The global incidence and disability of eye injury: an analysis from the Global Burden of Disease Study 2019

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Summary

Background The aim of the present study was to estimate the incidence, years lived with disability (YLDs), and cause of eye injury at global, regional, and national levels by age and sex based on the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019.

Methods This is a retrospective demographic analysis based on aggregated data. GBD 2019 included the burden of eye injury worldwide and its temporal and spatial characteristics in the past three decades. The Bayesian meta-regression tool and DisMod-MR 2.1 were used to analyse the estimates based on a linear regression mode of the age-standardised rates (ASR). Average annual percent change (AAPC) was calculated to represent the temporal trends of the ASR.

Findings Globally, there were 59,933.29 thousand (95% uncertainty interval [UI]: 45,772.34–77,084.03) incident cases and 438.4 thousand (95% UI: 132.44–898.38) YLDs of eye injury in 2019. Both the ASR of incidence and YLDs decreased from 1990 to 2019, with AAPC −0.46 (95% confidence interval [CI]: −0.52 to −0.39) and −0.45 (95% CI: −0.52 to −0.39), respectively. Males had higher rates of incidence and YLDs in all age groups. Young and middle-aged adults had higher disease burdens. Regionally, Australasia had the highest ASR of YLDs to be 9.51 (95% UI: 3.00–19.58) per 100,000. Nationally, New Zealand had the highest burden of eye injury to be 11.33 (95% UI: 3.57–23.10) per 100,000. Foreign bodies, exposure to mechanical forces, and falls were the main causes of global eye injury burden in 2019, and there was an increased worldwide burden due to road injuries and executions and police conflict compared with 1990.

Interpretation Our findings suggest that the incidence and burden of eye injury have decreased over the last 30 years, while the absolute number of eye injuries has substantially increased, representing a major public health concern. Males and young adults were affected to a greater degree than females and elder individuals. More attention should be paid to road injuries and executions and police conflict in order to prevent eye injury.

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Keywords: Eye injury; GBD 2019; Incidence; Years lived with disability; Cause

Introduction

Eye injury is one of the major causes of blindness and low vision worldwide and the primary cause of unilateral vision loss in low and middle-income countries.[1] It affects nearly half a million people, commonly requiring surgical intervention and resulting in an immense burden on society.[2–4] Previous investigations in low and middle-income countries have indicated that eye injury

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Research in context

Evidence before this study

Previous epidemiological evidence on the incidence and burden of eye injury has been limited to select causes or countries. We searched PubMed, Web of Science, Ovid, and Embase for publications on the global burden of eye injury published up until April 1st, 2023. We used the following search terms: ((("eye injury" [Title/Abstract]) AND (Global [Title/Abstract])) AND (2019 [Title/Abstract])) AND (((("GBD" [Title/Abstract]) OR (Disability [Title/Abstract])) OR (Incidence [Title/Abstract])) OR (Burden [Title/Abstract])). Previously, Global Burden of Diseases, Injuries, and Risk Factors (GBD) studies have estimated the burden of eye injury from foreign bodies, but have not reported results from other injuries such as self-harm, road injuries, and falls. To date, no studies have systematically measured the incidence and burden of eye injury globally for all countries, ages, and sexes through the past 30 years and from all causes of injury. To estimate spatio-temporal changes in eye injury, we used data from the GBD 2019, including systematic reviews of injury incidence data for all causes of injury.

Added value of this study

In the present study, we used the GBD 2019 framework to analyse estimates of the global, regional, and national burden of the incidence and years of life lived with disability (YLDs) of eye injury in 204 countries and territories by age and sex. We further provided the global trends of these estimates from 1990 to 2019. We also presented estimates of the incidence and YLDs of eye injury due to different causes for each geographical region in 2019. Although the global incidence and burden of eye injury decreased significantly between 1990 and 2019, eye injury is one of the most significantly disabling injuries, with a large number of cases in 2019 compared with 1990. Age-standardised incidence and YLDs of eye injury were high in Australasia. Males had higher age-standardised incidence and YLDs in all years from 1990 to 2019. Young and middle-aged individuals were more likely to suffer from eye injuries compared with the elderly. Exposure to mechanical forces, foreign bodies, and falls were the three leading causes of eye injury in 2019, whereas it should be concerned that the increasing trends were noted in road injuries, executions and police conflict, and self-harm worldwide as well as in some regions.

Implications of all the available evidence

Addressing the global burden of these conditions requires improved efforts (e.g., wearing safety glasses, health care education, fall-prevention strategies, and improving road safety) to decrease the causes of eye injury and improve medical and social care. Future development of improved measures for the prevention of eye injury is important, particularly in males and young adults.

has become the leading cause of socioeconomic burdens in those populations.[5] In the U.S., a total of $793 million has been associated with open globe eye injury.[6] Improvement in socioeconomic status, change in lifestyle/behaviors, and development of industry have led to a higher likelihood of suffering from eye injury. A lack of timely and effective treatment will lead to a variety of consequences and even cause serious economic burden to the region. Therefore, it is of great importance to systematically understand the epidemiologic characteristics of eye injury in order to develop prevention strategies.

The Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019 estimated the incidence and disability-adjusted life-years (DALYs) due to 369 diseases and injuries in 204 countries and territories from 1990 to 2019.[7] Previous studies have indicated that an increase in both the age-standardised rates (ASR) of incidence and number of years lived with disability (YLDs) from eye injuries due to intraocular foreign bodies are going to present a global health challenge.[8,9] In addition to foreign body injuries, there are many causes of eye injuries, such as explosive eye injuries,[10] road traffic injuries,[11] mechanical or non-mechanical eye injuries (chemical/thermal/radiation),[12] and even self-inflicted injuries.[13] However, the incidence of and burden from eye injury have not been reported, and there has been no information regarding age-, sex-, spatial-, and temporal patterns of eye injury worldwide. Identification of the contributions of major causes of eye injury is crucial for discerning the population health effects of injury and its related disease trends over time. This may be important for priority setting with regard to injury prevention, treatment, and health service planning. Nevertheless, there has been no research on the comprehensive, systematical causes of eye injury at global and national levels.

Hence, the aim of this study was to estimate the global, regional, and national burden of eye injury in terms of counts and the ASR over the past three decades across 204 countries and territories by age and sex. Importantly, this investigation provides a singular and updated report regarding the common causes of eye injuries, including additional analyses not presented in earlier GBD reports.

