

## ORIGINAL ARTICLE-CLINICAL SCIENCE OPEN ACCESS

# Eye Injury Epidemiology in Australia: A 25-Year Systematic Review and Public Health Perspective

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## ABSTRACT

**Background:** Eye injuries are a significant cause of monocular blindness, contributing to individual morbidity and substantial healthcare costs. Despite this burden, eye injury prevention remains underrepresented in Australian public health initiatives. This systematic review (PROSPERO ID: CRD42024551054) aims to provide the first comprehensive nationwide synthesis of eye injury epidemiology in Australia.

**Methods:** Three databases (MEDLINE, Embase, Web of Science) were searched to identify Australian studies on eye injuries from 1 January 2000 to 1 May 2024. Studies were excluded per the following criteria: not in English; did not exclusively evaluate eye injury (e.g., evaluated all causes of blindness); only evaluated outcomes after injury; sample size < 25; conference abstracts, editorials, letters to the editor/other review articles. Critical appraisals of included texts were performed using the Joanna Briggs Institute Checklist for Analytical Cross-Sectional Studies. Results were synthesised using the International Globe and Adnexal Trauma Epidemiology Study (IGATES) as a framework.

**Results:** In total, 30 studies were included, ranging from statewide audits to nationwide surveys. Eye injuries were commonest among young males in occupational settings and older adults experiencing falls at home. Paediatric eye injuries frequently occurred during sport or at home. Rural Australians and First Nations women were disproportionately affected by assault-related injuries, including domestic violence.

**Conclusions:** This review highlights key demographic and contextual risk factors for eye injury in Australia and establishes a robust evidence base to inform targeted, data-driven national prevention strategies. The main limitation of this review is the heterogeneity of included studies, which emphasises the importance of using international, standardised registries such as IGATES.

## 1 | Introduction

Eye injuries are an important cause of avoidable monocular blindness globally and are associated with increased anxiety, depression and death [1, 2]. In Australia, between 2010 and 2015, an average of 10 400 patients were hospitalised annually due to eye injury, costing the healthcare system an estimated

\$1.89 billion Australian dollars [3, 4]. Despite the large burden imposed on patients, families and communities, eye injuries remain an under-recognised and under-resourced area within public health. Up to 90% of eye injuries are preventable through strategies such as health promotion, yet multiple Australian states and territories do not have a centralised eye health promotion body and the need to address this gap is seemingly

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overlooked—for example, the 2022–2026 Western Australia Health Promotion Strategic Framework does not mention eye health at all [5, 6]. Historically, other barriers to improving eye injury prevention have been a lack of funding and a lack of standardised systems for eye injury data collection. In the Australian literature, many studies have evaluated eye injury epidemiology; however, this knowledge has not been synthesised recently. The International Globe and Adnexal Trauma Epidemiology Study (IGATES) provides an excellent template for standardised and comprehensive data collection and analysis [7]. Using IGATES as a framework, this systematic review aims to synthesise the existing literature on Australian eye injury epidemiology and aims to identify demographic risk factors for eye injury (e.g., age, sex, race, rurality), common settings/circumstances (e.g., work, sport, domestic violence) and associated patterns of injury (e.g., open vs. closed globe injury).

## 2 | Methods

A systematic review was conducted in accordance with the Johanna Briggs Institute (JBI) papers on systematic reviews [8–13]. The full review protocol is registered on PROSPERO (ID: CRD42024551054). A search was performed on 2 May 2024 using three databases (MEDLINE, Embase and Web of Science). The included studies evaluated eye injury in all Australians or a subset; evaluated all mechanisms of injury or a subset (e.g., sport-related); and part of/all data collected in included studies were from 1 January 2000 to 1 May 2024. Only recent studies were included to ensure the relevance of this review in informing future eye injury prevention efforts. Excluded studies were in languages other than English; did not exclusively evaluate eye injury (e.g., studies that evaluated all causes of blindness); or only evaluated outcomes after eye injury. Studies with sample size <25; conference abstracts, editorials, letters to the editor and other review articles were also excluded. Search results were compiled into Rayyan, an online systematic review management platform, and independently screened for eligibility by two reviewers (QL, JD), based on titles and abstracts and then full texts [14]. Reference lists of included full texts were then screened for eligible studies, including grey literature, and a third reviewer (AT) was available to resolve any disagreements on eligibility. To ensure the inclusion of only high-quality studies, both reviewers performed independent critical appraisals of included texts using the JBI Checklist for Analytical Cross-Sectional Studies, prior to extracting data using the IGATES framework. Agreement was reached between the two reviewers without the need for arbitration. Data were synthesised descriptively due to heterogeneity and where not reported directly in studies, percentages were calculated for categorical data (e.g., sex, injury type, setting) to facilitate comparison across studies. Studies were grouped thematically; Section 3 begins with a broad comparison of eye injuries in the community/outpatient and hospital (admissions) context, however, subsequently delves into more focussed synthesis of epidemiology of specific injury types (e.g., open globe, assault, burns) and in specific populations and settings (e.g., children, at work). The granular synthesis of disaggregated data and broad scope of our review have allowed a nuanced yet comprehensive overview of eye injury epidemiology in Australia to be presented in the Results section.

## 3 | Results

This review included 30 studies (Figure 1). The quality of included studies was good (Table S2) and no study was excluded due to poor quality. As seen in Table 1, included studies varied greatly in scope and population examined. The majority are retrospective audits of emergency department (ED) or admissions data at the state/territory level, although several larger scale/Australia-wide audits were also included. Data from the studies with the broadest scope are synthesised in Sections 3.1 and 3.2, which provide a holistic overview of eye injury epidemiology in Australia. Sections 3.3, 3.4, and 3.5 report data from studies with a narrower focus on specific populations (e.g., children, rural Australia) and mechanisms of injury (e.g., work-, sport-, burn-related).

