



# Delivery of Eye and Vision Services in Aboriginal and Torres Strait Islander Primary Healthcare Centers

Anthea M. Burnett<sup>1,2,3\*</sup>, Anna Morse<sup>1,2</sup>, Thomas Naduvilath<sup>1,2</sup>, Andrea Boudville<sup>2,4</sup>, Hugh R. Taylor<sup>2,4</sup> and Ross Bailie<sup>5</sup>

<sup>1</sup>Brien Holden Vision Institute, Public Health, Sydney, NSW, Australia, <sup>2</sup>Vision CRC, Sydney, NSW, Australia, <sup>3</sup>School of Optometry and Vision Science, University of New South Wales, Kensington, NSW, Australia, <sup>4</sup>Indigenous Eye Health, Melbourne School of Population and Global Health, The University of Melbourne, Parkville, VIC, Australia, <sup>5</sup>Menzies School of Health Research, Charles Darwin University, Brisbane, QLD, Australia

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### \*Correspondence:

Anthea M. Burnett  
a.burnett@brienholdenvision.org

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**Background:** Routine eye and vision assessments are vital for the detection and subsequent management of vision loss, which is particularly important for Aboriginal and Torres Strait Islander people who face higher rates of vision loss than other Australians. In order to guide improvements, this paper will describe patterns, variations, and gaps in these eye and vision assessments for Aboriginal and Torres Strait Islander people.

**Methods:** Clinical audits from 124 primary healthcare centers (sample size 15,175) from five Australian states and territories were conducted during 2005–2012. Main outcome measure was adherence to current guidelines for delivery of eye and vision assessments to adults with diabetes, those without a diagnosed major chronic disease and children attending primary healthcare centers.

**Results:** Overall delivery of recommended eye and vision assessments varied widely between health centers. Of the adults with diabetes, 46% had a visual acuity assessment recorded within the previous 12 months (health center range 0–88%) and 33% had a retinal examination recorded (health center range 0–73%). Of the adults with no diagnosed major chronic disease, 31% had a visual acuity assessment recorded within the previous 2 years (health center range 0–86%) and 13% had received an examination for trichiasis (health center range 0–40%). In children, 49% had a record of a vision assessment (health center range 0–97%) and 25% had a record of an examination for trachoma within the previous 12 months (health center range 0–100%).

**Conclusion:** There was considerable range and variation in the recorded delivery of scheduled eye and vision assessments across health centers. Sharing the successful strategies of the better-performing health centers to support focused improvements in key areas of need may increase overall rates of eye examinations, which is important for the timely detection, referral, and treatment of eye conditions affecting Aboriginal and Torres Strait Islander people, especially for those with diabetes.

**Keywords:** Aboriginal and Torres Strait Islander people, primary healthcare centers, delivery of health care, eye care, diabetes, quality of health care, quality indicators

## INTRODUCTION

Aboriginal and Torres Strait Islander Australians experience significantly higher rates of vision impairment than other Australians (1, 2). The largely avoidable, preventable, or treatable nature of the majority (94%) of these cases (2) indicates the need for improved early detection pathways, timely referral, and appropriate and accessible treatment. Additionally, as Aboriginal and Torres Strait Islander adults with diabetes, older than 40 years, form 72% of those requiring an eye examination in any year (3), understanding ways to further improve access and uptake of eye assessments for patients with diabetes is important, given their higher risk of preventable vision loss.

Eye health services for Aboriginal and Torres Strait Islander communities are typically provided by visiting practitioners; even more so in remote or very remote locations (4). However, there is still a shortage of optometric and ophthalmic services in many rural and remote areas (4, 5) and significantly lower rates of eye examinations (by optometrists or ophthalmologists) in areas with higher proportions of Aboriginal and Torres Strait Islander people (4, 6). Current policy recommendations for better Aboriginal and Torres Strait Islander eye care in the “Roadmap to Close the Gap for Vision” place emphasis on primary eye care as part of comprehensive primary health care to address barriers to eye care (7). Similarly, international eye care strategies highlight the key role of primary health care in preventing vision loss and blindness (8).

