

Principal and Secondary Diagnoses Related to Eye Injury: Characteristics from a tertiary center in Northern Thailand

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ABSTRACT

OBJECTIVE This study aimed to explore the epidemiological characteristics of primary and secondary diagnoses of eye injuries requiring hospitalization in a tertiary referral center.

METHODS The medical records of 726 patients with diagnoses of eye injury who were admitted between January 2016 and December 2019 were reviewed.

RESULTS Four hundred and thirty-six of the patients (60.1%) were hospitalized with a principal diagnosis related to eye injury, while 290 patients (39.9%) were admitted with secondary diagnoses. Over the four-year period of study, the proportion of admissions with a principal diagnosis stayed consistently in the range of 54.0% to 63.9%. Most of the patients in the principal diagnosis group were age between 41 and 60 years. Patients in the secondary diagnosis group, however, were mostly between the age of 21 and 40 years. The majority of patients in the principal diagnosis group (267 patients, 61.2%) had eye injuries which had occurred at work, whereas in the secondary diagnosis group most (230 patients, 79.3%) had eye injuries resulting from traffic accidents.

CONCLUSIONS Work-related accidents and traffic accidents were the two main types of at-risk behaviors in both the primary and secondary diagnosis categories. Initiatives for public health education related to eye injuries should pay more special attention to these two primary causes of severe eye injuries.

KEYWORDS principal diagnosis, secondary diagnosis, eye injury, hospitalization

INTRODUCTION

Although many regulations and/or programs have been established to reduce the incidence of eye injury in at-risk populations, eye injuries remain one of the leading causes of acquired visual impairment worldwide (1-8). Reviews of previous publications have shown that the study setting,

time-trend period, and geographic location can significantly impact the incidence and characteristics of the eye injury. For acute eye injury patients with minor or insignificant ocular damage, treatment at outpatient clinics was mostly successful. On the contrary, individuals with significant eye injuries alone or in combination with other systemic

illnesses required hospital admission for emergency medical attention (9-13). In-hospital patients had a higher risk of visual loss and decreased quality of life. However, other clinical variables, apart from the severity of the eye injury, can also have an impact on the clinical profiles of patients, including the criteria for hospital admission which can potentially change with the development of new medical and surgical advancements. Thus, understanding of shifts in epidemiological patterns and characteristics of eye injuries necessitating hospitalization should be taken into consideration when evaluating the impact of an eye injury.

This study aimed to identify trends in patients who were admitted to hospital with either principal or secondary diagnoses of eye injury. This information could be useful in the prevention of impaired vision from eye injury in a tertiary care context and in improving understanding the epidemiology of severe eye injury.

METHODS

This retrospective observational study was approved by the Hospital Research Ethics Committee, Faculty of Medicine, Chiang Mai University Hospital (Study Code: OPT 2562 06958). As the review of medical records was conducted without having direct contact with the patients, informed consent was waived. All study processes were performed in accordance with the Declaration of Helsinki. The data was recorded in Microsoft Excel spread sheets and was then deidentified to maintain patient confidentiality.

The medical records of patients who had been admitted between January 2016 and December 2019 with principal or secondary diagnoses related to eye injury (under the standard International Classification of Diseases, Tenth Edition, Clinical Modification (ICD-10 -CM) codes of S001-2, S011, S021, S023, S041-4, S050-9, T150-1, T158-9, and T260) were identified. All patients with a principal diagnosis as well as those with any one of the first four secondary diagnoses of any eye injury-related codes were recruited. In the case of patients who had multiple admissions as a consequence of the same eye injury, only the initial admission was reviewed. In cases where individuals suffered repeated occurrences of an eye injury during the study period, either in the originally injured eye or in the other eye, only the first event was included in the analyses.

Statistical analysis

For descriptive analyses, continuous data is presented as means (standard deviation, SD) or medians (interquartile range, IQR), while frequencies are shown as percentages. The Wilcoxon rank sum test was used to compare continuous data, and the Chi-square test to compare categorical data. The data was analyzed by the STATA® software, version 17 (StataCorp, College Station, TX, USA). P values less than 0.05 were considered statistically significant.

