into the group 'other' due to a small sample size in each group (for Indigenous and non-Indigenous participants, respectively, n=44 and n=21 for GP/local doctor, n=13 and n=7 for nurse, n=70 and n=3 for health worker, n=36 and n=21 for other), resulting in three outcome groups (optometrist, ophthalmologist, or 'Other' as defined above). Regression analysis measured associations with the following explanatory variables: Indigenous status, age, education, gender, geographic remoteness, and self-reported conditions including glaucoma, age-related macular degeneration (AMD), diabetic retinopathy, cataract, refractive error and diabetes. The 'other' group was not included in analysis for non-Indigenous participants due to small sample size (n=54). As the outcome measure for Indigenous participants included three groups, a multinomial logit model was used, while odds ratios (OR) were calculated for the non-Indigenous group. A total of 1593 Indigenous participants and 2990 non-Indigenous were included in this model.

Logistic regression analyses included two distinct models. The first model involved analysing Indigenous and non-Indigenous samples in one model to ascertain whether Indigenous status was a significant risk factor. The second model involved testing all explanatory variables on Indigenous and non-Indigenous groups separately, due to differences in sampling procedures and inclusion criteria between these groups. All analyses were calculated using Stata 14.1 software (Stata Corp, College Station, TX, USA), and p-values were significant at <0.05.

RESULTS

Study participants

Across all survey sites, 23,235 residences were visited by recruiters, in which a total of 11,883 (51.1%) residents were contactable at the time of recruitment. In total, 2240 Indigenous residents were identified as eligible, of whom 1738 participated in the survey, resulting in a response rate of 77.6%, while 3098 out of 4520 eligible non-Indigenous residents participated (response rate=68.5%). The most common reasons for non-participation were lack of interest (26.1%) and having had a recent eye test (16.7%). The mean [SD] age of Indigenous and non-Indigenous participants was 55.0 [10.0] years (range 40 to 92 years), and 66.6 [9.7] years (range 50 to 98 years) respectively. Males comprised 41.1% of Indigenous participants and 46.4% of non-Indigenous participants.

Time since most recent eye examination and associated risk factors

Multivariate analysis revealed that Indigenous status predicted less recent eye examinations (Relative Risk Reduction [RRR] 0.48 and 0.54 for undergoing eye examinations within 1 or >1-2 years, respectively, compared to the referent group >5 years or never). All subsequent analyses interrogated Indigenous and non-Indigenous groups separately due to differences in sampling between groups.

Indigenous Australians

Seven Indigenous Australians had missing data. Of the remaining 1731 Indigenous participants, 1159 reported that they had undergone an eye examination within the past two years, and fewer than 50% (814/1731) had undergone an eye examination within the previous year in line with National Aboriginal Community Controlled Health Organisation and the Royal Australian College of General Practitioners recommendations (Table 1).¹⁵ One hundred and forty-two (8.2%) Indigenous participants had never undergone an eye examination.

Each additional year of education was associated with an increased likelihood of having undergone an eye examination within the past two years (RRR: 1.05 for < 1

year and 1.06 for 1 < - 2 years) (Table 2). Older age was associated with Indigenous participants having undergone eye examinations more recently (compared to the referent group of >5 years or never, with RRR: 1.03 for 1 < - 2 years and 1.04 for 2 < -5 years), however this did not apply to <1 year. Participants with self-reported DR were significantly more likely to have undergone an eye examination within the past year compared to the referent group (RRR: 6.35). Indigenous Australians with histories of cataract, refractive error, diabetic retinopathy and diabetes were more likely to have undergone eye examinations within the past year (RRR: 4.17; 6.12; 6.35; 3.04, respectively) than 5 years ago or never. Similarly, cataract, refractive error and diabetes were associated with participants being more likely to have undergone eye examinations 1 < - 2 years ago (RRR: 1.99; 3.90; 1.82,), with cataract and refractive error also being associated with participants being more likely to have had eye examinations 2 < -5 years ago (RRR: 2.32; 3.81), compared to the referent group. Those residing in Outer Regional (RRR: 0.53 for ≤ 1 year and 0.55 for 1 < - 2 years) and Very Remote (RRR: 0.28 for ≤ 1 year and 0.46 for 1 < - 2 years) sites were less likely to have their eyes examined in the past 2 years than participants residing in Major Cities.