As primary healthcare (PHC) centers are the frontline of health service delivery, they can often be the first point of contact for Aboriginal and Torres Strait Islander adults with diabetes or vision/eye problems. Hence, PHC centers play a crucial role in eye care (9), especially for patients with diabetes (7). Basic eye and vision screening assessments are conducted during routine health assessments such as the Aboriginal and Torres Strait Islander Health Assessment (10). When linked with distinct eye care referral processes, regular screening can help to identify and refer eye problems earlier, preventing vision loss (11). Primary healthcare practitioners also play a case management role, supporting and coordinating patients’ timely access to comprehensive eye examinations and specialist eye care, particularly for patients with chronic conditions such as diabetes (12). This process can help improve efficiency of eye care service delivery systems by identifying and referring cases needing comprehensive eye care, targeting visiting eye care services to patients who most need them, and detecting vision problems at earlier stages (particularly important in the case of diabetic retinopathy) (13).

To gain insight into primary eye care coverage in Aboriginal and Torres Strait Islander PHC centers and to establish a baseline for comparison with future studies, we undertook an exploratory analysis of datasets from clinical file audits of PHC centers participating in the quality improvement action research project – the Audit and Best practice for Chronic Disease (ABCD) project (14). This study describes patterns, variations, and gaps in eye and vision assessments and associations with geographic location of health center, patient age, gender, and health center attendance. We discuss the implications of the findings with a focus on identifying approaches that will drive improvements in

primary eye care services for Aboriginal and Torres Strait Islander communities.

## MATERIALS AND METHODS

### Study Population and Data Collection

The data presented here were collected as part of a national quality improvement project – the ABCD project (15), between 2005 and 2012. One hundred and twenty-four Aboriginal and Torres Strait Islander PHC centers in five states/territories voluntarily performed annual audits of client medical records and provided de-identified audit data to the ABCD National Research Partnership to investigate variations in quality of care. The audits were conducted by trained members of the project team in conjunction with local PHC center staff using three standardized audit tools and protocols developed by the Menzies School of Health Research. These tools assess: (1) delivery of services to clients with Type 2 diabetes, (2) delivery of preventative health care, and (3) delivery of child health care. For each of these client cohort datasets, the delivery of eye and vision services according to existing best practice guidelines (**Table 1**) was assessed.

For the three client cohorts, the records of Aboriginal and Torres Strait Islander clients who met the following criteria were eligible for audit: (1) Aboriginal and Torres Strait Islander patients with a definite diagnosis of Type 2 diabetes aged 15 years and over, (2) Aboriginal and Torres Strait Islander adults with no diagnosed major chronic disease attending the PHC center, in the prior 24 months from the date of the audit, for an annual well-person’s check, acute care, or a preventative service, and aged between 15 and 64 years, and (3) Aboriginal and Torres Strait Islander children aged 15 years and under. For each of these client cohorts, clients were required to be residents of the community for at least 6 months of 12 months prior to the audit (or in the case of an infant, half the infant’s life) in order to be eligible. A random sample of 30 clinical records for each cohort was audited from participating centers (**Table 2**), where there were fewer than 30 eligible records identified, all eligible records were included. Eye and vision services were assessed as “delivered” if there was a record of the service being delivered within specific periods in line with best practice eye care guidelines.

### Statistical Analysis

Treating individual clients as the unit of analysis, our data had inherent multilevel, dependency structure as eye and vision care data collected at the individual level were clustered within health centers. Multistage logistic regression models were used to examine associations of specific factors (location, age, gender, and attendance), with delivery of eye and vision care services (**Tables 3–5**). The outcomes included eye examination, vision assessment, and examination for trichiasis and trachoma. The year of audit was added as a factor in the model to account for the variation over time. Association with outcomes was described using odds ratio and 95% confidence intervals. Variations in eye or vision assessments between health centers were described using violin plots. Level of statistical significance was set at 5%.