RESULTS

In total, there were 726 patients, with 436 patients (60.1%) in the principal diagnosis group and 290 patients (39.9%) in the secondary diagnosis group. The mean (SD) age of patients in the principal diagnosis group was 42.9 (18.8) years, whereas in the secondary diagnosis group it was 32.7 (16.5) years ($p < 0.001$). Despite a downward trend over the four-year study period, there was no statistically significant difference in the proportion of patients in the principal vs the secondary diagnosis groups in any year: 63.3% (114/180) in 2016, 63.9% (110/172) in 2017, 59.8% (104/174) in 2018, and 54.0% (108/200) in 2019; $p = 0.165$. Patients in the principal diagnosis group were more likely to be older (between the ages of 41 and 60 years), whereas those in the secondary diagnosis group tended to be younger (between the ages of 21 and 40 years). Females had a greater diversity in age distribution in each study year and in diagnosis than males (Figures 1 and 2).

Among the 436 patients in the principal diagnosis group, the three most common conditions related to eye injuries were open wound of the eyeball (277 patients, 63.5%), contusion of the eye and adnexa (67 patients, 15.4%), and open wound of eyelid and periocular area (44 patients, 10.1%). Over the four study years, there was no difference in the proportion of injury conditions in the principal diagnosis group ($p = 0.752$). Among the 290 patients in the secondary diagnosis group, open wounds of the eyelid and periocular area (67 patients, 23.1%), fractured orbital walls (63 patients, 21.7%) and contusions of the eye and adnexa (54 patients, 18.6%) were the most common conditions. Among patients in the secondary diagnosis group, a trend of an increasing proportion of fractured orbital walls and a decreasing proportion of contusion of the eye and adnexa were observed, but

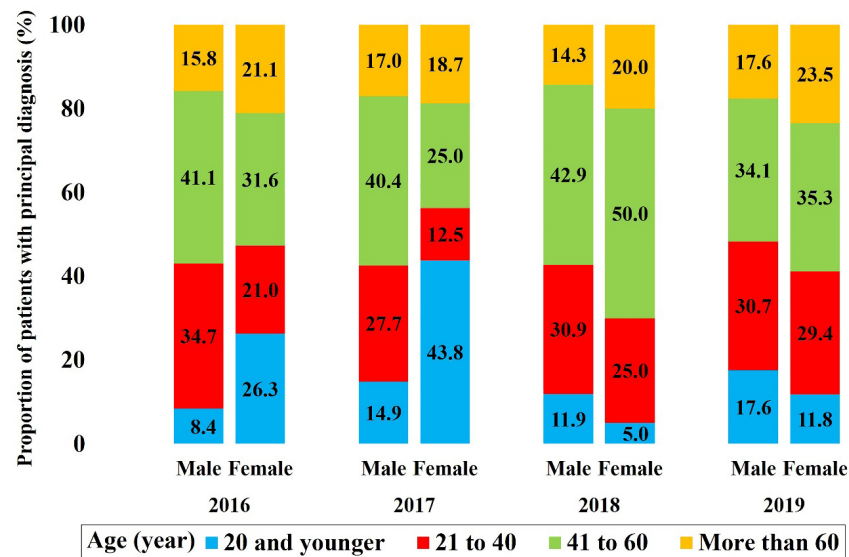


Figure 1. The distribution of age by gender and calendar year in patients with principal diagnoses related to eye injury subgroup

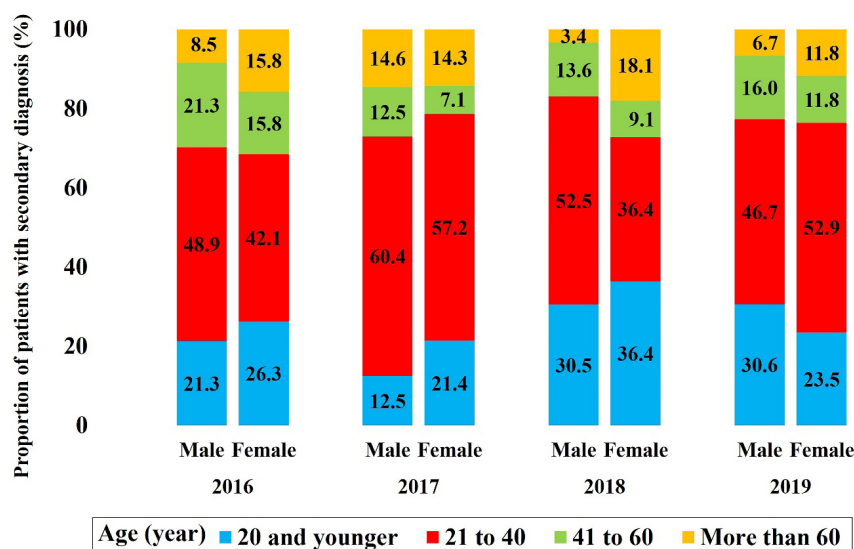


Figure 2. The distribution of age by gender and calendar year in patients with secondary diagnoses related to eye injury subgroup

the differences were not statistically significant ($p = 0.076$) (Figures 3 and 4).