Non-Indigenous Australians

More than 80% (2555/3098) of non-Indigenous Australians reported that they had undergone an eye examination within the last two years, with 59.3% of participants having been examined within the previous year. Only 1.6% of non-Indigenous participants had never undergone an eye examination.

For non-Indigenous Australians, each additional year of education was associated with an increased likelihood of having undergone an eye examination within the past two years (RRR: 1.08 for < 1 year and 1.06 for 1 < - 2 years) (Table 2). Those with a history of glaucoma or AMD were significantly more likely to have undergone an eye examination within the past year (RRR: 18.29). Compared to the referent group

of more than 5 years or never, histories of cataract, refractive error and diabetes were associated with non-Indigenous participants having undergone eye examinations within the past year (RRR: 8.84; 8.30; 6.08, respectively), followed by either 1 < - 2 years (RRR: 3.98; 6.43 and 3.23) and 2 < -5 years (RRR: 2.53; 4.79 and 3.44). Conversely, those residing in Outer Regional areas were less likely to have had an eye examination within the past year than those residing in Major Cities (RRR: 0.63). Non-Indigenous males were also less likely to have had an eye examination within the past 5 years (RRR: 0.36 – 0.55).

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Table 1: Sociodemographic characteristics of Indigenous and non-Indigenous participants, by time since last eye examination

	Indigenous (n=1731) †				Non-Indigenous (n=3098)			
	≤ 1 years n=814	1 < -2 years n=345	2 < - 5 years n=256	>5 years or never [‡] n=316	≤ 1 year n=1840	1 < - 2 years n=715	2 < - 5 years n=322	>5 years or never [‡] n=221
Age, mean (SD)	56.1 (10.0)	55.3 (10.0)	55.7 (9.6)	51.1 (9.1)	67.8 (9.8)	65.1 (9.1)	65.4 (9.3)	62.5 (8.9)
Education (year), mean (SD)	11.0 (3.3)	11.2 (3.7)	10.9 (3.4)	10.9 (2.8)	12.6 (3.7)	12.7 (3.7)	12.2 (3.9)	12.3 (3.7)
Gender (male), n (%)	339 (41.7)	114 (33.0)	100 (39.1)	159 (50.3)	809 (43.9)	304 (42.5)	174 (54.0)	150 (67.8)
English at home, n (%)	786 (95.6)	329 (95.4)	244 (95.3)	306 (96.8)	1736 (94.4)	681 (95.2)	302 (93.8)	204 (92.3)
Ethnicity, n (%) [‡]								
Oceanian	812 (47.0)	344 (19.9)	256 (14.8)	316 (18.3)	1315 (74.5)	58 (3.3)	230 (13.0)	163 (9.2)
European	2 (66.6%)	1 (33.3%)	0	0	388 (59.2)	157 (24.0)	65 (9.9)	45 (6.9)
Others	0	0	0	0	137 (60.4)	50 (22.0)	27 (11.9)	13 (5.7)
History of AMD	30 (3.69)	6 (1.74)	3 (1.17)	5 (1.58)	133 (7.48)	19 (2.75)	6 (1.93)	1 (0.51)
History of DR	89 (10.93)	8 (2.32)	7 (2.73)	3 (0.95)	34 (1.87)	5 (0.71)	4 (1.27)	0 (0)
History of glaucoma	25 (3.07)	6 (1.74)	2 (0.78)	2 (0.63)	131 (7.30)	9 (1.30)	7 (2.26)	0 (0)
History of cataracts	217 (26.66)	45 (13.04)	38 (14.84)	15 (4.75)	852 (47.12)	181 (26.01)	65 (20.57)	17 (8.46)

†Seven Indigenous participants had missing data for time since last eye examination

‡In the group “>5 years or never”, there were 142 Indigenous participants 49 non-Indigenous participants who reported that they had never had eye examined.