**TABLE 1 | Recommended eye and vision assessments for Aboriginal and Torres Strait Islander Australians.**

Cohort	Service item	Age group	Frequency	Guideline (release date)
Aboriginal and Torres Strait Islander people with diabetes	Record of VA examination	All	Annually	NH&MRC (1997/2008) NACCHO/RACGP (2005/2012)
	Record of a dilated eye examination or retinal photograph	All	Annually	NH&MRC (1997/2008) NACCHO/RACGP (2005/2012)
Aboriginal and Torres Strait Islander adults with no diagnosed major chronic disease	Record of VA examination	Adults >40 years	Two yearly	NACCHO/RACGP (2005/2012) MBS item 715 (2010)
	Record of trichiasis assessment	Adults >40 years	Two yearly	NACCHO/RACGP (2005/2012) MBS item 715 (2010)
Aboriginal and Torres Strait Islander children	Record of eye examination	Children >4 years in NT; all ages in other areas	Annually	MBS item 708 (2006) MBS item 715 (2010) NACCHO/RACGP (2012)
	Record of parental concern around vision; record of vision/VA assessment	≥6 months in NT/QLD; all ages in other areas	Annually	MBS item 708 (2006) MBS item 715 (2010) NACCHO/RACGP (2012)
	Record of trachoma examination <sup>a</sup>	≥4 years in NT; if indicated in other areas	Annually	MBS item 708 (2006) MBS item 715 (2010) NACCHO/RACGP (2005)

VA, visual acuity; NT, the Northern Territory; QLD, Queensland.

NACCHO/RACGP – National guide to a preventive health assessment for Aboriginal and Torres Strait Islander people (16, 17).

NH&MRC – guidelines for the management of diabetic retinopathy (18, 19).

Medicare benefit schedule item 708 – Aboriginal and Torres Strait Islander Child Health Check (MBS item 708) (20).

Medicare benefit schedule item 715 – Medicare Health Assessment for Aboriginal and Torres Strait Islander people (MBS ITEM 715) (21).

<sup>a</sup>Communicable Diseases Network Australia (CDNA) guideline recommends screening by jurisdictional teams.

Analysis was performed using STATA and SPSS (Version 22.0., IBM Corp., Armonk, NY, USA).

Ethics approval was obtained from research ethics committees in each jurisdiction [Human Research Ethics Committee of the Northern Territory Department of Health and Menzies School of Health Research (HREC-EC00153); Central Australian Human Research Ethics Committee (HREC-12-53)]; New South Wales Greater Western Area Health Service Human Research Committee (HREC/11/GWAHS/23); Queensland Human Research Ethics Committee Darling Downs Health Services District (HREC/11/QTDD/47); South Australian Aboriginal Health Research Ethics Committee (04-10-319); Curtin University Human Research Ethics Committee (HR140/2008); Western Australian Country Health Services Research Ethics Committee (2011/27); Western Australia Aboriginal Health Information and Ethics Committee (111-8/05); University of Western Australia Human Research Ethics Committee (RA/4/1/5051).

## RESULTS

The records of 15,175 Aboriginal and Torres Strait Islander clients were audited from 124 participating health centers across various locations (comprising city, regional, and remote jurisdictions) from five Australian states and territories (Table 2). Among the records of adults with diabetes, 46% (3,320/7,320) had a VA assessment recorded and 33% (2,381/7,300) had records of receiving a retinal examination within the previous 12 months. Of the records of the adults with no diagnosed major chronic disease, 31% had a VA assessment recorded within the last 2 years (236/759), while only 13% (380/2,829) of the audited records

had received an examination for trichiasis. From the records of children, 49% (2,415/4,909) had a vision assessment recorded within the past 12 months (guidelines recommend an annual assessment for children aged ≥4 years in NT or ≥3 months in all other areas), 45% (2,085/4,632) had a record of an eye examination and 25% (223/893) had a record of an examination for trachoma (guidelines recommend an annual examination for children aged ≥4 years old in the NT, or if indicated in other states and territories).

There was significant variability in documented delivery of these assessments by state/territory and location (Tables 3–5). Participating PHC centers in New South Wales (NSW), the Northern Territory (NT), and Queensland (QLD) had relatively high recorded VA assessments and retinal examinations for adults with diabetes, while Western Australian (WA) health centers recorded higher rates of trichiasis examinations to adults with no diagnosed major chronic disease. Similarly, variation was observed in delivery between states among the audited child records, with participating PHC centers in NSW and South Australia (SA) delivering the most eye assessments and those in the NT recording the most trachoma examinations for children.