Regarding the circumstances that led to the eye injury, the majority of the patients in the principal diagnosis group (267 patients, 61.2%) of the eye injuries occurred at work whereas in the secondary diagnosis group (230 patients, 79.3%) most of the eye injuries were a result of traffic accidents. Among the 285 patients in both groups who suffered injuries in traffic accidents, 242 (84.9%) of those accidents were related to motorcycles. The most common cause of injuries

was blunt objects with 168 patients (38.5%) in the principal diagnosis group and 256 patients (88.3%) in the secondary diagnosis group. Of the bilateral eye injuries, 14 patients belonged to the primary diagnostic group, while 82 patients were in the secondary diagnosis group. The predominant causes of primary and secondary diagnoses of eye injuries were similar: traffic – 60 patients (73.2%) in the primary and 5 patients (35.7%) in the secondary diagnosis group; assault – 7 patients (8.5%) in the primary and 3 patients (21.4%) in the secondary diagnosis group, and work-related – 6 patients

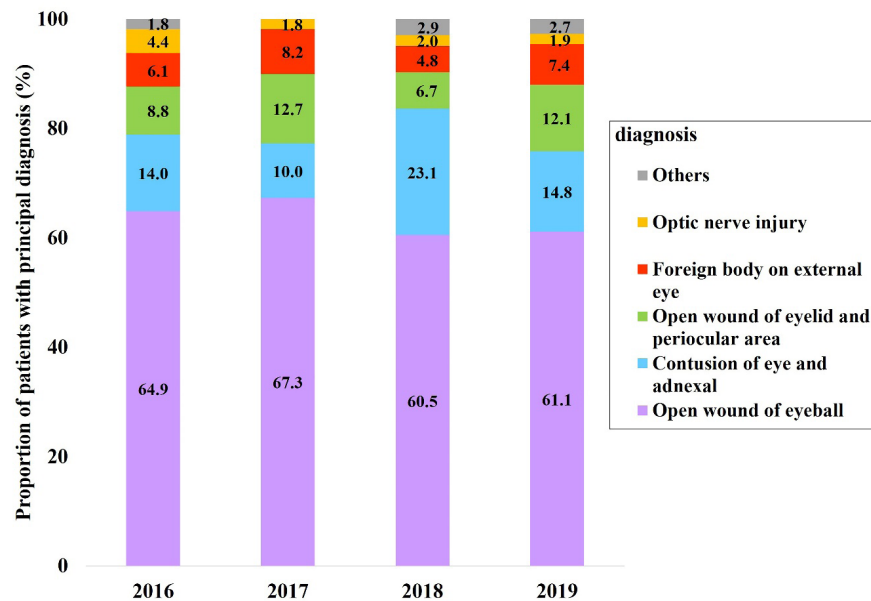


Figure 3. The distribution of eye injury diagnosis by calendar year in patients with principal diagnoses related to eye injury subgroup