Methods

Data source

All data were generated from the most up-to-date version of the GBD 2019 from the Global Health Data Exchange (GHDx) query tool (http://ghdx.healthdata.org/gbdresults-tool). The detailed GBD 2019 protocol and methods have been reported in previous GBD literature.[14] Briefly, the data sources of eye injuries were hospital records, emergency department records, insurance claims, and surveys.

GBD data framework

Disease Modeling-Meta Regression (DisMod-MR) version 2.1, which is a Bayesian meta-regression framework applied to GBD data modeling, was used to model the outcomes of injuries. This framework integrates measures (i.e., prevalence, incidence, remission, and mortality data) into a single model. To estimate morbidity from injuries, all data sources were used to produce YLDs by country, year, sex, age, external cause-of-injury, and nature-of-injury categories. Some studies usually report hospital data using a mix of cause-of-injury and nature-of-injury codes. In order to retain as much of the data as possible, datasets that had at least 15% of cases coded to the cause of injury were included in the modeling. In our study, the incidence and YLDs due to eye injuries were collected using global, regional, and national specific data from 1990 to 2019 and presented as absolute number and ASR. The detailed description of GBD regions and countries is presented in Supplementary Methods 1. Once a weighting scheme was chosen, 1000 draws were created for the final ensemble, and the number of draws contributed by each model was proportional to its weight. The mean of the draws was used as the final estimate for the CODEm process, and a 95% uncertainty interval (UI) was created from the 0.025 and 0.975 quantiles of the draws.

Case definition

The injuries estimation process for non-fatal health outcomes in the GBD 2019 encompasses a range of 30 causes, including transport injuries, falls, drowning, self-harm, interpersonal violence, and animal contact. Injury incidence was defined using ICD-9 codes E000-E999 and ICD-10 chapters V to Y. For non-fatal estimation, Chapters S and T in ICD-10 and codes 800-999 in ICD9 are used to estimate morbidity. The detailed ICD codes used to identify causes of injury are described in the Supplementary Methods 2. Each of these 30 causes of injury can result in a variety of physical injury sequelae (e.g., traumatic brain injury), which we call the "nature of injury." Although the initial DisMod models are at the "cause of injury" level (e.g., drowning), each cause of injury was distributed into cause–nature pairs to capture the actual disability that developed. The cause-of-injury categories covered by the GBD were arranged in standard hierarchical categories of four levels. For the present analysis, we report the level 3 cause-of-injury categories (see Supplementary Methods 3).

Statistical analysis

The trends of the disease burden of eye injuries over the past three decades were analysed using average annual percent change (AAPC) by the Joinpoint Regression Program (Version 4.9.0.0. Statistical Research and Applications Branch, National Cancer Institute, USA). The calculation was based on the default option in the Joinpoint program using the best model, with a maximum of five joinpoints pertaining to six segments. The AAPC value and its 95% confidence interval (CI) over 0 indicate an upward trend. On the contrary, the AAPC value and its 95% CI less than 0 signify a downward trend. Nevertheless, the burden was identified as stable during the study period. All analyses and data visualizations were accomplished using the R program (version 4.2.2). Statistical significance was considered to be a two-tailed P value less than 0.05.

Ethics approval

This study followed the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER). The GBD 2019 study consists of aggregated, de-identified data. The protocol for this study was exempted by the Research Ethics Committee of the Guangdong Provincial People's Hospital (KY-Q-2022-495-01) because of the public availability of the data.

Role of the funding source

The funders had no role in the study design, data collection, analysis, interpretation, or writing of the article. The authors were independent from the study sponsors. All authors had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

The incidence, and changes of eye injury

The number of incident cases of eye injury increased by 24% (95% UI: 17%–32%), from 48,220.83 thousand (95% UI: 36,081.91–62,899.27) in 1990 to 59,933.29 thousand (95% UI: 45,772.34–77,084.03) in 2019 (Table 1). Moreover, the global ASR of eye injury incidence decreased, with an AAPC of −0.46 (95% CI: −0.52 to −0.39), from 879.24 (95% UI: 656.26–1147.5) per 100,000 population in 1990 to 773.45 (95% UI: 593.47–991.75) per 100,000 population in 2019 (Table 1). Notably, the ASR of eye injury incidence showed a downward trend from 1990 to 2011, while it increased significantly after 2011 (Fig. 1A). Regionally, the highest and lowest ASR of incidence was observed in Australasia (1298.15, 95% UI: 1031.06–1649.66), and Oceania (402.12, 95% UI: 320.67–509.83) per 100,000 population in 2019, respectively. At national levels, the highest ASR of incidence was seen in Greenland (996.87 per 100,000, 95% UI: 805.28–1222.85) in 1990, while in 2019 the highest ASR of incidence worldwide was noted in New Zealand (1548.29 per 100,000, 95% UI: 1249.4–1908.02) (Table S1). Furthermore, the Central African Republic (AAPC: 0.48, 95% CI：0.17–0.79),