SD: Standard deviation; AMD: Age-related macular degeneration; DR: Diabetic retinopathy

Table 2: Multivariable multinomial logistic regression to examine the associations between recentness of undergoing an eye examination and related risk factors in non-Indigenous and Indigenous Australians

Risk factors	Indigenous (1731)			Non-Indigenous (3098)		
	Time since last eye examination			Time since last examination		
	≤1 year RRR (95% CI)	1 < - 2 years RRR (95% CI)	2 < -5 years RRR (95% CI)	≤1 year RRR (95% CI)	1 < - 2 years RRR (95% CI)	2 < -5 years RRR (95% CI)
Age (year)		1.03 (1.01, 1.06)	1.04 (1.02, 1.06)			
Education (years)	1.05 (1.00, 1.11)	1.06 (1.00, 1.11)		1.08 (1.03, 1.12)	1.06 (1.01, 1.11)	
Gender (male)		0.55 (0.40, 0.77)	0.69 (0.48, 0.97)	0.38 (0.27, 0.52)	0.36 (0.26, 0.50)	0.55 (0.38, 0.79)
Remoteness						
Major City	1	1		1		
Inner Regional	1.22 (0.79, 1.90) NS	1.27 (0.79, 2.06)		0.87 (0.56, 1.35) NS		
Outer Regional	0.53 (0.37, 0.76)	0.55 (0.36, 0.83)		0.63 (0.42, 0.94)		
Remote	0.68 (0.42, 1.10) NS	0.92 (0.53, 1.58)		0.93 (0.56, 1.56) NS		

Very Remote	0.28 (0.15, 0.54)	NS		0.57 (0.30, 1.07) NS		
History of glaucoma or AMD [†]		0.46 (0.23, 0.92)		18.29 (2.50, 133.79)		
History of cataract	4.17 (2.59, 8.57)	1.99 (1.23, 2.72)	2.32 (1.17, 4.62)	8.84 (4.99, 15.66)	3.98 (2.21, 7.18)	2.53 (1.35, 4.78)
History of RE	6.12 (4.07, 9.21)	3.90 (2.51, 6.05)	3.81 (2.40, 6.03)	8.30 (5.72, 12.05)	6.43 (4.38, 9.45)	4.79 (3.16, 7.26)
History of DR	6.35 (1.46, 27.43)					
Self-reported DM	3.04 (2.12, 4.35)	1.82 (1.23, 2.72)		6.08 (2.75, 13.42)	3.23 (1.43, 7.31)	3.44 (1.47, 8.07)

>5 years or never was the referent group

RRR: Relative risk reduction; CI: Confidence Interval DR: Diabetic retinopathy; AMD: Age-related macular degeneration; RE: refractive error; DM: diabetes mellitus

†Glaucoma and AMD were analysed separately for Indigenous participants, but they were combined for non-Indigenous participants due to small sample size

Only statistically significant RRRs are provided except where indicated with NS (non-significant). RRRs are provided for non-significant Remoteness Areas (RA) within a time interval column where at least 1 RA was significantly associated to allow comparisons between groups.

Statistical significance was set at $p < 0.05$ (two-tailed).

Type of eye healthcare service provider most recently visited and associated risk factors

Indigenous participants

Seventy-five percent (1195/1589) of Indigenous participants had seen an optometrist, 14.3% (228/1589) had seen an ophthalmologist, 10.3% (163/1589) reported they had seen one of the 'Other' eye healthcare providers, and 0.1% (3/1589) had missing data.