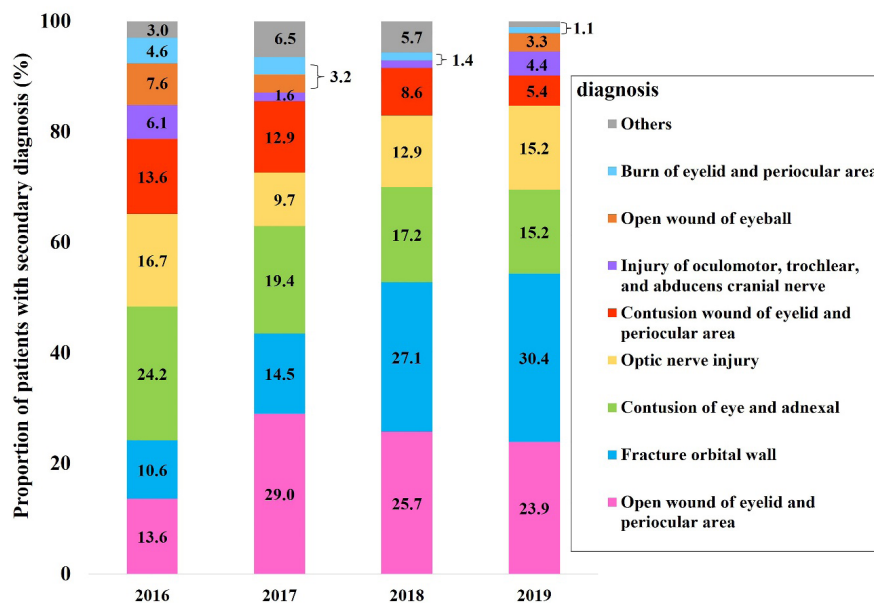


Figure 4. The distribution of eye injury diagnosis by calendar year in patients with secondary diagnoses related to eye injury subgroup

(7.3%) in the primary and 2 patients (14.3%) in the secondary diagnosis group. Table 1 summarizes patients' demographics, circumstances of and mechanisms/objects causing eye injury by eye injury-related diagnosis and calendar year.

Regarding ophthalmic interventions, 393 patients (90.1%) in the principal diagnosis group and 40 patients (13.8%) in the secondary diagnosis group required ophthalmic surgical treatment (Table 2). Additionally, 52 patients (11.9%) in the principal diagnosis group had other systemic involvements. Notably, 165 patients (56.9%) in the

secondary diagnosis group received medical care from more than two subspecialties compared to only 8 patients (1.8%) in the primary diagnosis group.

A large proportion (174 patients, 60.0%) of patients in the secondary diagnosis group lost to follow-up. In the principal diagnosis group, 122 patients (36.5%) had final vision of worse than 20/200, and 39 patients (11.7%) were lost to follow-up. Table 2 summarizes ophthalmic management and final visual acuity by eye injury-related diagnosis.

Table 1. The distribution of demographics, circumstances and mechanisms/objects causing eye injury by eye injury-related diagnosis of in-patients and calendar year

Characteristics	Total, n (%)	Year, n (%)			
		2016	2017	2018	2019
Principal diagnosis	436	114	110	104	108
Demographics					
Male, n (%)	364 (83.5)	95 (83.3)	94 (85.4)	84 (80.8)	91 (84.3)
Age (year), n (%)					
20 and younger	63 (14.4)	13 (11.4)	21 (19.1)	11 (10.6)	18 (16.7)
21 to 40	129 (29.6)	37 (32.5)	28 (25.5)	31 (29.8)	33 (30.5)
41 to 60	170 (39.0)	45 (39.5)	42 (38.1)	46 (44.2)	37 (34.3)
More than 60	74 (17.0)	19 (16.6)	19 (17.3)	16 (15.4)	20 (18.5)
Unilateral eye injury	422 (96.8)	114 (100.0)	104 (94.6)	101 (97.1)	103 (84.5)
Circumstances related to injury					
Work-related activities	267 (61.2)	71 (62.3)	68 (61.8)	66 (63.5)	62 (57.4)
Traffic-related activities	55 (12.6)	14 (12.3)	15 (13.6)	10 (9.6)	16 (14.8)
Household-related activities	37 (8.5)	11 (9.7)	7 (6.4)	9 (8.7)	10 (9.3)
Assault	22 (5.1)	7 (6.2)	5 (4.6)	4 (3.8)	6 (5.5)
Others	55 (12.6)	11 (9.5)	15 (13.6)	15 (14.4)	14 (13.0)
Mechanisms/objects related to injury					
Hit by blunt objects	168 (38.5)	45 (39.5)	42 (38.2)	36 (34.6)	45 (41.7)
Hit by sharp objects	81 (18.6)	25 (21.9)	18 (16.4)	21 (20.2)	17 (15.7)
Hit by high velocity objects	145 (33.3)	34 (29.8)	41 (37.3)	38 (36.5)	32 (29.6)
Exposed to explosive, chemical, or thermal-related objects	29 (6.6)	6 (5.3)	5 (4.6)	8 (7.7)	10 (9.3)
Others	13 (3.0)	4 (3.5)	4 (3.5)	1 (1.0)	4 (3.7)
Secondary diagnosis	290	66	62	70	92
Demographics					
Male, n (%)	229 (79.0)	47 (71.2)	48 (77.4)	59 (84.3)	75 (81.5)
Age (year), n (%)					
20 and younger	73 (25.2)	15 (22.7)	9 (14.5)	22 (31.4)	27 (29.4)
21 to 40	147 (50.7)	31 (47.0)	37 (59.7)	35 (50.0)	44 (47.8)
41 to 60	43 (14.8)	13 (19.7)	7 (11.3)	9 (12.9)	14 (15.2)
More than 60	27 (9.3)	7 (10.6)	9 (14.5)	4 (5.7)	7 (7.6)
Unilateral eye injury	208 (71.7)	46 (69.7)	45 (72.6)	51 (72.9)	66 (71.7)
Circumstances related to injury					
Work-related activities	19 (6.6)	6 (9.1)	4 (6.5)	5 (7.1)	4 (4.4)
Traffic-related activities	230 (79.3)	52 (78.8)	51 (82.3)	54 (77.1)	73 (79.4)
Household-related activities	13 (4.5)	3 (4.6)	1 (1.6)	3 (4.3)	6 (6.5)
Sport-related activities	1 (0.3)	0 (0.0)	1 (1.6)	0 (0.0)	0 (0.0)
Assault	16 (5.5)	4 (6.1)	1 (1.6)	6 (8.6)	5 (5.4)
Others	11 (3.8)	1 (1.5)	4 (6.5)	2 (2.9)	4 (4.4)
Mechanisms/objects related to injury					
Hit by blunt objects	256 (88.3)	60 (90.9)	50 (80.7)	60 (85.7)	86 (93.5)
Hit by sharp objects	9 (3.1)	1 (1.5)	3 (4.8)	3 (4.3)	2 (2.2)
Hit by high velocity objects	4 (1.4)	1 (1.5)	0 (0.0)	2 (2.9)	1 (1.1)
Exposed to explosive, chemical, or thermal eye injuries	12 (4.2)	3 (4.6)	2 (3.2)	5 (7.2)	2 (2.2)
Others	9 (3.0)	1 (1.5)	7 (11.3)	0 (0.0)	1 (1.1)