There was considerable variation in delivery of scheduled services to Aboriginal and Torres Strait Islander clients across health centers (Figure 1). The range between health centers for delivery of VA assessments to adults with type 2 diabetes was from 0 to 88%, while the delivery of retinal examinations ranged from 0 to 73%. For adults with no diagnosed major chronic disease, the range of documented delivery of visual acuity assessments was between 0 and 86%, with the range of trichiasis examinations delivered between 0 and 40%. Some centers provided vision and

**TABLE 2 | Characteristics of the three cohorts audited.**

Cohort	Aboriginal and Torres Strait Islander people with diabetes	Aboriginal and Torres Strait Islander adults with no diagnosed major chronic disease	Aboriginal and Torres Strait Islander children
Age group	>15 years	15–64 years	3 months to <15 years
Inclusion criteria	Recorded diagnosis of type 2 diabetes	No diagnosis of chronic disease, not pregnant, or <6 weeks postpartum	No major health anomaly
Audit dates	2005–2012	2005–2012	2007–2012
Health centers included	124	59 <sup>a</sup>	93 <sup>a</sup>
States/territories represented	5	5	5
Files audited	7,323	2,943	4,909
Median age (range)	50 (15–89)	29 (15–69) <sup>b</sup>	2 (0–14)
Gender (% female)	60.6	50.4	49.5
<b>Aboriginal and Torres Strait Islander status (%)</b>			
Aboriginal	94.9	95.6	94.1
Torres Strait Islander	3.8	3.0	2.1
Both	1.3	1.5	3.9
<b>Health centers</b>			
	<b>No. centers (adults, %)</b>	<b>No. centers (adults, %)</b>	<b>No. centers (children, %)</b>
New South Wales	6 (507, 6.9)	4 (211, 7.3)	6 (824, 15.3)
Northern Territory	63 (3,952, 54.0)	33 (1,583, 54.4)	46 (2,303, 42.8)
Queensland	38 (1,615, 22.1)	16 (649, 22.3)	27 (1,313, 24.4)
South Australia	5 (219, 3.0)	4 (250, 8.6)	4 (315, 5.9)
Western Australia	12 (1,026, 14.0)	2 (215, 7.4)	10 (628, 11.7)
<b>Health center locations</b>			
	<b>No. centers (adults, %)</b>	<b>No. centers (adults, %)</b>	<b>No. centers (children, %)</b>
City	8 (322, 4.4)	4 (344, 11.8)	5 (306, 5.7)
Regional town	15 (745, 10.2)	5 (2,477, 9.5)	8 (937, 17.4)
Remote community	64 (4,326, 59.1)	49 (2,265, 77.9)	55 (3,092, 57.4)
Other/unknown	37 (1,926, 26.4)	1 (22, 0.8)	25 (1,048, 19.5)

<sup>a</sup>Not all health centers participated in all three audits.

<sup>b</sup>One participant was aged 68.5 years and was retained in analysis.

**TABLE 3 | Adjusted multilevel logistic regression analysis of patient characteristics and documented delivery of vision and eye health services for Aboriginal and Torres Strait Islander adults with diabetes in participating health centers between June 2005 and August 2012.**

Variable	Aboriginal and Torres Strait Islander adults with type 2 diabetes; 124 health centers; 7,323 patient records			
	Delivery of VA assessment <sup>a</sup>		Delivery of retinal exam <sup>a</sup>	
	% (n)	Odds ratio (95% CI)	% (n)	Odds ratio (95% CI)
<b>State or territory</b>				
NSW	49.3 (509)	1 (Ref)	46.6 (509)	1 (Ref)
NT	49.0 (3,950)	0.95 (0.54, 1.65)	31.1 (3,949)	0.71 (0.42, 1.18)
QLD	45.9 (1,615)	0.78 (0.47, 1.29)	37.0 (1,615)	0.76 (0.46, 1.25)
SA	23.6 (203)	<b>0.16</b> (0.04, 0.57)	8.4 (202)	<b>0.08</b> (0.02, 0.31)
WA	33.6 (1,025)	0.56 (0.31, 1.01)	29.6 (1,025)	<b>0.54</b> (0.38, 0.75)
<b>Age group</b>				
≤20 years	31.7 (60)	1 (Ref)	16.7 (60)	1 (Ref)
21–30 years	36.6 (347)	1.5 (0.8, 2.8)	20.7 (347)	1.28 (0.61, 2.7)
31–40 years	41.6 (1,336)	1.7 (0.95, 3.07)	25.9 (1,336)	1.91 (0.88, 4.14)
41–50 years	42.9 (2,026)	<b>1.97</b> (1.1, 3.52)	30.1 (2,024)	<b>2.45</b> (1.16, 5.15)
51–60 years	49 (1,998)	<b>2.46</b> (1.36, 4.43)	35.8 (1,998)	<b>3.07</b> (1.44, 6.57)
61–70 years	49.8 (1,012)	<b>2.52</b> (1.4, 4.52)	40.9 (1,012)	<b>3.86</b> (1.82, 8.22)
≥71 years	51.1 (519)	<b>2.88</b> (1.66, 5.00)	41.0 (519)	<b>4.41</b> (2.12, 9.21)
<b>Gender</b>				
Male	46.4 (2,877)	1 (Ref)	31.6 (2,877)	1 (Ref)
Female	44.9 (4,423)	0.97 (0.86, 1.1)	33.3 (4,421)	1.08 (0.96, 1.22)
<b>Date last attended</b>				
Within 1 year	46.2 (6,993)	1 (Ref)	33.1 (6,991)	1 (Ref)
Within 1–2 years	8.7 (138)	<b>0.13</b> (0.05, 0.32)	12.3 (138)	<b>0.34</b> (0.17, 0.68)
More than 2 years	5.9 (51)	<b>0.06</b> (0.01, 0.29)	7.8 (51)	<b>0.08</b> (0.02, 0.36)