Location	Incidence						YLDs					
	Number, in thousands (95% UI)		1990–2019 percentage change in number (95% UI)	ASR, per 100,000 (95% UI)		AAPC (95% CI)	Number, in thousands (95% UI)		1990–2019 percentage change in number (95% UI)	ASR, per 100,000 (95% UI)		AAPC (95% CI)
	1990	2019		1990	2019		1990	2019		1990	2019	
Global	48220.83 (36,081.91–62,899.27)	59933.29 (45,772.34–77,084.03)	0.24 (0.17–0.32)	879.24 (656.26–1147.5)	773.45 (593.47–991.75)	−0.46 (−0.52 to −0.39)	352.68 (107.76–721.13)	438.4 (132.44–898.38)	0.24 (0.17–0.32)	6.43 (1.93–13.28)	5.66 (1.72–11.51)	−0.45 (−0.52 to −0.39)
Andean Latin America	302.36 (241.16–368.55)	457.82 (362.55–573.21)	0.51 (0.41–0.61)	747.46 (597.48–915.29)	704.84 (561.54–875.46)	−0.23 (−0.26 to −0.19)	2.22 (0.69–4.44)	3.35 (1.03–6.74)	0.51 (0.4–0.61)	5.48 (1.69–10.92)	5.16 (1.59–10.43)	−0.23 (−0.26 to −0.19)
Australasia	265.81 (210.61–334.92)	327.4 (260.43–411.18)	0.23 (0.19–0.28)	1350.59 (1072.4–1717.77)	1298.15 (1031.06–1649.66)	−0.13 (−0.18 to −0.09)	1.95 (0.61–4.05)	2.4 (0.76–4.84)	0.23 (0.19–0.28)	9.89 (3.08–20.53)	9.51 (3–19.58)	−0.13 (−0.18 to −0.09)
Caribbean	264.71 (209.14–327.96)	348.43 (276.05–432.48)	0.32 (0.26–0.37)	720.4 (575.86–893.2)	745.55 (594.56–922.66)	0.16 (−0.01 to 0.34)	1.94 (0.6–3.9)	2.55 (0.78–5.18)	0.32 (0.26–0.37)	5.28 (1.63–10.64)	5.46 (1.7–11.08)	0.22 (−0.07 to 0.52)
Central Asia	578.43 (464.89–716.63)	734.16 (589.85–911.5)	0.27 (0.22–0.32)	789.21 (638.02–972.69)	759.6 (613.02–941.76)	−0.15 (−0.37 to 0.08)	4.24 (1.32–8.43)	5.38 (1.67–10.85)	0.27 (0.22–0.32)	5.78 (1.81–11.58)	5.56 (1.74–11.24)	−0.15 (−0.37 to 0.08)
Central Europe	1383.47 (1114.43–1704.03)	1057.83 (845.12–1300.74)	−0.24 (−0.27 to −0.2)	1169.31 (943.02–1438.27)	1095.05 (877.05–1360.42)	−0.2 (−0.31 to −0.09)	10.13 (3.18–20.78)	7.74 (2.43–15.81)	−0.24 (−0.27 to −0.2)	8.57 (2.68–17.61)	8.02 (2.5–16.65)	−0.2 (−0.31 to −0.1)
Central Latin America	1651.55 (1323.28–2037.79)	2219.8 (1772.7–2741.09)	0.34 (0.27–0.43)	937.38 (753.84–1148.68)	877.39 (701.45–1085.26)	−0.21 (−0.39 to −0.03)	12.1 (3.81–24.23)	16.26 (5.04–32.77)	0.34 (0.27–0.43)	6.87 (2.15–13.63)	6.43 (2–12.95)	−0.21 (−0.39 to −0.03)
Central Sub-Saharan Africa	328.21 (260.26–408.78)	739.93 (582.85–930.95)	1.25 (1.14–1.34)	556.4 (445.04–695.31)	532.56 (424.03–669.5)	0.03 (−1.53 to 1.61)	2.4 (0.75–4.79)	5.42 (1.67–10.85)	1.25 (1.13–1.34)	4.07 (1.23–8.03)	3.9 (1.2–7.84)	0.04 (−1.57 to 1.67)
East Asia	13805.48 (7930.79–22,116.13)	12132.8 (7117.98–19,333.21)	−0.12 (−0.26 to 0.07)	1084.34 (650.07–1695.85)	776.75 (471.58–1202.87)	−1.28 (−1.53 to −1.03)	100.6 (27.79–232.45)	88.41 (24.59–203.89)	−0.12 (−0.26 to 0.08)	7.9 (2.2–17.86)	5.66 (1.62–12.71)	−1.27 (−1.52 to −1.02)
Eastern Europe	2567.78 (2085.25–3133.96)	1963.74 (1583.88–2408.41)	−0.24 (−0.27 to −0.2)	1179.64 (958.54–1440.44)	1040.69 (842.62–1284.93)	−0.42 (−0.5 to −0.35)	18.8 (5.84–38.67)	14.37 (4.45–29.46)	−0.24 (−0.27 to −0.2)	8.64 (2.71–17.69)	7.62 (2.39–15.66)	−0.42 (−0.5 to −0.35)
Eastern Sub-Saharan Africa	1768.28 (1356.71–2340.87)	3070.83 (2450.27–3846.75)	0.74 (0.35–1.02)	853.05 (660.31–1131.94)	688.53 (555.01–851.42)	−0.76 (−1.58 to 0.06)	12.97 (3.86–25.87)	22.5 (6.9–45.11)	0.73 (0.34–1.01)	6.25 (1.85–12.61)	5.04 (1.54–10.02)	−0.76 (−1.8 to 0.3)
High-income Asia Pacific	1671.03 (1352.81–2043.43)	1455.98 (1167.11–1791.28)	−0.13 (−0.17 to −0.09)	977.53 (792.65–1182.74)	940.91 (757.11–1147.54)	−0.12 (−0.16 to −0.08)	12.24 (3.75–24.9)	10.65 (3.26–21.59)	−0.13 (−0.17 to −0.09)	7.16 (2.21–14.47)	6.89 (2.14–14.07)	−0.12 (−0.16 to −0.08)
High-income North America	2817.72 (2156.37–3613.52)	3006.67 (2301.46–3844.93)	0.07 (0.02–0.12)	1023.57 (783.18–1297.82)	899.36 (685.7–1145.52)	−0.49 (−0.78 to −0.21)	20.61 (6.27–41.51)	21.96 (6.85–44.51)	0.07 (0.02–0.13)	7.49 (2.3–15.15)	6.58 (2.01–13.2)	−0.49 (−0.76 to −0.22)
North Africa and Middle East	2671.17 (2111.27–3322.2)	4700.86 (3731.88–5915.37)	0.76 (0.63–0.88)	746.18 (595.07–926.33)	736.53 (587.36–919.2)	−0.01 (−0.22 to 0.21)	19.57 (6.1–39.72)	34.44 (10.55–69.56)	0.76 (0.63–0.88)	5.46 (1.7–11.01)	5.4 (1.65–10.87)	−0.01 (−0.22 to 0.21)
Oceania	26.36 (20.79–33.37)	54.96 (43.57–69.83)	1.08 (1.02–1.14)	400.12 (318.16–507.09)	402.12 (320.67–509.83)	−0.04 (−0.13 to 0.06)	0.19 (0.06–0.39)	0.4 (0.12–0.82)	1.08 (1.02–1.14)	2.93 (0.9–5.9)	2.95 (0.91–5.94)	−0.04 (−0.14 to 0.06)
South Asia	9243.66 (7211–11766.68)	15191.41 (11841.52–19480.48)	0.64 (0.57–0.71)	826.05 (651.66–1051.35)	811.5 (640.19–1035.48)	−0.08 (−0.11 to −0.05)	67.7 (20.56–137.27)	111.24 (33.06–227.54)	0.64 (0.57–0.71)	6.05 (1.8–12.23)	5.94 (1.77–12.07)	−0.08 (−0.11 to −0.05)
Southeast Asia	2540.14 (2029.29–3132.24)	3437.64 (2746.99–4326.85)	0.35 (0.27–0.44)	519.9 (419.37–638.97)	497.87 (399.81–620.16)	−0.08 (−0.23 to 0.07)	18.62 (5.86–37.02)	25.18 (7.66–50.71)	0.35 (0.27–0.44)	3.81 (1.17–7.52)	3.65 (1.13–7.34)	−0.08 (−0.23 to 0.07)
Southern Latin America	386.12 (313.43–471.74)	480.37 (389.72–586.17)	0.24 (0.2–0.29)	768.31 (622.14–938.45)	747.92 (606.81–913.98)	−0.1 (−0.12 to −0.07)	2.83 (0.89–5.78)	3.52 (1.12–7.3)	0.24 (0.2–0.29)	5.63 (1.77–11.54)	5.48 (1.74–11.34)	−0.09 (−0.11 to −0.08)