### 3.1 | Overview of Eye Injury Epidemiology in Australia

#### 3.1.1 | Eye Injuries in the Australian Community and Outpatient Settings

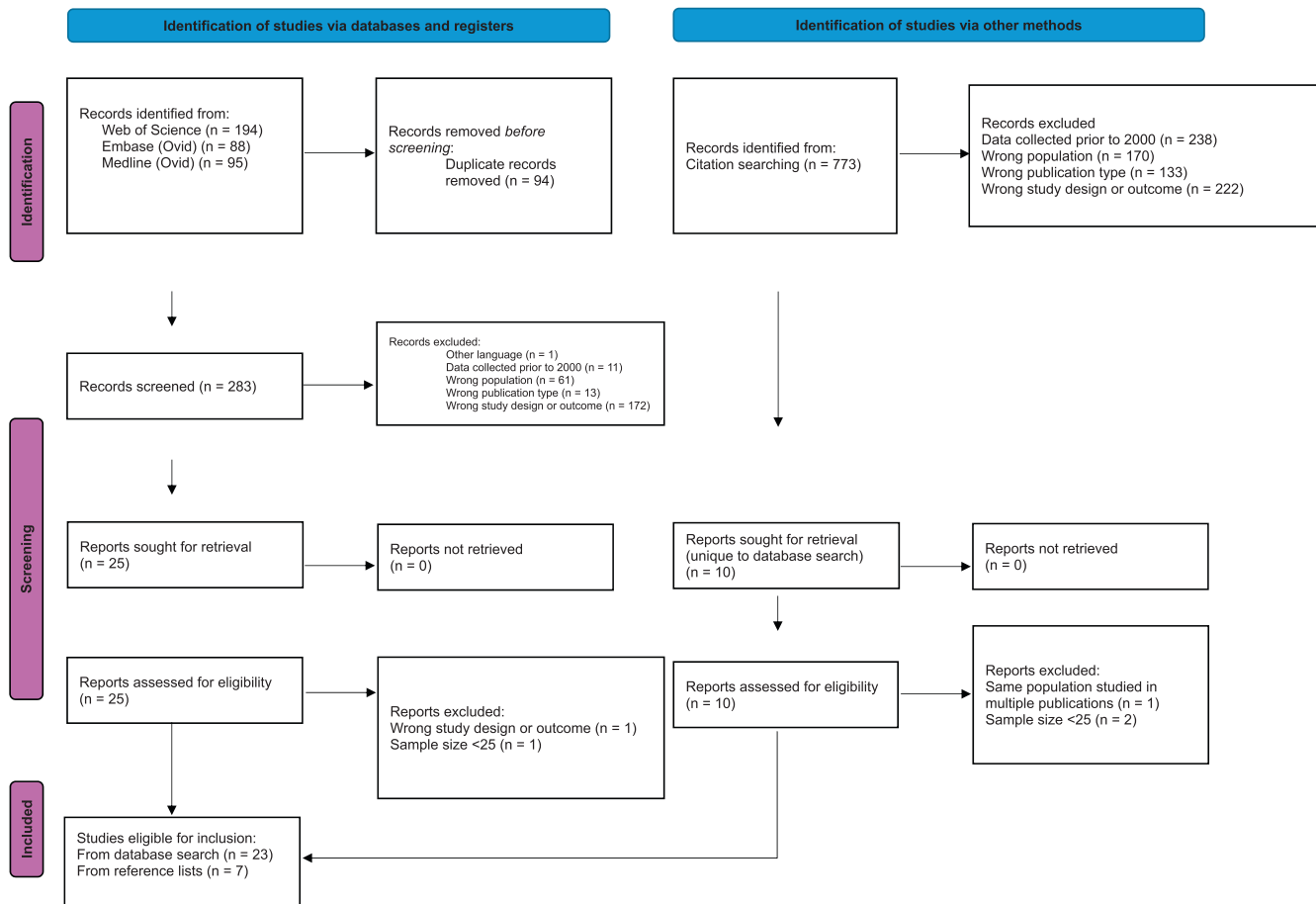
Eye injuries are common; the 2016 Australian National Eye Health Survey (#1) estimated that 2% of non-First Nations people and 4% of First Nations people have vision loss due to eye injury. In an Australia-wide audit (#2), eye injuries accounted for 2% of all general practice (GP) presentations, and an estimated 225 000 GP presentations annually, with 11.4% of cases requiring referral (9.7% to a specialist; 1.7% to ED/hospital). In Victoria, eye injuries accounted for 6% of all ED presentations (#2) and in Western Australia, the estimated incidence of eye injury presenting to ED was 248 per 100 000 person years (#4). Table S3 provides more data; however, in summary, younger males appeared at most risk, and closed globe injuries, particularly superficial foreign bodies, were commonest (#1–5).

#### 3.1.2 | Eye Injury Admissions in Australia

An estimated 4.4% of all injury admissions are eye related (#2). Admission rates for eye injuries presenting through ED varied between 0.8% and 2.7% (#2, 3). As shown in Table 2, the incidence of eye injury admission ranged from 12 to 77 per 100 000 person years; males accounted for 64%–72% of admissions and most admissions were for adnexal injuries (47%–71%), whereas closed globe injuries (CGI) (11%–15%) and open globe injuries (OGI) (5%–11%) were less common (#2–4, 6–7). The age distribution of eye injury admissions was bimodal, with a large peak among working age adults, particularly young men who accounted for 81% of admissions in 20–24-year-olds (#6) and a smaller peak among older adults where in the 65–80+ age range female admissions exceeded male admissions (#2–4, 7). An audit of fall-related eye injuries in older adults (>65 years) confirmed an over-representation of women (57%) and adnexal injuries (84%), although 52% of OGI occurred in men (#8).

#### 3.1.3 | Open Globe Injuries in Australia

A summary of OGI epidemiology in Australia identified that globe ruptures and penetrating eye injuries were the



**FIGURE 1** | PRISMA flowchart for study selection.

commonest (Table 3). Males were over-represented for all OGIs (#9–13). Intraocular foreign bodies and penetrating/perforating eye injuries often occurred in younger males (#11), whereas globe ruptures often occurred in older males, who had prior intraocular surgery (#9, 11). The commonest settings (Table 4) for OGI were work (20%–40%) and home (28%) with males and females over-represented at work and home, respectively (#9–13).

## 3.2 | Settings for Eye Injury in Australia

Based on the “broad scope” studies (#2–4, 6–7) which evaluated all eye injury types across the entire population, the commonest settings for eye injury in Australia were home/residential (15%–37%), streets/highways (9%–31%), work (4%–31%) and sport (3%–26%) (Table 4). Commonest settings for open globe injuries, paediatric injuries, injuries in rural Australia, and burns are discussed in later sections.

### 3.2.1 | Home/Residential Institutions

Falls caused 55%–58% of eye injuries in home/residential settings, with females and older adults (>65 years) accounting for 63%–64% and 59% of these cases, respectively (#3, 7). A focussed audit of fall-related eye injuries in older adults (#8)

confirmed home/residential was the commonest setting (67%) (Table 4). The commonest injury type was adnexal (84%), particularly orbital fractures (70%); however, OGIs were not rare (9%) (Table 2) (#8).