DISCUSSION

This study explored patterns of eye injury necessitating hospitalization in a university hospital in Northern Thailand based on principal and

secondary diagnoses for eye injury at discharge. The results demonstrate that there were disparities between the two groups in terms of patient age, diagnostic conditions, and the injury-causing

Table 2. The distribution of in-patients by ophthalmic management and final visual acuity by eye injury-related diagnosis

	Total, n (%)	Eye Injury-related diagnosis, n (%)		p-value
		Principal diagnosis (n=436)	Secondary diagnosis (n=290)	
Ophthalmic management (n=726)				
Observation	56 (7.7)	2 (0.5)	54 (18.6)	< 0.001
Medical treatments	168 (23.1)	26 (6.0)	142 (49.0)	
Minor interventions	69 (9.5)	15 (3.4)	54 (18.6)	
Operational interventions	433 (59.6)	393 (90.1)	40 (13.8)	
Final snellen visual acuity (n=624)				
20/200 and better	259 (41.5)	173 (51.8)	86 (29.7)	< 0.001
Worse than 20/200	152 (24.4)	122 (36.5)	30 (10.3)	
Undetermined	213 (34.1)	39 (11.7)	174 (60.0)	

events. Young males who sustained orbital and adnexal injury in traffic accidents made up a significant number proportion of cases in the secondary diagnosis group, whereas middle-aged or adult men who had received open globe injuries at work made up the majority of cases in the principal diagnosis group. For that reason, in developing eye injury prevention strategies, it is imperative to pay close attention to the key risks in different populations.

Notably, a large proportion of eye injuries are treated at an outpatient clinic or an emergency setting, whereas eye injuries of greater severity which had a higher risk of visual loss are more likely to receive inpatient care (14–18). The epidemiology of ocular injuries requiring inpatient care has been thoroughly investigated and updated in numerous publications covering various study designs, clinical situations, and study sites (2, 10, 19).

A study in the US that examined the National Inpatient Sample database discovered that although the overall incidence of eye injuries requiring hospitalization increased from 18 per 100,000 population in 2001 to 22 per 100,000 population in 2014, the proportion in which eye injury was the principal diagnosis declined. That study proposed that the rise in secondary diagnosis of eye injuries was due mainly to falls among the elderly (12). In another population-based study that compared data from the years 2000, 2005, 2010, and 2015 in Taiwan, the rate of eye injuries requiring inpatient care decreased from 1.34% in 2000 to 0.63% in 2015 (13). That study also found no discernible change in the proportion of patients with a principal diagnosis compared to a secondary

diagnosis throughout the four study years (a maximum value of 30.0% in 2010 and a minimum value of 25.5% in 2015). The authors postulated that enforcement to use eye protection may have contributed to the decline in the rate of eye injuries requiring hospitalization.