Indigenous Australians of older age (RRR: 1.03/year) and those with a history of glaucoma or AMD (RRR: 5.56), DR (RRR: 4.05), cataract (RRR: 3.38), or diabetes (RRR: 1.61) were significantly more likely to have visited an ophthalmologist than an optometrist for their most recent eye examination (Table 3). Indigenous males (RRR: 1.58), and those living in Inner Regional (RRR: 17.5), Outer Regional (RRR: 2.83) and Remote (RRR: 2.50) areas were more likely to have seen a healthcare provider that was not an ophthalmologist or optometrist ('Other'), while those in Very Remote areas were likely to have seen either an ophthalmologist (RRR: 2.07) or a provider from the 'Other' category (RRR: 2.52) than an optometrist. Indigenous Australians with a history of refractive were more likely to have seen an optometrist (RRR: 0.67 for ophthalmologist and 0.24 for 'Other').

Non-Indigenous participants

A total of 2461 non-Indigenous Australians (81%) had visited an optometrist, 529 (17.4%) reported that they had visited an ophthalmologist and 59 (1.9%) had visited 'other' types of healthcare providers for their most recent eye examination. Histories of glaucoma or AMD (RRR:4.88), DR (RRR: 6.54) and cataract (RRR: 3.80) were associated with having seen an ophthalmologist rather than an optometrist in non-Indigenous Australians. Conversely, non-English speakers (RRR: 0.46), those with a history of refractive error (RRR: 0.64) and those residing in Inner Regional

(RRR: 0.47) and Outer Regional (RRR: 0.65) areas were less likely to have seen an ophthalmologist than an optometrist. Participants who had their last eye examination more than 5 years ago were more likely to have visited an ophthalmologist (RRR: 1.91). On the other hand, those who had their last eye examination 1-2 years or 2-5 years previously, were less likely to have consulted an ophthalmologist than an optometrist (RRR: 0.46 and 0.55, respectively).

Table 3: Multivariable logistic regression analysis for having seen an optometrist (referent group), ophthalmologist, or other eye healthcare provider in non-Indigenous and Indigenous participants

Risk factors	Indigenous (n=1593)		Non-Indigenous (n=2990)
	Ophthalmologist RRR (95% CI)	Other [†] RRR (95% CI)	Ophthalmologist OR (95% CI)
Age (year)	1.03 (1.01, 1.05)		
Gender (male)		1.58 (1.11, 2.25)	
English-speaking home Remoteness			0.46 (0.29, 0.72)
Major City	1	1	1
Inner Regional	0.64 (0.39, 1.05) NS	1.75 (1.05, 2.90)	0.47 (0.34, 0.65)
Outer Regional	1.24 (0.81, 1.90) NS	2.83 (1.80, 4.47)	0.65 (0.49, 0.88)
Remote	1.26 (0.75, 2.10) NS	2.50 (1.41, 4.42)	1.05 (0.75, 1.47) NS
Very Remote	2.07 (1.02, 4.20)	2.52 (1.16, 5.48)	1.13 (0.75, 1.71) NS
History of glaucoma or AMD	5.56 (2.88, 10.74)		4.88 (3.61, 6.63)
History of DR	4.05 (2.36, 6.94)		6.54 (3.04, 14.08)
History of cataract	3.38 (2.29, 5.00)		3.80 (2.90, 4.97)
History of RE	0.67 (0.48, 0.96)	0.24 (0.15, 0.39)	0.64 (0.51, 0.80)
Self-reported DM	1.61 (1.12, 2.44)		
Time since last exam			
Within 1 year			
1-2 years			0.46 (0.33, 0.63)
2-5 years			0.55 (0.36, 0.85)
>5 years			1.91 (1.21, 3.01)

OR: Odds ratio; RRR: Relative risk reduction

[†]Other includes: GP/local doctor, nurse, health worker, ophthalmic nurse or other. n in each of these categories was too small to provide sufficient statistical power and

were collapsed into 1 group.

Even with all categories collapsed into 'Other', power was too low for the non-Indigenous group, and 'Other' was not included in analysis.

DR: Diabetic retinopathy; AMD: Age-related macular degeneration; RE: refractive error; DM: diabetes mellitus.

Statistical significance was set at $p < 0.05$ (two-tailed).