### 3.2.2 | Streets and Highways

As seen in Table 4, up to 31% of eye injuries occurred on streets or highways; direct estimates for transport-related eye injury ranged from 7%–22% (#2–7). Study #7 found that males accounted for 67% of transport-related eye injuries, and 57% of patients were 20–49 years old. Study #3 found that 34% of patients were 25–44 years old; 75% of injuries occurred in traffic, and cars, bicycles, and motorbikes were implicated in 41%, 23%, and 14% of cases, respectively. The commonest injury type was orbital fractures (53%–55%), which were less common in vehicle occupants (46%) and more common in pedestrians (69%); although open eyelid/periorcular wounds were also common, accounting for 27% of injuries (#2–3).

### 3.2.3 | Work

Work-related eye injuries were common in metropolitan Australia (up to 31% of all eye injuries) (#2–7) and rural Australia (23%–46%) (#22–24, 26–27) (Table 4). 88%–97% of work-related

**TABLE 1** | Study characteristics according to category.

First author	Type of audit	Scope	Dataset	Patient location	Years data		Study identifier
					collected	Sample size	
Keel [15]	Retrospective	All	Australian National Eye Health Survey	Australia-wide	2015–2016	133	#1
AIHW [16]	Retrospective	All	GP	Australia-wide	2000–2007	1716	#2a
			ED	VIC	1999–2006	102 538	#2b
			Admissions	Australia-wide	1999–2006	106 306	#2c
Tovell [3]	Retrospective	All	ED	Australia-wide	2013–2015	86 602	#3a
			Admissions	Australia-wide	2010–2015	51 778	#3b
Blaszowska [17]	Retrospective	All	ED	WA	2013–2015	56 239	#4a
			Admissions	WA	2010–2015	6774	#4b
Lee [18]	Retrospective	CGI	ED	NSW	2011–2021	529	#5
Long [4]	Retrospective	All	Admissions	NSW	2000–2005	8485	#6
Raymond1 [19]	Retrospective	All	Admissions	VIC	2001–2005	435	#7
Lee [20]	Retrospective	Falls in older adults	Admissions	VIC	2009–2018	270	#8
Lee [21]	Retrospective	OGI	Admissions	NSW	2008–2018	155	#9
Ho [22]	Retrospective	OGI	Admissions	NSW	2005–2017	104	#10
Beshay [23]	Retrospective	OGI	Admissions	NSW	2010–2015	205	#11
Kong [24]	Retrospective	OGI	Admissions	VIC	2009–2011	263	#12
Rofail [25]	Retrospective	OGI	Admissions	QLD	1992–2003	271	#13
Work- and sport-related eye injuries							
Ramakrishnan [26]	Retrospective	Work	ED	VIC	2009	100	#14
Australian Government [27]	Retrospective	Work	ED	VIC	2002–2004	7299	#15a
			ED	QLD	2002–2004	2144	#15b
			Workers' compensation	QLD/SA/TAS	2002–2004	822	#15c
Ashraf [28]	Retrospective	Sport	Admissions	Australia-wide	2002–2004	1049	#15d
			ED	VIC	2015–2020	1793	#16
Hoskin [29]	Retrospective	Sport/paediatric	Admissions	WA	2002–2013	93	#17

(Continues)

TABLE 1 | (Continued)

First author	Type of audit	Scope	Dataset	Patient location	Years data collected	Sample size	Study identifier
Paediatric eye injuries							
Liu [30]	Retrospective	Paediatric	ED	NSW	2009–2015	295	#18
Kadappu [31]	Retrospective	Paediatric	ED	NSW	2000–2008	203	#19
Franchina [32]	Retrospective	Paediatric	ED	WA	2020	110	#20
Yardley [33]	Retrospective	Paediatric	Admissions	WA	2002–2013	482	#21
Eye injuries in rural Australia							
Northey [34]	Retrospective	Rural	ED	NSW	2011–2012	411	#22a
	Prospective	Rural	ED	NSW	2012	117	#22b
Raymond2 [35]	Retrospective	Rural	ED/clinic	VIC	2004	435	#23
Smith [36]	Retrospective	Rural	Admissions	QLD	1995–2002	226	#24
Dorman [37]	Retrospective	Rural	Admissions	QLD	2014–2018	142	#25
Kennedy [38]	Retrospective	Rural	Admissions	NT	2013–2015	104	#26
Burns-related eye injuries							
Cabalag [39]	Retrospective	Burns (all)	Admissions	VIC	2000–2010	125	#27
Bartimote [40]	Retrospective	Burns (all)	Admissions	NSW	2015–2019	101	#28
Spencer [41]	Retrospective	Burns (thermal)	Admissions	VIC	1990–2000	66	#29
Sher [42]	Prospective	Burns (chemical)	Victorian Poisons Information Centre	VIC	2009–2010	1480	#30

Abbreviations: AIHW, Australian Institute of Health and Welfare; CGI, closed globe injury; ED, emergency department; GP, general practice; NSW, New South Wales; NT, Northern Territory; OGI, open globe injury; QLD, Queensland; SA, South Australia; TAS, Tasmania; VIC, Victoria; WA, Western Australia.

TABLE 2 | Eye injury admissions in Australia.

Study identifier	Incidence (per 100 000 person years)	% Male sex	High risk groups (years)	Type of injury			
				Adnexal	Closed globe injuries	Open globe injuries	Other
#2c	77	68%	20% 20–24, 15% 75+	67% <ul style="list-style-type: none"><li>• 35% periorbital fracture</li><li>• 20% superficial eyelid/periocular injury</li><li>• 12% open eyelid/periocular wound</li></ul>	11% <ul style="list-style-type: none"><li>• 6% SFB</li><li>• 3% abrasion</li><li>• 3% lamellar laceration</li></ul>		2.1% burns (thermal)
#3b	12	66%	M: 51% 15–44, F: 29% 15–44, 42% 65+	71% <ul style="list-style-type: none"><li>• 34% orbital fracture</li><li>• 27% open eyelid/periocular wound</li><li>• 10% superficial eyelid/periocular injury</li></ul>	11% <ul style="list-style-type: none"><li>• 6% SFB</li><li>• 3% abrasion</li><li>• 2% lamellar laceration</li></ul>	5% <ul style="list-style-type: none"><li>• 2% IOFB</li><li>• 2% globe rupture</li><li>• 1% PEI</li></ul>	1.9% burns <ul style="list-style-type: none"><li>• 0.5% thermal</li></ul>
#4b	28–31	66%					
#6	26	72%	M: 20–24 F: 85+	47% <ul style="list-style-type: none"><li>• 23% orbital floor fracture</li><li>• 14% open eyelid/periocular wound</li><li>• 11% superficial eyelid/periocular injury</li></ul>	15% <ul style="list-style-type: none"><li>• 10% SFB</li><li>• 3% abrasion</li><li>• 3% lamellar laceration</li></ul>	11% <ul style="list-style-type: none"><li>• 5% IOFB</li><li>• 4% globe rupture</li><li>• 2% PEI</li></ul>	1.5% burns <ul style="list-style-type: none"><li>• 1.4% chemical</li><li>• 0.1% thermal</li></ul>
#7	54	64%	M: 50% 20–49 F: 50% 60+	54% (all eyelid/periocular)	15% <ul style="list-style-type: none"><li>• 6% SFB</li><li>• 5% abrasion</li><li>• 4% lamellar laceration</li></ul>	10% <ul style="list-style-type: none"><li>• 7% IOFB</li><li>• 3% PEI</li></ul>	5.2% burns <ul style="list-style-type: none"><li>• 2.9% thermal</li><li>• 2.3% chemical</li></ul>
#8 (Falls in older adults)		43%		84% <ul style="list-style-type: none"><li>• 70% orbital fracture</li><li>• 8% retrobulbar haematoma</li><li>• 6% open eyelid wound</li></ul>	3%	9% (unspecified)	