(Table 1 continues on next page)

Location	Incidence						YLDs					
	Number, in thousands (95% UI)		1990–2019 percentage change in number (95% UI)	ASR, per 100,000 (95% UI)		AAPC (95% CI)	Number, in thousands (95% UI)		1990–2019 percentage change in number (95% UI)	ASR, per 100,000 (95% UI)		AAPC (95% CI)
	1990	2019		1990	2019		1990	2019		1990	2019	
(Continued from previous page)												
Southern Sub-Saharan Africa	468.24 (374.91–582.07)	658.7 (525.31–831.5)	0.41 (0.34–0.48)	830.19 (666.53–1029.25)	802.75 (641.4–999.09)	−0.1 (−0.14 to −0.06)	3.43 (1.04–6.89)	4.82 (1.44–9.59)	0.41 (0.34–0.48)	6.08 (1.8–12.04)	5.88 (1.74–11.68)	−0.1 (−0.14 to −0.06)
Tropical Latin America	1554.82 (1237.33–1945.74)	2007.27 (1579.29–2539.83)	0.29 (0.2–0.39)	968.9 (776.48–1201.87)	885.88 (703.45–1115.87)	−0.3 (−0.33 to −0.28)	11.38 (3.55–22.35)	14.69 (4.39–29.27)	0.29 (0.2–0.39)	7.09 (2.19–13.97)	6.48 (1.98–12.96)	−0.31 (−0.33 to −0.28)
Western Europe	2380.43 (1910.22–2903.99)	2335.87 (1884.43–2839.46)	−0.02 (−0.05 to 0.02)	667.15 (540.46–815.16)	636.69 (512.95–783.87)	−0.15 (−0.19 to −0.12)	17.43 (5.48–35.39)	17.09 (5.37–34.42)	−0.02 (−0.05 to 0.02)	4.89 (1.53–9.96)	4.66 (1.45–9.43)	−0.16 (−0.19 to −0.12)
Western Sub-Saharan Africa	1545.08 (1234.64–1915.04)	3550.82 (2823.38–4438.85)	1.30 (1.25–1.34)	738.6 (593.79–914.83)	715.04 (574.37–889.27)	−0.07 (−0.15 to 0.01)	11.32 (3.41–22.73)	26.01 (7.89–52.59)	1.3 (1.24–1.34)	5.41 (1.63–10.82)	5.24 (1.58–10.32)	−0.07 (−0.15 to 0.00)

YLDs, years Lived with Disability; UI, uncertainty interval; ASR, age-standardised rate; AAPC, average annual percent change; CI, confidence interval.

Table 1: **Incidence and YLDs of injury to eyes in 1990 and 2019, and change from 1990 to 2019 by regions.**

Libya (AAPC: 0.43, 95% CI: 0.05–0.82), Cuba (AAPC: 0.34, 95% CI: 0.29–0.4), the Dominican Republic (AAPC: 0.3, 95% CI: 0.24–0.36), and Grenada (AAPC: 0.25, 95% CI: 0.22–0.29) were the top five countries with significantly increasing trends of eye injury over the past three decades (Fig. 2). In contrast, downward trends of the ASR of incidence were observed in Kuwait (AAPC: −1.41, 95% CI: −1.63 to −1.19), China (AAPC: −1.29, 95% CI: −1.54 to −1.04), Timor-Leste (AAPC: −1.25, 95% CI: −1.75 to −0.73), Sri Lanka (AAPC: −1.11, 95% CI: −1.52 to −0.69), and Angola (AAPC: −0.84, 95% CI: −1.22 to −0.45).

The YLDs, and changes of eye injury

The global number of YLDs of eye injury in 2019 was estimated to be 438.4 thousand (95% UI: 132.44–898.38), with an ASR of YLDs to be 5.66 (95% UI: 1.72–11.51) per 100,000, which decreased from 1990 to 2019 (AAPC: −0.45, 95% CI: −0.52 to −0.39; Table 1). The Australasia region had the highest ASR of YLDs (9.51 per 100,000; 95% UI: 3.00–19.58), followed by Central Europe (8.02 per 100,000; 95% UI: 2.50–16.65) and Eastern Europe (7.62 per 100,000; 95% UI: 2.39–15.66). The highest decrease of the ASR of YLDs was seen in East Asia (AAPC: −1.27; 95% CI: −1.52 to −1.02), while no significant increase was observed in all regions. Figure S1 shows the geographical distribution of the ASR of YLDs for 204 countries. New Zealand, Australia and Poland were the three leading countries in eye injury-related disabilities in 2019 worldwide. Yemen had the largest increase of YLDs due to eye injury, while Timor-Leste had the largest decrease in disease burden (Fig. 3, Table S1).

The main causes of eye injury

In terms of level one causes, unintentional injuries had the largest incident number of eye injury and were the leading cause worldwide in 2019 (Table S2), followed by self-harm and interpersonal violence (Table S3) and transport injuries (Table S4). In 2019, unintentional injury-related incident cases of eye injury were estimated to be 57607.18 thousand (95% UI: 43,353.58–74762.7), with an ASR of incidence of 743.55 (95% UI: 564.25–959.77) per 100,000. From 1990 to 2019, increasing trends were observed for the ASR of incidence and YLDs caused by transport injuries (Table S4), but decreasing trends were seen in unintentional injuries (Table S2), and trends of self-harm and interpersonal violence-related eye injury were unchanged (Table S3). The national incidence and YLDs of eye injury by different causes are shown in Tables S5–S7, respectively.