A number of covariables can also affect the likelihood of eye injuries requiring hospitalization. In this study, the ratio of hospitalized patients in the principal diagnosis group to the secondary diagnosis group remained steady over the study period. Severe injuries were more likely to be transferred to tertiary care institutions, which might have contributed to the high percentage of patients in the principal diagnosis group.

Regarding gender distribution, the presence of more males than females in this study is consistent with earlier studies of eye injuries (10, 11) in which disparities in the age-specific distribution by gender were observed (11, 13). For example, according to a study that examined data from the Taiwan National Health Insurance Research Database, males between the ages of 20 and 34 and females between the ages of 70 and 74 had the highest incidence rates of eye injuries (13). Additionally, a population-based study that analyzed data from 2005 to 2014 in Western Australia reported that males in of working age were most likely to appear for emergency eye care or be admitted after eye injuries, whereas females in the elderly age range were more likely to be admitted following eye injuries and children were most likely to present at the emergency room (20).

In this study, the age distribution of males remained relatively constant over the course of

the study period, peaking at medium to older adult age in the principal diagnosis group and at the adolescent to young adult age range for the secondary diagnosis group. In contrast, the age distribution of females fluctuated more widely across specific years, despite a trend towards an increased proportion of older patients in the principal diagnosis group over the study period. The small number of females in this study, however, may have had a confounding effect on the findings. Further studies with larger samples and more females could provide additional information on the distribution of eye injury by gender and age.

This study demonstrates that eye injury sustained at work continues to be a risk factor for patients in the principal diagnosis group. Several studies have underlined the importance of the use of eye protection to prevent workplace-related eye injury regardless of the type of occupation (21–24). As a majority of injured patients in this study worked independently in the agricultural sector where the importance of eye protection may have been largely overlooked. This is supported by the fact that many patients in the principal diagnosis group were struck by blunt or high-velocity objects, suffered open globe injuries, and were identified as having open wounds of the eyeball. On the other hand, the main causes of injury in the secondary diagnosis group were related to traffic accidents, particularly those involving motorbikes. These results are consistent with the finding that a significant proportion of patients in the secondary diagnosis group were hit by blunt objects, had orbital and adnexal injuries, were diagnosed as having open wounds of eyelid and periocular area, and experienced orbital wall fractures. Studies in Taiwan report similar results of traffic accidents in terms of hospitalization for eye injuries (13–25). Although wearing protective equipment when performing high-risk tasks or using a motor vehicle are encouraged in Thailand, ocular injuries still occur frequently. It is essential to emphasize personal safety awareness when engaging in both work- and vehicle-related activities to help reduce eye injuries.

This study provides an epidemiological review of significant eye injuries requiring hospitalization in a tertiary hospital over four years. However, detailed data addressing the circumstances

surrounding ocular damage, the overall rate of eye injury, and the use of eye protection devices or other safety equipment could not be extracted due to the retrospective nature of the study. Additionally, final vision outcomes could not be evaluated for patients who did not return for follow-up care or who were transferred back to their local hospitals for ongoing care. Lastly, due to socioeconomic structural changes, changes in lifestyle, and changes in ophthalmology admission criteria, particularly during the COVID 19 outbreak, further longitudinal in-depth research is essential to determine the trend of severe eye injuries requiring inpatient care.

CONCLUSIONS

Males made up the majority of patients needing inpatient care due to eye injuries. Work-related eye injuries in the principal diagnosis group and traffic-related injuries in the secondary diagnosis group reflect the typical at-risk circumstances. This study provides a better understanding of serious eye injuries and also highlights associated risks for eye injuries which could aid in the establishment of public health education programs.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to report.

ADDITIONAL INFORMATION

Authors contribution

P.A.: conceptualization, methodology, implementation, data analysis, writing, review, and editing manuscript; J.C.: conceptualization, methodology, data analysis, review manuscript, and supervision; S.C.: conceptualization, acquisition of data, interpretation of data, and review manuscript; C.P.: conceptualization, acquisition of data, and review

manuscript. All authors have read and approved the content of the final manuscript.

Data availability statement

The data analyzed in this study are not publicly available due to participant privacy but are available from the corresponding author upon reasonable request.

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