Abbreviations: F, females; IOFB, intraocular foreign body; M, males; PEI, penetrating eye injury; SFB, superficial foreign body.

**TABLE 3** | Open globe injuries in Australia.

Study identifier	% Male sex	Mean age (years)	Type of open globe injury			
			Globe rupture	Penetrating eye injury	Intraocular foreign body	Perforating eye injury
#9	79%	42	<b>45%</b> • Mean age: 53 years • 70% male • 34% prior intraocular surgery	<b>41%</b>	<b>8%</b>	<b>6%</b>
#10		43	<b>23%</b>	<b>61%</b>	<b>16%</b>	<b>0%</b>
#11	80%	46	<b>39%</b> • Mean age: 60 years • 65% male • 60% prior intraocular surgery	<b>35%</b> • Mean age: 39 years • 85% male • 7% prior intraocular surgery	<b>23%</b> • Mean age: 36 years • 94% male • 7% prior intraocular surgery	<b>3%</b> • Mean age: 34 years • 100% male • 17% prior intraocular surgery
#12	83%	45	<b>31%</b>	<b>68%</b>	<b>16%<sup>a</sup></b>	<b>1%</b>
#13	83%	38			<b>12%</b>	

<sup>a</sup>Total exceeds 100% as intraocular foreign body and other injury types not treated as mutually exclusive (contrary to convention).

eye injuries affected men and 64%–78% affected young adults between 20 and 44 years old (#5–6, 14–15) (Table 5). Superficial foreign bodies were the commonest (#5, 6, 14, 15, 22); although of note, 20%–40% of OGIs (#9–13) and 18%–43% of eye burns (#23, 28, 30) occurred at work (Table 4). “Industrial/Construction” and “Trade/Service” were the commonest sectors for work-related eye injury (#2, 5–7, 9, 15, 23, 30).

### 3.2.4 | Sport

Between 3% and 26% of eye injuries in Australia were due to sport (Table 4). As shown in Table 6, children and younger adults were overrepresented, as were males, who accounted for 77%–92% of sports-related eye injuries (#2–7, 9, 12, 17–19, 21–23, 25). The commonest causes of sport-related eye injury were projectiles (22%–54%), equipment (6%–46%), and body contact (18%–28%) (#7, 16, 17, 21).

## 3.3 | Eye Injuries in Specific Populations

### 3.3.1 | Paediatric Eye Injuries in Australia

Over half (48%–62%) of paediatric eye injuries in Australia occurred at home. Paediatric eye injuries also commonly occurred outdoors (20%–29%), where sport was the leading cause (11%–24%), and at school/daycare (7%–12%) (#17–21, 25). Transport- and work-related eye injuries were rare in children. Table 7 shows that the common mechanisms for paediatric eye injury were ‘struck/poked’ (27%–45%), ‘projectile’ (21%–36%) and ‘fell/ran into object’ (8%–16%). Frequently implicated objects were

sport/play equipment, toys and sharp objects (#17–19, 21). Falls commonly caused adnexal injury, whereas sharp objects caused up to 53% of OGIs which were mostly penetrating in nature, involved young children (3–6 years), and another child in 33% of cases (#17–19, 21). Children appeared at higher risk of eye injury during the afternoon/evening and on weekends (#17, 19, 21).

### 3.3.2 | Eye Injuries in Rural Australia and First Nations People

Table 8 shows the increased incidence of eye injury presenting to ED in rural Australia (258–950 per 100 000 person years) (#22, 23). Admission rates varied from 1.4%–6.8% (#22, 23) and the incidence of admission was up to 221 per 100 000 person years in very remote areas (Modified Monash) (#2). First Nations people were overrepresented in rural eye injury admissions and accounted for 33%–41% of cases (up to 79% in a remote setting) (#24–26). Children accounted for 20%–24% of rural eye injury admissions, and 45% of paediatric cases were in First Nations children (#24, 25). Rurally, work-related injuries were more common (10%–46%) and transport-related injuries were less common (1%–3%) than in metropolitan settings (Table 4) (#22–24, 26). Compared to metropolitan settings, burns were more common, accounting for 9%–17% of ED eye presentations (#22, 23) and OGIs were more often penetrating in nature (#23–25). 44% of rural patients and 72% of First Nations patients with eye injury lived more than 100 km from a tertiary hospital (#26) and rural patients travelled a mean distance of 224 km and endured a mean delay of 38 h until ophthalmology review (#25). 22%–28% of rural patients with eye injury required plane transfer (#24, 25).

TABLE 4 | Settings for eye injury in Australia.