VA, visual acuity, NSW, New South Wales, NT, Northern Territory, QLD, Queensland, WA, Western Australia, SA, South Australia.

Odds ratios significant at 0.05 level are shown in bold.

<sup>a</sup>Within the previous 12 months.

**TABLE 4 | Adjusted multilevel logistic regression analysis of patient characteristics and documented delivery of vision and eye health services for Aboriginal and Torres Strait Islander adults in participating health centers between June 2005 and August 2012.**

Variable	Aboriginal and Torres Strait Islander adults with no diagnosed major chronic disease; 103 health centers; 2,943 patient records			
	Delivery of VA assessment <sup>a</sup>		Delivery of trichiasis examination <sup>a</sup>	
	% (n)	Odds ratio (95% CI)	% (n)	Odds ratio (95% CI)
<b>State or territory</b>				
NSW	25.4 (71)	1 (Ref)	1.7 (179)	1 (Ref)
NT	24.3 (350)	0.89 (0.34, 2.32)	14.9 (1,559)	8.11 (0.87, 75.42)
QLD	42.8 (222)	1.12 (0.35, 3.55)	12.2 (647)	3.22 (0.25, 41.28)
SA	53.8 (39)	1 (0.12, 8.09)	9.3 (248)	1.45 (0.05, 46.28)
WA	22.1 (77)	0.91 (0.31, 2.66)	21.9 (196)	<b>21.76</b> (2.38, 198.91)
<b>Age group</b>				
≤20 years			11.7 (673)	1 (Ref)
21–30 years			13.5 (864)	1.19 (0.72, 1.97)
31–40 years	21.7 (69)	1 (Ref)	13.8 (602)	1.23 (0.72, 2.11)
41–50 years	27.9 (470)	0.37 (0.11, 1.27)	16.4 (470)	1.57 (0.86, 2.85)
51–60 years	40.1 (187)	0.55 (0.2, 1.48)	10.2 (187)	0.84 (0.23, 3.05)
61–70 years	45.5 (33)	0.91 (0.39, 2.16)	15.2 (33)	1.95 (0.33, 11.43)
≥71 years				
<b>Gender</b>				
Male	33.8 (367)	1 (Ref)	13.9 (1,392)	1 (Ref)
Female	28.6 (392)	0.72 (0.47, 1.11)	12.9 (1,437)	0.91 (0.63, 1.3)
<b>Date last attended</b>				
Within 1 year	32.7 (681)	1 (Ref)	13.6 (2,601)	1 (Ref)
Within 1–2 years	16.7 (78)	<b>0.28</b> (0.14, 0.57)	11.4 (228)	0.72 (0.48, 1.06)

VA, visual acuity; NSW, New South Wales; NT, Northern Territory; QLD, Queensland; WA, Western Australia; SA, South Australia.

Odds ratios significant at 0.05 level are shown in bold.

<sup>a</sup>Within the previous 2 years.