Fig. 4 shows the ASR of incidence and YLDs per 100,000 by cause-of-injury category and region for 1990 and 2019. Across all the GBD regions, there were higher rates of injury caused by foreign bodies, exposure to mechanical forces, and falls worldwide in 2019, yet

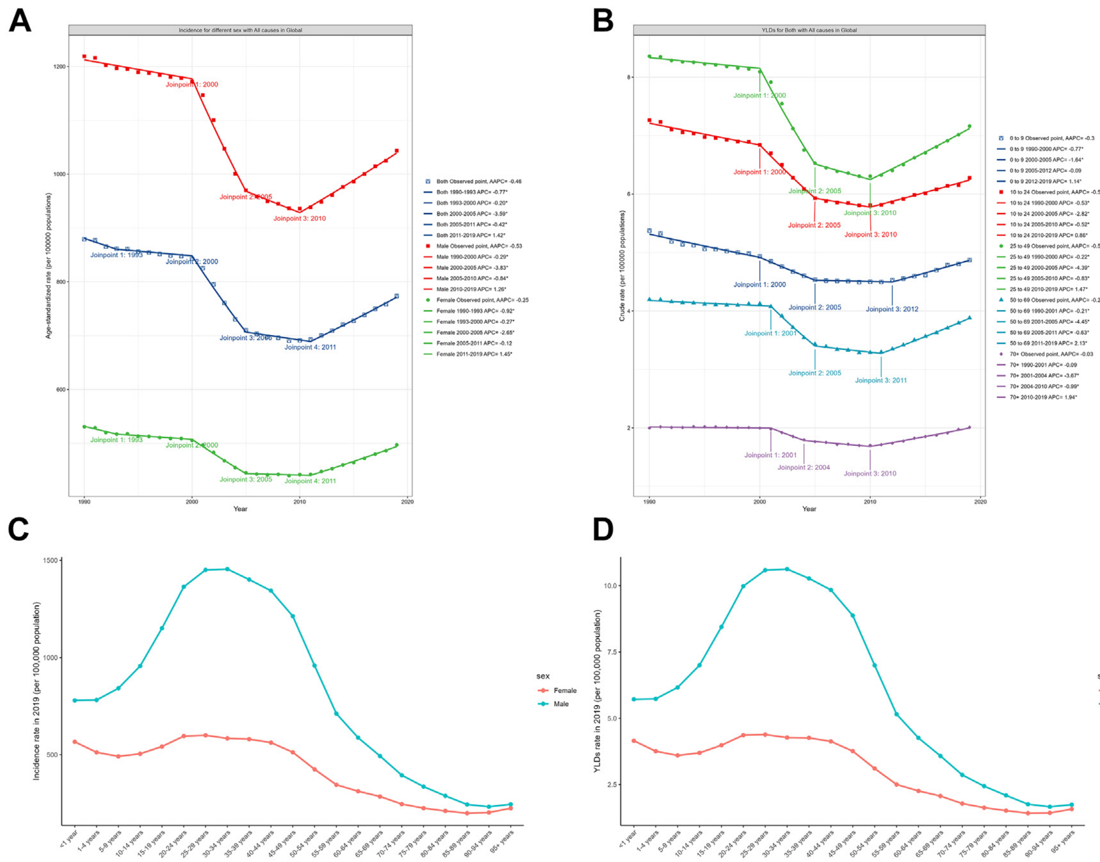

Fig. 1: Global changes of age-standardised rates (ASR) of incidence from 1990 to 2019 by sex (A); Global changes of ASR of years lived with disability (YLDs) rate from 1990 to 2019 by age (B); The incidence rate of eye injury at all ages by sexes in 2019 (C); The YLDs of eye injury at all ages by sexes in 2019 (D).

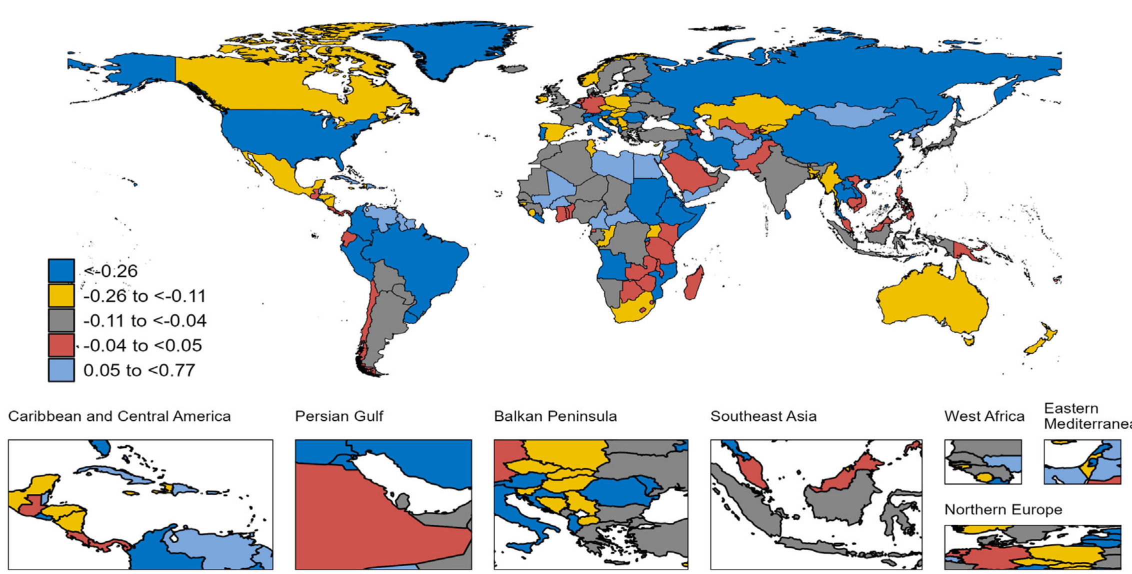

Fig. 2: The average annual percentage change of age-standardised rate of incidence of eye injury for both sexes in 204 countries and territories from 1990 to 2019.