Study identifier	Scope	Setting of eye injury				
		Home/residential	Street/highway	Sport/leisure	Work	Other
Eye injuries presenting to ED						
#2b	All	—	—	26% sport/leisure	31% work	• 43% other/unspecified
#5	CGI	32% home	17% street/highway • 12% traffic accident	16% sport/recreation	16% work	• 14% public building • 4% correctional centre • 1% school
Eye injury admissions						
#2c	All	24% home/residential	17% street/highway	3% sport	9% work	• 42% other/unspecified • 5% school/public administration/institution
#3b	All	—	—	12% sport/leisure	10% work	• 78% other/unspecified
#4b	All	15% home	—	4% sport	4% industrial/construction	• 77% other/unspecified
#6	All	21% home/residential	9% street/highway	5% sport	9% work	• 51% other/unspecified • 4% school/public administration
#7	All	37% home/residential	31% 'path'	4% sport	22% work	• 5% other/unspecified • 1% school
#8	Falls in older adults	67% home/residential	—	—	—	• 28% 'outdoor' • 5% hospital
Open globe injury admissions						
#9	OGI	28% home • 40% for females, 4% for males	8% street/highway • 6% MVA	17% sport/recreation	36% work	• 8% public building • 2% school • 2% correctional centre
#10	OGI	—	7% MVA	—	20% work	• 73% other/unspecified
#11	OGI	—	2% transport accident	—	31% work	• 67% other/unspecified
#12	OGI	—	—	4% sport	40% work	• 47% other/unspecified • 9% gardening
#13	OGI	—	9% MVA	—	32% work	• 59% other/unspecified
Paediatric eye injuries						

(Continues)

TABLE 4 | (Continued)

Study identifier	Scope	Setting of eye injury			
		Home/residential	Street/highway	Sport/leisure	Work
#17	Paediatric/sport (Admissions)	<i>Did not examine other settings for injury</i>		19% sport/leisure	<i>Did not examine other settings for injury</i>
#18	Paediatric (ED)	—	4% MVA	13% sport equipment	• <b>83% other/unspecified</b>
#19	Paediatric (ED)	48% home	1% footpath/driveway	11% sport	• <b>26% other/unspecified</b> • 12% school • 9% park/playground
#21	Paediatric (Admissions)	52% home	—	20% sport	• <b>10% other/unspecified</b> • 9% school/daycare
#25	Paediatric/rural (Admissions)	62% home	—	24% sport	• <b>7% other/unspecified</b> • 7% school
Eye injuries in rural Australia					
#22a	Rural (ED)	—	—	3% sport	• <b>57% other/unspecified</b>
#22b	Rural (ED)	—	—	8% sport	• <b>46% other/unspecified</b>
#23	Rural (ED)	36% home	1% street/highway/road	12% sport/leisure	• <b>25% other/unspecified</b> • 3% school
#24	Rural (Admissions)	20% home	—	—	• <b>68% other/unspecified</b>
#26	Rural (Admissions)	—	3% MVA	—	• <b>76% other/unspecified</b> • 11% animal
Burn-related eye injuries					
#27	Burns (all)	—	—	—	• <b>98% other/unspecified</b> • 2% fireworks
#28	Burns (all)	48% home • 22% cleaning • 13% cooking • 13% household maintenance	5% MVA	26% work	• 10% campfire • 4% hand sanitiser • 3% nature • 2% fireworks
#29	Burns (thermal)	—	5% MVA	—	• <b>95% other/unspecified</b>

(Continues)

TABLE 4 | (Continued)

Study identifier	Scope	Setting of eye injury			
		Home/residential	Street/highway	Sport/leisure	Work
#30	Burns (chemical)	58% home <ul style="list-style-type: none"> <li>• 33% cleaning agents</li> <li>• 25% personal products</li> </ul>			18% work
#23 <sup>a</sup>	Burns (chemical)	43% home			43% work
					<ul style="list-style-type: none"> <li>• 20% miscellaneous</li> <li>• 4% petrol products</li> </ul>
					<ul style="list-style-type: none"> <li>• 14% other/unspecified</li> </ul>

Abbreviations: CGI, closed globe injury; ED, emergency department; MVA, motor vehicle accident; OGI, open globe injury.  
<sup>a</sup>Data on chemical burns extracted from this study.

3.4 | Eye Injuries From Assault and Self-Harm

Assault caused 12%–27% of eye injury admissions across Australia (#2–4, 6, 7), and this proportion rose to 32%–54% in rural settings (#25–26) and 48%–76% in First Nations patients (#2, 3, 24–26) (Table 9). Most assault-related eye injuries occurred in younger males (15–59 years old) (#3–5, #11) although of note, assault caused 70%–76% of eye injuries in First Nations females (#2, 24). Females were vulnerable to assault in the home (#3, 5, and 25) where the perpetrator was specified in 75% of cases (mostly spouse or domestic partner) (#3). Males were at risk of assault in public (#3, and 5) where the perpetrator was specified in only 40% of cases (usually ‘multiple unknown people’) (#3). Alcohol and/or other drugs were implicated in 33%–76% of assault-related eye injuries (#5, 10, 11, 22, 24, and 25).

Adnexal injuries were most common (39%–51% periorbital fracture) (#2, 3); although 8%–14% of all OGIs were assault-related (#10–13). 64%–74% of assaults were inflicted through bodily force, with the remainder caused by inanimate objects, usually blunt (#2, 3, 25). Assault in paediatric eye injuries was only commented on in study #25, with 17% of cases due to assault. Across all studies, 0.1%–1.4% of all eye injuries were self-inflicted (#2–7, 20, 25) with between 2% and 7% of OGIs self-inflicted (#12, 13).

3.5 | Burns-Related Eye Injuries

Burns caused up to 8% of eye injuries presenting to ED (Table S3) (#4) and up to 5% of eye injury admissions in Australia (Table 2) (# 7). A higher proportion of burn-related eye injuries were seen rurally (9%–17% of ED presentations) (Table 8) (#22, 23) and in work settings (9%–19%) (Table 5) (#15). Most burn-related eye injuries occurred at home (43%–58%) or work (18%–43%) (Table 4) (#23, 28, 30). Table 10 shows that overall, most burns affected males (#27, 28). However, chemical burn-related eye injuries showed a more uniform sex distribution, with cleaning and personal care products often implicated, and with children being especially vulnerable (Table 10) (#23, 30). Separate studies found that 33% of burn-related eye injuries were bilateral (#28) and 89% of eyelid burns, specifically, were bilateral (#27). Thermal burns caused diffuse injury, extending beyond the periocular region in 100% of cases in Study #28 (c.f. 2% for chemical burns). Chemical burns were more likely to involve the globe (100% c.f. 72% for thermal burns) (#28); however, for both chemical and thermal burns, concurrent adnexal and globe injury was common (Table 10).