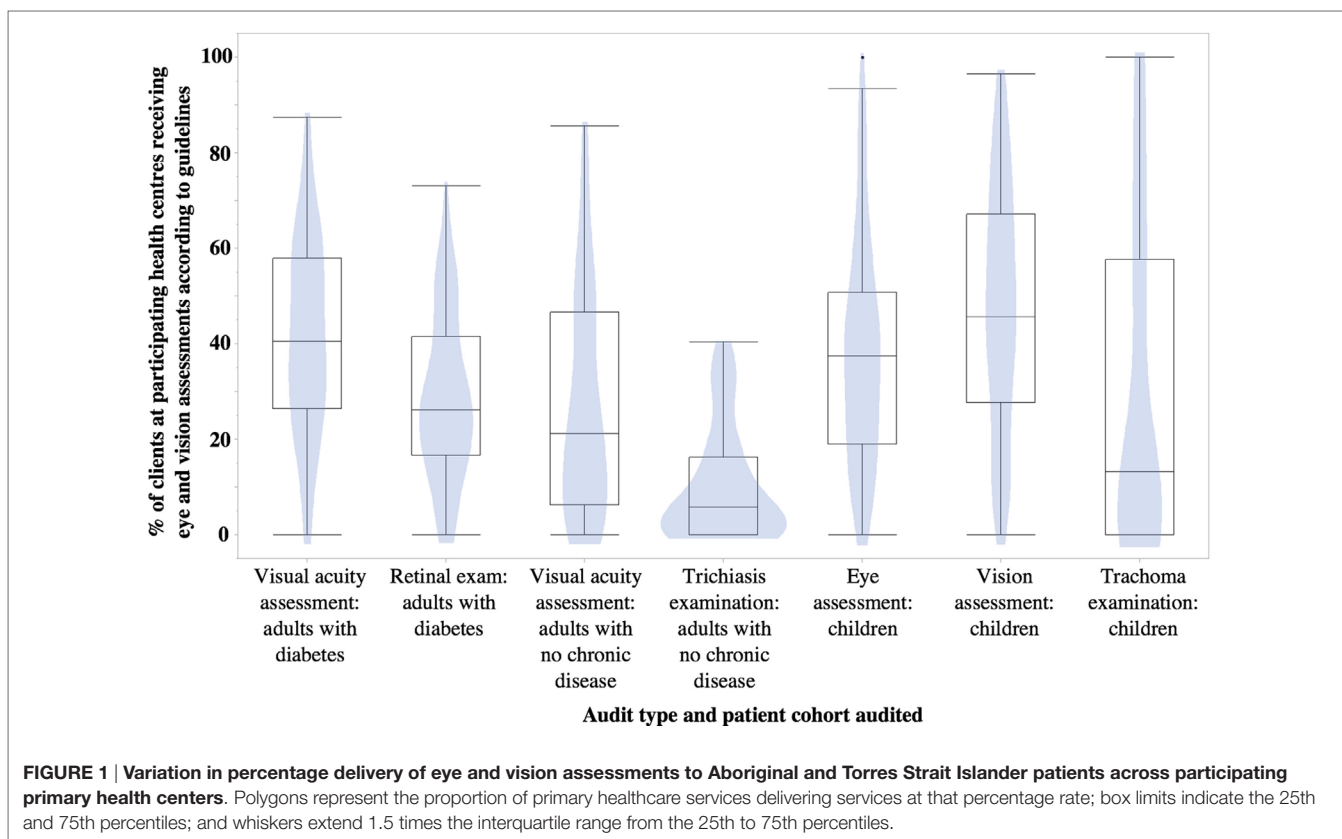
**TABLE 5 | Adjusted multilevel logistic regression analysis of patient characteristics and documented delivery of vision and eye health services for Aboriginal and Torres Strait Islander children in participating health centers between June 2005 and August 2012.**