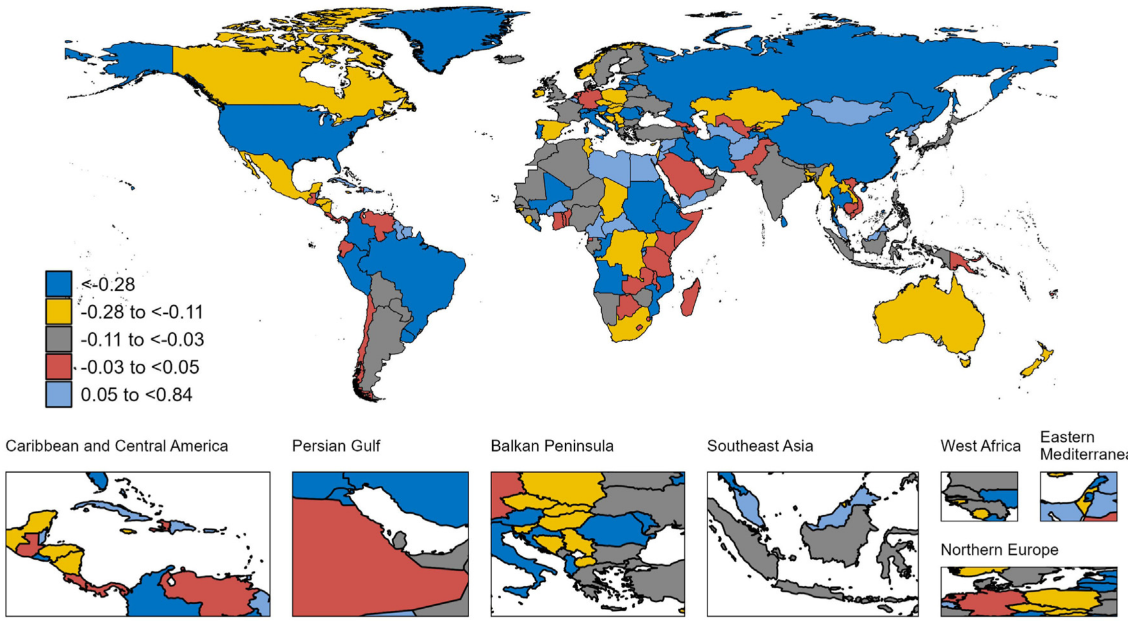

Fig. 3: The average annual percentage change of age-standardised rate of years lived with disability of eye injury for both sexes in 204 countries and territories from 1990 to 2019.

these rates decreased compared with 1990. However, the ASR of incidence and YLDs of eye injury due to road injuries and executions and police conflict increased from 1990 to 2019.

In Australasia, which had the highest burden of eye injury, exposure to mechanical forces, foreign bodies, and falls were the three leading causes of eye injury in 2019; furthermore, falls and drowning had higher ASR of incidence and YLDs compared with 1990. Increasing burdens of eye injury due to conflict and terrorism were seen in Eastern Europe, North Africa, and the Middle East. An increasing burden of eye injury due to foreign bodies was observed in Southeast Asia, Southern Sub-Saharan Africa, Eastern Europe, Eastern Sub-Saharan Africa, and Western Europe. In 2019, high-income Asia Pacific, Southern Latin America, High-income North America, and Western Sub-Saharan Africa had a higher burden of eye injury due to self-harm compared with 1990.

The incidence and YLDs of eye injury by age and sex

Overall, males had higher ASR of incidence and YLDs than females in each age group (Fig. 1C and D). The YLDs rates were the highest in both males and females in early adulthood (25–49 years old) but the lowest at an older age (70+ years old) (Fig. 1B). Regarding specific causes of eye injury, males also had higher ASR of incidence and YLDs than females of eye injury due to level one (unintentional injuries, self-harm and interpersonal violence and transport injuries) and level three causes, respectively (Fig. 5).

Discussion

Eye injury is a major cause of visual impairment or blindness worldwide.[4] It has been estimated that a total of 1.6 million cases of blindness and 2.3 million cases of low vision can be attributed to eye injuries per year.[3] In order to make targeted public health campaigns to prevent and control the occurrence of eye injury, it is most important to understand which segments of the world are at greatest risk of eye injuries and their epidemic characteristics. In the present study, we estimated the incidence and burden of eye injuries at global, regional, and national levels from 1990 to 2019 by age and sex. Moreover, we also analysed the spatial–temporal changes of eye injury and its causes. Globally, the burden of eye injury is extremely concerning. The global incidence and YLDs of eye injury were substantial in 2019, despite showing a decreasing trend over the past three decades. We further found that unintentional injuries, such as foreign bodies, were the leading cause of eye injury globally. Most eye injuries occurred in people aged 25–49 years, and males were more likely to experience them. Australasia tended to have the highest ASR of incidence and YLDs in 2019. Countries with widespread armed conflicts such as Yemen, Burundi, Central African Republic, Libya, and Afghanistan have the largest upward trends of disease burden over the past 30 years. Knowing the temporal and geographic trends in the incidence and burden of eye injury, as well as exploring its related causes, will help individuals, decision-makers, and health managers take better action.