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DISCUSSION

This paper provides the first nationally representative data on the utilisation of eye health care services by both Indigenous and non-Indigenous Australians across all levels of geographic remoteness. Specifically, we report how recently participants accessed eye health care services, the types of services used, and sociodemographic and clinical factors associated with the utilisation of these services. The results presented in this paper may be beneficial to eye healthcare policy and resource allocation.

The lower prevalence of eye examinations in the Indigenous population compared to the non-Indigenous population is consistent with previous research.^{7, 16, 17} A multitude of factors have resulted in Indigenous Australians using eye healthcare services less frequently than their non-Indigenous counterparts. These include insufficient availability of services in areas with large Indigenous populations (particularly in remote locations),¹⁶ prohibitive distances to the nearest service provider, financial cost,⁷ and importantly, a lack of well-integrated and culturally appropriate Aboriginal Medical Service (AMS)-mediated optometry services.¹⁸ Despite this, the NEHS has revealed a substantial increase, when compared to the National Indigenous Eye Health Survey (NIEHS) conducted in 2008, in both the proportion of Indigenous Australians who had ever received an eye test (92% vs 65%) and the recentness of testing (47% vs 15% within the previous year).⁷ This signifies a noteworthy increase in uptake over the past 7 years, suggesting that programs aimed at improving education, availability and utilisation of services in Indigenous communities are working.¹⁹ However, a considerable proportion of Indigenous Australians, particularly those of older age and those living in non-metropolitan areas, may be at higher risk for undiagnosed eye disease and vision loss due to the infrequency of eye health service utilisation. Since the completion of the NIEHS, the recommended frequency of eye examinations for the general Indigenous population

has increased from biennially to annually as part of a routine health check,¹⁵ and initiatives aimed at increasing culturally-appropriate optometry or ophthalmology services in AMSs may further improve adherence to these guidelines.

More than 80% of non-Indigenous participants had undergone an eye examination in the past two years. This figure was considerably higher than that reported in the Blue Mountains Eye Study (62%) and the Melbourne Visual Impairment Project (VIP) (63%), and was similar to the proportion of participants who had undergone eye examinations (85%) after an extended awareness and education campaign in The Vision Initiative (TVI) study,²⁰ suggesting that considerable improvements in the uptake of eye healthcare services have been made over the past 20 years. It should be noted that potential variations in key sociodemographic variables including cohort age, gender composition, and most obviously, geographic remoteness, between studies necessitates cautious comparisons. Nonetheless, the current study may even have underestimated the proportion of Australians who have undergone eye examinations within the past one to two years, as one of the leading reasons for non-participation was having had a recent eye examination, and the effect of non-response bias cannot be ruled out. Furthermore, relying on self-report to accurately recall when the participant last underwent an eye examination, and to correctly recall the type of eye healthcare service provider consulted, is likely to have introduced the risk of recall bias. Of particular concern are older participants and participants for whom a long time had elapsed since their last examination, as their recall would be likely to be less accurate. Nonetheless, the effect of recall bias on the outcomes measured in this paper cannot be quantified.

In contrast to previous literature, age was not found to be a risk factor for the recentness of use of eye care services in non-Indigenous Australians.⁵ However, older age was associated with a higher likelihood of Indigenous Australians undergoing an eye examination more than one year and less than five years previously, compared to five or more years previously. It should be noted that the

finding that older age did not increase the likelihood that Indigenous Australians underwent an eye examination within the previous year may impact the early detection of disease. Considering the rapid progression of blinding eye diseases in Indigenous Australians, particularly in those of older age, waiting more than 1 year between eye examinations may be sufficient time for some diseases to cause irreversible damage.¹⁷

Men have been found in many studies to have eye examinations less frequently than women.^{5-7, 20-22} Our findings indicate that this continues to be a problem in both Indigenous and non-Indigenous Australians, with men being significantly less likely to have accessed eye health care services. This may be partly explained by women showing greater awareness of their health and therefore a greater predisposition to engage with health services than men.²²