4 | Discussion

This comprehensive review exhibits that women and children are at high risk of eye injury at home, whereas work-, sport- and transport-related eye injuries affect young males in Australia. This is the first systematic review of eye injury epidemiology in Australia. The Global Burden of Disease Study 2019 previously showed Australasia to have the highest age-standardised incidence and years lived with disability for eye injury [43]. Despite this burden, there is a lack of centralised eye health promotion

**TABLE 5** | Work-related eye injuries in Australia.

Study identifier	Scope	% Male sex	High risk groups (years)	Commonest injuries by type	Type of work				% Eye protection	Other findings
					Industrial/construction	Trade/service	Farming/agriculture	Cause of injury		
Community/outpatient setting										
#5	ED (CGI)	89%		100% SFB	89%	—	11%		11%	
#14	ED (SFB)	97%						95% machinery • 88% grinding (metal) • 4% welding	45% • Patients with prior FB: 48%	
#15a	ED	92%	78% 20–44	64% SFB	23%	66% • 4% healthcare	—	35% strike/collision 20% machinery	15% • Grinding: 40% • Welding: 23%	9% burns • 8% thermal • 1% chemical
#15b	ED				53% • 21% manufacturing • 19% construction • 13% mining	—	—		26% • Grinding: 35% • Welding: 35%	
#15c	Workers' compensation	88%	70% 20–44		50% • 38% manufacturing • 12% construction	11% (trade—retail or wholesale)	8% (agriculture, forestry, fishing)	4% strike/collision	18% • Grinding: 29% • Welding: 14%	11% burns • 8% chemical • 3% thermal
#22a	ED (rural)			16% SFB				36% machinery • 22% grinding • 6% welding 20% strike	28% • Grinding: 54%	

(Continues)

TABLE 5 | (Continued)

Study identifier	Scope	% Male sex	High risk groups (years)	Commonest injuries by type	Type of work			Cause of injury	% Eye protection	Other findings
					Industrial/construction	Trade/service	Farming/agriculture			
#22b	ED (rural)			7% SFB				40% machinery • 27% grinding • 4% welding • 20% strike	39% • Grinding: 55%	
#23	ED (rural)				73%	—	27%			
#30	Victoria Poisons Information Centre (Chemical burns)				67%	—	33% (herbicide, pesticide)			
Admissions										
#2c	All				25%	63%	11%			
#6	All	92%	64% 20–44	25% SFB	35%	59%	7%	24% strike		
#7	All				10%	84% • 44% healthcare • 41% trade	6%			
#9	OGI				80%	—	20%		11%	
#15d	All	93%	69% 20–44	37% CGI (30% SFB) 17% OGI 17% adnexal	32%	14%	6%	18% strike/collision 5% machinery		19% burns • 17% chemical • 2% thermal

Note: 'Machinery' includes but is not limited to grinding, welding, cutting, piercing, drilling, hammering, sawing and sanding. Abbreviations: CGI, closed globe injury; ED, emergency department; OGI, open globe injury; SFB, superficial foreign body.

**TABLE 6** | Sport-related eye injuries in Australia.

Study identifier	Scope	% Male sex	High risk groups (years)	Commonest injuries by type	Commonest sports	Cause of injury
#5	ED (CGI)	92%			Cricket, badminton, soccer	
#16	ED	80%	<ul style="list-style-type: none"> <li>• 5% 0–9</li> <li>• 27% 10–19</li> <li>• 27% 20–29</li> <li>• 19% 30–39</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Orbital blowout fracture</b> (skiing, hockey, cricket)</li> <li>• <b>Hyphaema</b> (squash, badminton, cricket)</li> <li>• <b>Globe rupture</b> (martial arts, golf)</li> </ul>	64% ball sports <sup>a</sup>	<ul style="list-style-type: none"> <li>• 54% projectile</li> <li>• 28% body part</li> <li>• 6% equipment</li> </ul>
#2c	Admissions		<ul style="list-style-type: none"> <li>• 54% 15–29</li> </ul>			
#3b	Admissions		<ul style="list-style-type: none"> <li>• 19% 5–15</li> <li>• 32% 15–25</li> <li>• 33% 25–44</li> </ul>			
#7	Admissions					<ul style="list-style-type: none"> <li>• 46% equipment</li> </ul>
#17	Admissions (Paediatric)	77%	Mean age • OGI: 6 • CGI: 14 • Adnexal: 8	<ul style="list-style-type: none"> <li>• <b>72% adnexal</b> (29% orbital fracture, 26% lid laceration)</li> <li>• <b>18% CGI</b></li> <li>• <b>7% OGI</b></li> </ul>	22% cycling/scooter/motocross	<ul style="list-style-type: none"> <li>• 28% equipment</li> <li>• 22% projectile (ball)</li> <li>• 18% body part</li> </ul>
#21	Admissions (Paediatric)					<ul style="list-style-type: none"> <li>• 45% equipment</li> </ul>

Abbreviations: CGI, closed globe injury; ED, emergency department; OGI, open globe injury.

<sup>a</sup>Soccer, Australian rules football, basketball, tennis, cricket.

in Australia, which is likely perpetuating disparities for vulnerable demographics, contravening the United Nations Sustainable Development Goal 3 [44–46]. We hope that this review can draw attention to the large, yet under-recognised burden that eye injuries pose on all Australians of varying age, sex, race, location and occupation. The inclusion of only high-quality studies in this review ensures that the findings may be used to form a strong evidence base to design future, targeted eye injury prevention campaigns. This may empower efforts to reduce personal and financial morbidity for Australian individuals and society and rectify a chronically under-resourced public health issue. The following section highlights several target areas for intervention.

## 4.1 | Key Targets for Eye Injury Prevention

### 4.1.1 | Eye Injuries at Home—The Old and the Young

In Australia, 15%–37% of eye injuries occur at home, although in children, this proportion rises to 48%–62%. For adults, falls are the leading cause, and females over 65 years are at greatest risk. Older adults with falls-related eye injury have an admission rate

of 96%, a blindness rate of 10%, and a mortality rate of 5%, even after timely management [20]. This highlights the importance of promoting routine fall risk assessments in an ageing Australian population [47]. For children, sharp objects, toys, and play equipment commonly cause eye injury, and cleaning/personal products often cause chemical burns. Storing away dangerous items and supervising children during playtime may minimise preventable injury. Health promotion to parents and caregivers is crucial in disseminating this knowledge [5].

### 4.1.2 | Work-Related Eye Injuries

Superficial foreign bodies are the commonest work-related eye injury; although eye protection is universally recommended for grinding and welding, compliance to recommendations is low, including in patients with prior foreign body [26, 27]. Patients may lack the awareness that eye protection is important to prevent superficial foreign bodies and more serious injuries (e.g., OGIs, burns). Other barriers to the use of eye protection include concerns related to price, style, comfort, visibility, and convenience [6]. Overcoming these barriers is crucial to reduce the burden of work-related eye injuries.