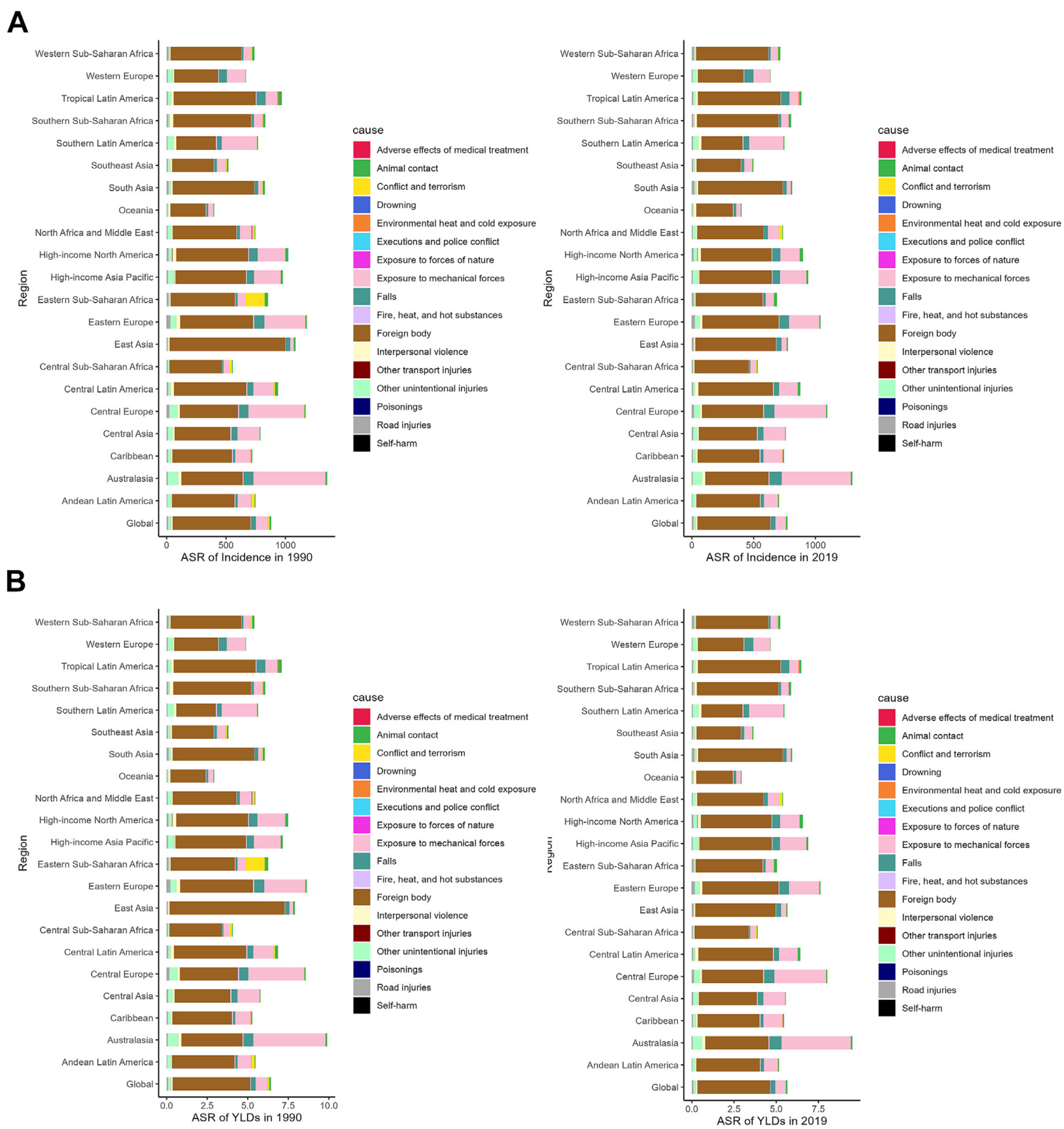

Fig. 4: Pyramid figure with age-standardised rate of incidence (A) and years lived with disability (B) of eye injury by region and cause of injury (Level 3) in 1990 and 2019.

To our knowledge, data on the incidence of eye injury are relatively scarce. With the development of economy and society, the estimated number of patients affected by eye injuries in 2019 was substantial. It was 1.25 times as large in 2019 as it was in 1990. In this study, the ASR of incidence and YLDs decreased, but the absolute number slightly increased, which might be attributed to the global population changes from 1990 to 2019.[15] In addition, we found that the major inflection point for the trends of ASR and YLDs appeared in 2010. The underlying reasons for this tendency might be war, conflict, and environmental disasters such as the war in Afghanistan, earthquake in Haiti, European sovereign debt crisis, Deepwater Horizon oil spill, and South Africa World Cup Soccer Tournament.[16–20] In 2019, South Asia and East Asia had the largest number of eye injury incidents. The reason for this may be that South Asia and East Asian regions have the largest populations and are rapidly changing from mostly rural to highly industrialised societies. In China, the 5-year incidence of ocular trauma was 2.6% and associated with male gender, younger age, and lower income.[21]

Notably, North Africa and Middle East regions experiencing wars or conflicts also had a larger number

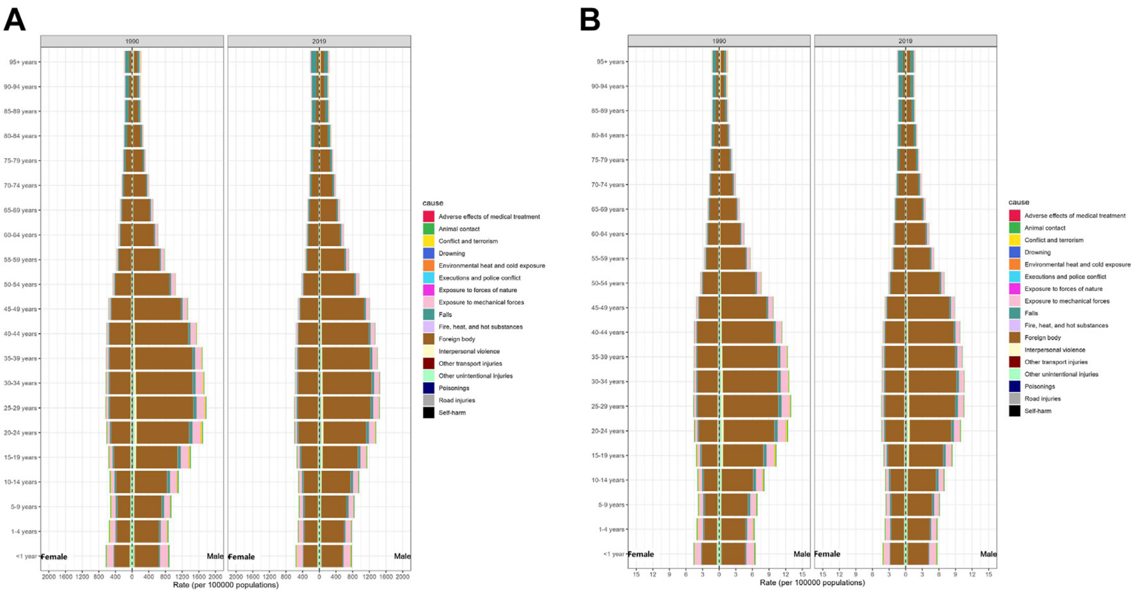

Fig. 5: Pyramid figure with incidence (A) and years lived with disability (B) rate by sex, age and cause of injury (Level 3) in 2019.

of eye injuries compared to other areas. Yemen, the Central African Republic, and Libya had significantly increasing trends of eye injury burden over the past three decades. Increasing trends of eye injury burden over the past three decades were also noted in Afghanistan and the Syrian Arab Republic, but these results did not reach significance; despite this, they should still be considered important.