Variable	Delivery of eye assessment to Aboriginal and Torres Strait Islander children <sup>a</sup>		Delivery of vision assessment to Aboriginal and Torres Strait Islander children <sup>a</sup>		Delivery of trachoma examination to Aboriginal and Torres Strait Islander children <sup>a</sup>	
	% (n)	Odds ratio (95% CI)	% (n)	Odds ratio (95% CI)	% (n)	Odds ratio (95% CI)
	<b>State or territory</b>					
New South Wales	61.5 (824)	1 (Ref)	60.7 (685)	1 (Ref)	0.0 (10)	–
Northern territory	33.2 (1,552)	<b>0.25</b> (0.12, 0.52)	43.0 (2,291)	<b>0.22</b> (0.11, 0.47)	37.8 (558)	29.1 (6.68, 126.6)
Queensland	51.4 (1,313)	<b>0.39</b> (0.19, 0.83)	61.3 (1,305)	<b>0.4</b> (0.19, 0.82)	0.0 (61)	–
South Australia	56.8 (315)	0.67 (0.16, 2.77)			6.5 (170)	4.43 (0.64, 30.7)
Western Australia	33.3 (628)	<b>0.37</b> (0.19, 0.71)	34.1 (628)	<b>0.31</b> (0.15, 0.66)	1.1 (94)	1 (Ref)
<b>Age group</b>						
0–2 years	52.6 (2,409)	1 (Ref)	55.1 (2,789)	1 (Ref)	5.6 (233)	1 (Ref)
3–5 years	37.1 (1,784)	<b>0.51</b> (0.4, 0.65)	44.6 (1,793)	<b>0.65</b> (0.5, 0.84)	35.6 (421)	<b>4.11</b> (2.03, 8.34)
6–8 years	27.4 (157)	<b>0.21</b> (0.11, 0.39)	15 (120)	<b>0.11</b> (0.04, 0.3)	28.4 (88)	<b>5.24</b> (1.6, 17.11)
9–11 years	36.4 (132)	<b>0.31</b> (0.14, 0.72)	16.5 (91)	<b>0.13</b> (0.03, 0.53)	29.6 (71)	<b>4.91</b> (1.9, 12.68)
12–14 years	43.6 (149)	0.45 (0.16, 1.31)	39.1 (115)	<b>0.39</b> (0.15, 0.99)	17.5 (80)	3.26 (0.83, 12.76)
<b>Gender</b>						
Male	43.8 (2,296)	1 (Ref)	48.1 (2,480)	1 (Ref)	24.2 (459)	1 (Ref)
Female	46.2 (2,336)	1.07 (0.94, 1.22)	50.3 (2,429)	1.12 (0.95, 1.31)	25.8 (434)	0.97 (0.69, 1.37)
<b>Date last attended</b>						
Within 1 year	47.1 (4,355)	1 (Ref)	50.9 (4,632)	1 (Ref)		
Within 1–2 years	4.1 (121)	<b>0.01</b> (0, 0.11)	5.8 (121)	<b>0.01</b> (0, 0.1)		
More than 2 years			1.6 (63)	<b>0.02</b> (0, 0.2)		

Odds ratios significant at 0.05 level are shown in bold.

<sup>a</sup>Within the previous 12 months.





eye assessments to 100% of eligible children – the delivery of trachoma and eye examinations to eligible children ranged from 0 to 100%, while the delivery of the vision assessment ranged from 0 to 97%.

Documented delivery of VA and retinal examinations increased with age for adults with diabetes, but not for documented delivery of VA and trichiasis assessments to adults with no major chronic disease (Table 4). There was no variability between genders for adults (Tables 3 and 4) or children (Table 5). Documented eye assessments were significantly more likely for patients who had visited the health center within the previous 12 months.

## DISCUSSION

Our investigation revealed significant variation in the documented delivery of eye and vision assessments to Aboriginal and Torres Strait Islander clients attending PHC centers. While some centers provided excellent levels of assessments, others provided low levels. This variation in performance presents an opportunity for improvement in the documented delivery of these assessments by examining the factors that underlie variation in delivering services, as has previously been conducted in Aboriginal and Torres Strait Islander communities for preventative and diabetes care (22, 23). The successful strategies of the better-performing health centers could then be shared with the under-performing, to inform and support focused improvements in key areas of need.

On average, clients with diabetes were more likely to have a VA assessment recorded (46%) than adults with no diagnosed major chronic disease (31%). This may reflect the stricter adherence to routine screening and regular monitoring for patients with diabetes encouraged by chronic disease management plans. It may also reflect practitioners' knowledge of the risk of increased vision loss for patients with diabetes or patients' reports of issues with their vision. Additionally, patients with greater engagement in their health care may be more likely to engage with eye care services.

In this study, only 33% of Aboriginal and Torres Strait Islander adults with diabetes had a documented retinal examination within the previous 12 months. This is consistent with a previous audit of patient files in the NT, which reported that 34% had a documented fundus examination in the prior 12 months (24). The National Indigenous Eye Health Survey conducted in 2008 also reported low frequencies (20%) of eye examinations for patients with diabetes (self-reported) (2). Understanding ways to further improve access and uptake of eye assessments for patients with diabetes is important, given their higher risk of preventable vision loss. As retinal examinations largely rely on services being provided by visiting or off-site eye practitioners, utilizing retinal photo-screening integrated with primary care, image grading, and reporting systems may increase rates of examinations. This strategy has been shown to improve screening outcomes for other Australians with diabetes (25, 26). As we were unable to determine which centers used retinal imaging in this dataset, we could

not investigate whether retinal imaging influences examinations rates. This may be useful in future audits.