TABLE 7 | Paediatric eye injuries in Australia.

Study identifier	% Male sex	High risk groups (years)	Commonest injuries by type			Cause of injury			Other findings
			Adnexal	Closed globe injuries	Open globe injuries	Mechanism	Object	Timing	
ED									
#18	72%	OGI: 3–5 CGI: 12–14	N/A <sup>a</sup>	68%	32% <ul style="list-style-type: none"><li>• 24% PEI</li><li>• 2% globe rupture</li><li>• 1% IOFB</li><li>• 0.3% perforating eye injury</li></ul>	<ul style="list-style-type: none"><li>• 36% projectile</li><li>• 28% struck</li><li>• 16% fell/ran into object</li></ul>	<ul style="list-style-type: none"><li>• Sport equipment</li><li>• Toy</li><li>• Sharp object<sup>b</sup></li></ul>	<ul style="list-style-type: none"><li>• No association with day of week/season/holidays</li></ul>	3% burns (chemical)
#19	78%	OGI: 3–5 CGI: 9–11	N/A <sup>a</sup>	60% <ul style="list-style-type: none"><li>• 48% contusion (44% hyphaema)</li><li>• 12% lamellar laceration</li></ul>	40% <ul style="list-style-type: none"><li>• 33% PEI</li><li>• 4% globe rupture</li><li>• 1% IOFB</li><li>• 0.5% perforating eye injury</li></ul>	<ul style="list-style-type: none"><li>• 45% struck/poked</li><li>• 21% projectile</li><li>• 8% fell/ran into object</li></ul>	<ul style="list-style-type: none"><li>• 37% sharp object<sup>b</sup></li><li>• 11% ball</li><li>• 8% toy/play equipment</li></ul>	<ul style="list-style-type: none"><li>• 35% 3 pm–6 pm</li><li>• 35% weekends</li><li>• No association with season</li></ul>	
#20	68%		35%	64%	1%				
Admissions									
#17	77%	Mean age: <ul style="list-style-type: none"><li>• OGI: 6</li><li>• CGI: 14</li><li>• Adnexal: 8</li></ul>	72% <ul style="list-style-type: none"><li>• 29% orbital fracture</li><li>• 26% lid laceration</li></ul>	18%	7%		<ul style="list-style-type: none"><li>• 28% sport equipment</li><li>• 22% ball</li><li>• 18% body part</li></ul>	<ul style="list-style-type: none"><li>• Injury 2× more likely on weekends</li><li>• 57% spring and summer</li></ul>	
#21	72%		47% <ul style="list-style-type: none"><li>• 30% lid laceration</li><li>• 10% orbital fracture</li></ul>	38% <ul style="list-style-type: none"><li>• 21% contusion</li><li>• 11% SFB/abrasion</li><li>• 2% lamellar laceration</li></ul>	15% <ul style="list-style-type: none"><li>• 13% PEI</li><li>• 1% IOFB</li><li>• 0.4% globe rupture</li><li>• 0.2% perforating eye injury</li></ul>	<ul style="list-style-type: none"><li>• 27% struck</li><li>• 26% projectile</li></ul>		<ul style="list-style-type: none"><li>• 70% afternoon/evening</li><li>• More injuries on weekends</li><li>• No association with season</li></ul>	4% burns (all CGI)
Admissions (rural)									
#25	69%								

Abbreviations: CGI, closed globe injury; ED, emergency department; IOFB, intraocular foreign body; OGI, open globe injury; PEI, penetrating eye injury; SFB, superficial foreign body.

<sup>a</sup>Excluded injuries to only adnexa.<sup>b</sup>Sharp objects = sticks, stationery, kitchen items (knives etc.), metal.

**TABLE 8** | Eye injuries in rural Australia and First Nations people.

Study identifier	Rural Australia				First Nations		
	Commonest injuries by type				Incidence (per 100 000 person years)	% Male sex	Percentage of sample (c.f. population prevalence)
	Incidence (per 100 000 person years)	% Male sex	Adnexal	Closed globe injuries	Open globe injuries	Other findings	
ED							
#22a	258 (M), 449 (F)	78%				10% burns (chemical)	
#22b	334 (M), 537 (F)	90%				9% burns (chemical)	
#23	950	83%	7% • 5% eyelid/periorbital contusion • 2% eyelid laceration • 0.2% orbital blowout fracture	76% • 49% SFB • 16% abrasion • 5% contusion • 3% lamellar laceration	0.2% (all IOFB)	17% burns • 10% chemical • 7% flash	
Admissions							
#2c	221 (very remote)					281 (M), 193 (F)	
#3b						199 (25- to 44-year-olds)	
#4b						109	
#7	122 (remote), 63 (outer regional)						
#24	12 <sup>a</sup>	77%	N/A <sup>b</sup>	69% • 43% contusion • 10% lamellar laceration • 2% SFB • 14% 'mixed'	31% • 23% PEI • 4% globe rupture • 3% IOFB • 1% perforating eye injury • 1% 'mixed'		38% (c.f. 12%) • 79% in Cape York (remote)
#25	10 <sup>a</sup>	79%	N/A <sup>b</sup>	65% • 51% contusion • 8% lamellar laceration • 6% 'mixed'	34% • 15% PEI • 9% globe rupture • 7% IOFB • 3% perforating eye injury	23	33% (c.f. 15%) • 45% in children
#26		66%	N/A <sup>b</sup>	81%	19%	60%	41% (c.f. 27%)

Abbreviations: CGI, closed globe injury; ED, emergency department; F, females; IOFB, intraocular foreign body; M, males; OGI, open globe injury; PEI, penetrating eye injury; SFB, superficial foreign body.

<sup>a</sup>Included metropolitan and rural patients.

<sup>b</sup>Excluded injuries to only adnexa.

TABLE 9 | Eye injuries from assault and self-harm.