New Zealand and Australia have the highest ASR of incidence and disease burden in 2019. Previously, the overall national incidence of adult eye injury in New Zealand was 1007 per 100,000 adult population per year.[22] Of these cases, the annual incidence of those requiring emergent management was 37/100,000 population/year, which was higher than other international estimates of 11.1–29.1/100,000 population/year reported in the United States, Croatia, and worldwide.[23–25] The higher burden in Australia and New Zealand might have resulted from specific environmental and behavioral factors. For example, in Australia and New Zealand, the sunlight intensity is relatively high, and bush areas may have mosquitoes, reptiles, and other organisms that can cause eye injuries. There is high volcanic activity in New Zealand which also presents an additional risk of eye injury. Moreover, bungee jumping and water activities, which could increase the risk of eye injury, are relatively more common in people in Australia and New Zealand.[26] Additionally, non-indigenous Australians aged 50 years and over have a relatively low prevalence of eye injury (0.24%), while the prevalence of eye injury among Indigenous Australian adults aged 40 years and older reached 0.79%.[27] The observed higher prevalence of eye injury in the indigenous population may be due to well-recognised reasons, including greater occupational and physical risks.[28] The geographic variance may result from reporting bias, access to healthcare, or injury severity.

With respect to age and sex, young adults and males had higher incidences of and were more burdened by eye injury than elder and female people. These findings are consistent with previous studies.[27,29,30] More males are working on construction sites than females, which may explain why men make up a higher percentage of those injured. However, in Central Ethiopia, females are more likely to suffer eye injury compared to males (relative risk: 1.16); this is mostly due to work-related exposure to sticks during cooking.[31] Therefore, the gender disparity in eye injuries should be interpreted in conjunction with work or living environments. Female eye injury is also notable for its increasing trends. In the current study, younger and middle-aged people were found to be at higher risk of eye injury because of more frequent participation in social and high-energy activities, while the elderly tended to have less injury as a result of domestic activities and sedentary life. Notably, childhood eye injury also demonstrated a heavy disease burden, which is potentially sight threatening. More than half of the children were injured during play, 18 (16.5%) during corporal punishment, and 34 (31.2%) from accidents during domestic/schoolwork.[32] There is a need for improved parent/guardian education and practices in order to protect children from eye injuries.

Unintentional injuries are the leading cause of ocular trauma. Of these, foreign bodies, exposure to mechanical forces, and falls are the top three main causes of eye injury, but these sources of injury have decreased compared with 1990. A population-based study has indicated that most eye injuries occur at the workplace; workers did not have any eye protection at the time of trauma.[33] The incidence and YLDs of eye injuries owing to transport injuries have increased annually over the past three decades, indicating that the prevention of road injuries should receive more attention. Road traffic accidents are the most common mechanism of facial trauma and cause of blindness in at least one eye.[11] Many factors are associated with an increased risk of traffic accidents, including improved expressways and hence, increased vehicular movement, particularly in low and middle-income countries. It is recommended to implement preventive strategies such as legislation enforcing road traffic safety measures.

Although global self-harm and interpersonal violence-related eye injury remained stable, an increasing burden of eye injuries due to conflict and terrorism was seen in Eastern Europe, North Africa, and the Middle East during the study period. Therefore, improvement in the implementation of advanced protective eyewear and providing proper assessment, initial treatment, and rapid evacuation of casualties is needed to improve visual outcomes.[34] An increase in self-harm related eye injuries during the study period was observed in some regions, including High-income Asia Pacific, Southern Latin America, High-income North America, and Western Sub-Saharan Africa. Traumatic eye disease from self-injurious behavior is a diagnostic and therapeutic challenge due to poor patient cooperation or ongoing trauma. Self-injurious behavior typically starts in early childhood and encompasses a range of behaviors, including scratching, face slapping, head banging, or body hitting.[35] An international, multicentre, retrospective study revealed that the most common systemic diagnosis was autism spectrum disorder, and the most common behavior was face hitting.[36] Accordingly, eye injuries may be noted by home caregivers or staff in care facilities, and caution must be taken with patients who have evidence of persistent disease activity.

Our current study summarises the burden of global eye injuries based on advanced methodology and extensive and comprehensive data; thus, our findings have significant contributions to the evaluation of disease burden. However, there were some limitations according to the general defects of the GBD study. First, the raw data were not available in all the countries, and the data of those countries were estimated through the DisMod-MR 2.1 tool. Second, the variance of eye injury burden between different countries might be related to the data sparsity and corresponding reporting bias in certain geographies; this was the known limitation of injury burden estimation in the GBD framework. However, this variation does not hurt the reliability of the GBD data, which has rich and diverse data sources and the quality of the dataset was ensured by GBD collaborators. Third, the GBD 2019 study does not provide estimations on disease burden of eye injury by sociodemographic index (SDI). Hence, we were not able to investigate the association between the burden of eye injury and SDI levels within regions and countries during the study period. A further updated GBD study should be performed to provide this association. In addition, the cause versus nature-of-injury matrices, required for the injury YLDs calculations, were based on outpatient, inpatient, and emergency room discharge data. However, some patients with mild eye injury may not have seen a physician and thus were not represented in the analysis, potentially leading to underestimating the global eye injury estimations. Lastly, there was a considerable time lag between data collection and database inclusion, resulting in a time lag in evaluating the burden of eye injury.

Although the ASR of incidence and YLDs decreased between 1990 and 2019, the absolute number of eye injuries has substantially increased, representing a major concern and resulting in a great burden on visual health and well-being globally. Males and young and middle-aged adults were impacted by eye injuries to a greater degree than females and the elderly. Unintentional injuries were the most common mechanism of disability. Developing practical and effective measures remains critical to support individuals, decision makers, and healthcare providers in addressing the occurrence and disease burden of eye injury in a growing population of patients.

Contributors
All estimates presented in this article were provided by the GBD core team. LL, MXZ, XHY, and CL have verified the underlying data. CL, LL, SML, and MXZ provided data or critical feedback on data sources. CL and SML developed methods or computational machinery. LL, YYF, MXZ, and MXZ provided critical feedback on methods or results. All authors contributed to the drafting of the work or revised the article critically for important intellectual content. LL, HHY, XHY, and MXZ contributed to managing the overall research enterprise. All authors had full access to all the data in the study and had final responsibility for the decision to submit for publication. The corresponding authors attest that all listed authors meet authorship criteria and that no others who meet the criteria have been omitted. LL and MXZ are the guarantors.

Data sharing statement
Data are available on the Global Health Data Exchange GBD 2019 website (https://ghdx.healthdata.org/gbd-2019). Both the statistical code and detailed region- or country-specific decomposition results of vision loss are available upon request from LL at liulei@gdph.org.cn.

Declaration of interests
We have no competing interests to declare.

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from the study as planned (and, if relevant, registered) have been explained.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.eclinm.2023.102134.

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