Australia is the only high-income country in the world where trachoma is endemic – trachoma currently occurs in remote and very remote Aboriginal communities in the NT, SA, and WA (27), with pockets of trachoma in Far West NSW and Far North QLD (2). Although trachoma examinations were recorded more frequently for NT children, 60% of children from the NT did not have a trachoma examination recorded, despite guidelines stating that all children aged 4 years or older should be examined for trachoma annually. In the other participating states, less than 10% of children in areas where trachoma was indicated had a recorded trachoma examination. The National Trachoma Surveillance and Reporting Unit (NTSRU) jurisdiction covers communities designated as being at-risk or potentially at-risk of trachoma and has reported trachoma screening rates ranging from 63 to 92% (27). Our results are significantly less than this, and this would seem to reflect the failure to record in the clinical records the trachoma examinations conducted by the jurisdictional trachoma screening programs. Improved coordination between external trachoma screening services and PHC centers will enable PHC centers to continue to make a significant contribution toward closing the gap for vision in Australia (9).

Several limitations should be acknowledged when interpreting these data. First, the data only indicate recorded services provided. Given that some aspects of eye care may be accessed in other off-site settings (e.g., optometry and ophthalmology services), it is probable that the rates of retinal examinations may be higher than recorded in PHC records. Second, as these data are only from the Aboriginal and Torres Strait Islander health centers that agree to have their audit data included in the aggregate for the ABCD project, findings are not necessarily representative of all health centers across Australia. Third, the relatively small numbers, self-selection, and uneven distribution of participating health centers in some states/territories means that the data cannot be regarded as broadly representative for these jurisdictions and hence any comparison between state and territory data should only be considered as representative of the cluster of health services participating from each jurisdiction. The inclusion of the state/territory variables in the multivariate models was primarily to enhance model fit and adjust for state/territory level confounders. Finally, as the timeframe in which the adult audit data was collected (2005–2012) precedes the date (2013) from when adult vision and eye assessments became mandatory within Aboriginal and Torres Strait Islander health assessments (MBS715) (28), it is possible that reporting has since improved. A useful area for future analysis would be to determine whether mandatory inclusion of vision tests in adult health assessments has had a significant impact on rates of recorded eye assessments – these results provide an important baseline from which future improvements could be demonstrated. Furthermore, given that the ABCD program and associated audits exist for the purpose of supporting continuous quality improvement (CQI), another useful area for future study may be to track changes in recorded rates of eye and vision assessments over time.

This study has identified opportunities for PHC centers to increase the documented delivery of eye and vision assessments to Aboriginal and Torres Strait Islander clients. Establishing or strengthening systems for external eye practitioners to report back to PHC practitioners' results from retinal examinations or retinal photograph for people with diabetes may lead to notable improvements and represents a potential "quick win" to increase the rates of recorded retinal examinations. More importantly, it would also offer better patient care and coordination by informing PHC practitioners' of eye care history for the patients they oversee. Similarly, strengthening coordination with external trachoma screening programs may also allow PHC practitioners to better monitor trachoma endemicity in their community.

## CONCLUSION

Routine eye and vision assessments for Aboriginal and Torres Strait Islander adults and children attending PHC centers are currently not being recorded at the recommended levels with considerable variation between health centers. These results can represent a baseline, from which improvements in primary eye and vision assessments for Aboriginal and Torres Strait Islander Australians could be made and monitored.

These results also highlight the value of performing clinical audits to identify aspects of eye care and health centers that are being conducted relatively well, or need improvement. The successful strategies of the better-performing health centers could then be shared with the under-performing, to inform and support focused improvements in key areas of need.

## AUTHOR CONTRIBUTIONS

AB interpreted the data and drafted the manuscript. AM contributed to interpretation of the data, drafting, and critically revised the manuscript. TN analyzed the data and contributed to interpretation. AB, HT, and RB critically reviewed and commented on the project design and on the manuscript. All authors read and approved the final manuscript.

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**Conflict of Interest Statement:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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**Author/s:**

Burnett, AM; Morse, A; Naduvilath, T; Boudville, A; Taylor, HR; Bailie, R

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