Study identifier	Scope	Assault-related eye injuries					Self-inflicted eye injuries
		Prevalence		Intoxication	Common settings	Commonest mechanisms	
		General population	First Nations				
ED/community setting							
#1	All	6%					
#2b	All	2%					
#5	CGI	26%		59%	M: 44% public, 14% home F: 57% home		1.3%
#20	Paediatric						0.9%
#22a	Rural	4%					
#22b	Rural	8%		57%			
#23	Rural	3%					
Admissions							
#2c	All	27% (M), 15% (F)	48% (M), 70% (F)			• 64% body part • 13% object (blunt)	0.6% (M), 0.8% (F) • 29% chemical burns
#3b	All	23%	61%		M: public F: home	• 74% body part • 12% object (blunt) • 4% object (sharp)	0.2%
#4b	All	24%					0.8%
#6	All	27%					0.1%
#7	All	27% (M), 12% (F)					0.4%
#24	Rural		70% (M), 76% (F)	76%			
#25	Rural	32%	57%	76%	58% domestic violence	• 64% body part • 36% object	1.4%
#26	Rural	54%	74%				
Open globe injuries							
#10	OGI	14%		33%			
#11	OGI	10%		55%			
#12	OGI	8%					7%
#13	OGI	14%					2% (all gun/nail gun)

(Continues)

TABLE 9 | (Continued)

Assault-related eye injuries						Self-inflicted eye injuries	
Study identifier	Scope	Prevalence		Intoxication	Common settings		Commonest mechanisms
		General population	First Nations				
Work-related							
#15c	Work-related	2%					
#15d	Work-related	5%					
Burns							
#27	Burns (all)	2%				7%	
#28	Burns (all)	2%					
#29	Burns (thermal)	0%				18% (all self-immolation)	
Abbreviations: CGI, closed globe injury; ED, emergency department; F, females; M, males; OGI, open globe injury.							

Abbreviations: CGI, closed globe injury; ED, emergency department; F, females; M, males; OGI, open globe injury.

### 4.1.3 | Sport-Related Eye Injuries

Efforts to prevent sport-related eye injury in Australia should target children and younger adults, particularly males. Projectiles, equipment, and body contact are the commonest mechanisms. Protective eyewear is crucial to minimise injury from projectiles (e.g., during squash), particularly for less experienced players and children who may have poorer reflexes, coordination, and risk-detection ability, and avoidance of contact/high-risk sports altogether (e.g., martial arts) is recommended in functionally monocular individuals [5]. Regular optical spectacles increase the risk of eye injury and must be replaced by prescription protective eyewear during high-risk sports [48].

### 4.1.4 | Eye Injuries From Assault

Assault is a significant cause of eye injury admission in Australia, particularly rurally and among First Nations patients. Intoxication is often implicated, and most victims are men. Alcohol restrictions have previously demonstrated promise in rural and First Nations settings [37]. Women, particularly First Nations women, are highly vulnerable to eye injury from domestic/intimate partner violence. Health promotion initiatives are crucial for primary prevention of domestic violence, which poses high morbidity and mortality on women, especially. A female presenting with eye injury, particularly of a blunt mechanism (e.g., periorbital fracture, contusion, globe rupture) should raise suspicion for assault and prompt the use of a domestic violence screening tool, which can identify patients in need of secondary prevention measures [49]. Only one study from this review evaluated children, reporting that 17% of paediatric eye injuries were assault-related [37]. Similar to adults, the pattern of injury in children and other clues such as young age (<12 months) or suspicious history may alert providers to the need to screen for non-accidental injury [50].

## 4.2 | Limitations and Future Directions

The main limitation of this review is the heterogeneous design of the included studies, which often collected different data points or classified and analysed data using different coding systems, terminologies, and methodologies. This was mitigated through use of the IGATES framework, which ensured standardised and comprehensive data synthesis; however, there remained large amounts of missing data for example, relating to settings for eye injury (Table 4, see “Other/unspecified”). Another limitation was that this review did not evaluate outcomes after eye injury, as this would have dramatically increased the scope, especially given the heterogeneous literature. The Australia-wide adoption of IGATES would facilitate more accurate, efficient, and sustainable eye injury epidemiological research in future, including research on outcomes and prognostication, which would further guide preventive efforts to target the demographics and settings of eye injury with the greatest burden. IGATES would also facilitate cross-country comparisons of eye injury epidemiology and foster international collaboration on optimising prevention. It may also be desirable to conduct research that (1) audits the adequacy of current eye health promotion in Australia, and (2) evaluates the effectiveness of future efforts in improving awareness

TABLE 10 | Burns-related eye injuries in Australia.

Study identifier	Scope	% Male Sex	High risk groups (years)	Type of injury <sup>a</sup>			Type of burn	
				Adnexal	Globe	Thermal	Chemical	
#27	Burns (all)	81%		80% (eyelid)	72% <ul style="list-style-type: none"><li>• 70% corneal CGI</li><li>• 2% globe rupture (firework-related)</li></ul>	92% thermal <ul style="list-style-type: none"><li>• 62% fire</li><li>• 15% explosion</li><li>• 9% scald</li><li>• 6% electrical</li></ul>	8% chemical	
#28	Burns (all)	76%	<ul style="list-style-type: none"><li>• 7% 0–18</li><li>• 40% 19–35</li><li>• 44% 36–65</li></ul>	100% <ul style="list-style-type: none"><li>• 58% eyelid</li></ul>	82%	65% thermal <ul style="list-style-type: none"><li>• Fire, electrical, scald</li></ul>	35% chemical <ul style="list-style-type: none"><li>• 32% basic</li><li>• 3% acidic</li></ul>	
#29	Burns (thermal)			77% (eyelid)	52% (cornea)	100% thermal <ul style="list-style-type: none"><li>• 20% fire</li><li>• 20% explosion</li><li>• 20% electrical</li><li>• 17% scald</li></ul>	N/A	
#30	Burns (chemical)	52%	<ul style="list-style-type: none"><li>• 46% 0–16</li></ul>			N/A	100% chemical <ul style="list-style-type: none"><li>• 22% children rubbing orspraying self/sibling</li><li>• 23% splash</li></ul>	
#23 <sup>b</sup>	Burns (chemical)	60%						

Abbreviation: CGI, closed globe injury.  
<sup>a</sup>Globe and adnexal injury not treated as mutually exclusive; thus, total exceeds 100%.  
<sup>b</sup>Data on chemical burns extracted from this study.

and behaviour among high-risk populations. Validation of successful preventive strategies may influence policy and legislation. In settings where policy is already in place (e.g., protective eyewear at work), it is desirable to assess barriers to compliance.

### 4.3 | Conclusion

Eye injuries are common in Australia and impose a large but avoidable burden on patients, families, and society. Most injuries occur at home or are work-, sport-, or transport-related. Children, working-aged men, and older adults are at greatest risk. Eye injury incidence is higher rurally and among First Nations people, for whom there are concerning rates of domestic violence-related eye injury in women. Eye injury prevention efforts should focus on coordinated, evidence-based health promotion to increase awareness and use of protective eyewear, and on advocacy and policy change.

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### Conflicts of Interest

Annette Hoskin is an employee of EssilorLuxottica. The other authors have no conflicts of interest to declare.

### Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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## Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Appendix S1:** Supporting Information.