This study revealed that variations in geographic remoteness were associated with differences in the utilisation of eye health care services. Non-Indigenous Australians residing in Outer Regional areas were significantly less likely to have undergone an eye examination within the past year than their Major City counterparts, while Indigenous Australians residing in both Outer Regional and Very Remote regions were significantly less likely to have undergone eye examinations within the past two years than those in Major Cities. Considering that these remoteness strata have been shown to be significantly less equipped than metropolitan areas with optometrists, ophthalmologists and general health services, improvements in service availability and eye health promotion in these regions may improve utilisation rates.^{9,}

¹⁶ The Australian Government's Rural Health Outreach Fund (RHOF) and the Visiting Optometry Service (VOS) provide funding for eye health teams to visit non-metropolitan areas and aim to improve access to eye health services for rural and remote populations. While the RHOF aims to promote cost certainty for Indigenous Australians visiting outreach clinics by advocating for ophthalmologists to bulk-bill all services at Medicare rebate rates, some practitioners continue to charge additional

fees, and this cost uncertainty results in many Indigenous Australians avoiding these services.¹⁹ Increasing funding for the RHOF to meet the population-based needs for service availability, while avoiding the practice of charging gap fees by ophthalmologists in outreach clinics will likely improve utilisation rates in regional and remote areas.

Participants with a self-reported eye condition or diabetes underwent an eye examination more recently than those who did not report these conditions. Most non-Indigenous participants with AMD or glaucoma (86.6%) and most Indigenous Australians with DR (82.4%) underwent an eye examination within the previous year (derived from Table 1). Contrastingly, those with cataract had a greater distribution of times since their last eye examination. The observation that those with less readily treatable or reversible retinal conditions (AMD, glaucoma and DR) or a high risk of irreversible retinal disease (diabetes) are considerably more likely to get their eyes examined at least annually, while those with easily treatable conditions (refractive error and cataract) are likely to get eye examinations as infrequently as every 5 years or more, suggests public awareness of the importance of the annual monitoring of retinal diseases. While this undoubtedly increases the timely treatment and management of these sight-threatening and irreversible conditions, refractive or cataract-related vision loss should not be neglected. In fact, considering the ease with which these conditions can be reversed, and that they account for almost 80% of VI,³ increasing the regularity with which people with these conditions have their eyes examined may drastically reduce the prevalence of VI.²³

Indigenous Australians in Regional and Very Remote areas were between 1.8 and 2.8 times more likely to have had their eyes tested by a local doctor, nurse or technician than by an optometrist. The use of non-optometric services by Indigenous Australians in Regional areas may result from insufficiency in the supply of optometrists in non-metropolitan areas.⁹ While screening by these healthcare providers undoubtedly contributes to early detection and treatment of eye disease, a

significant proportion of Indigenous Australians living in remote regions already suffer from advanced eye disease and may require specialist care.²⁴ Sustainable models that ensure that health workers, particularly in Indigenous communities, are thoroughly educated and trained in detection of disease and appropriate referral are indispensable. It should be noted that those living in Very Remote areas were more likely to have seen an ophthalmologist for their last eye check, suggesting that the recent increase in outreach ophthalmology services may be effectively increasing the utilisation of these services.^{25, 26}

A history of refractive error was associated with a higher likelihood of seeing an optometrist which is consistent with the fact that refractive error services are provided at a primary care level by optometrists.⁹ This reinforces the point that, considering the overwhelming proportion of VI attributable to uncorrected refractive error,²⁷ improvements in the utilisation of optometry services will contribute substantially to tackling vision loss as a public health concern.

Compared with previous population research in Australia, improvements have been made in the frequency of eye examinations in older Australians. However, a significant proportion of those with potentially undiagnosed eye disease are still not undergoing examinations frequently enough. Improving the utilisation of eye healthcare services by risk groups including men, Indigenous Australians, and those living in non-metropolitan areas, as well as implementing strategies to treat refractive error and cataract in a timely manner, will assist in reducing the burden of vision loss in Australia.

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