PREVALENCE AND FACTORS ASSOCIATED WITH FOREIGN BODY-ASSOCIATED OCULAR INJURY AMONG OCULAR INJURY PATIENTS IN FOUR COMMUNITY HOSPITALS, CENTRAL, THAILAND: A MULTI-CENTER STUDY

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Abstract

Background: Foreign body (FB) associated ocular injury is a common cause of eye trauma. Understanding the prevalence and associated factors of FB-associated ocular injuries is essential for developing targeted prevention strategies and improving healthcare access for ocular trauma in community areas.

Objectives: This study aimed to determine the prevalence and associated factors of FB-associated ocular injuries among patients presenting with ocular trauma at four community hospitals in central Thailand.

Methods: This cross-sectional multicenter study reviewed ocular injury cases in four community hospitals in central Thailand, identified by ICD-10 codes from October 1, 2018, to September 17, 2024. Characteristics of FB-associated ocular injury, defined as ocular trauma with history or examination indicating a foreign body as the causative agent, were reviewed from medical records. Descriptive statistics and chi-square tests were used to analyze the differences between groups. Prevalence ratios (PRs) with 95% confidence intervals (CIs) were estimated using Poisson regression with robust variance to assess associations. Temporal trends were examined by fiscal year periods.

Results: Of 7,189 participants (60.8% male; mean age 45 years), 62% (n=4,456) had FB-associated ocular injuries. Male gender (aPR 1.12, 95% CI 1.08–1.16), metal/stone objects (aPR 1.53, 95% CI 1.46–1.59), and injury onset ≥24 hours (aPR 1.24, 95% CI 1.17–1.32) were associated with a higher risk. Trend analysis by fiscal year showed that health-seeking behavior shifted toward OPD visits ($p<0.001$).

Conclusion: The prevalence of FB-associated ocular injuries in community hospitals was high, with male gender, mechanical work, metallic objects, and delayed healthcare access (>24 hours) identified as significant risk factors. Preventive strategies such as promoting protective measures in industrial sectors and emphasizing the importance of seeking timely healthcare are essential to reducing the injury burden. Since 2019, a shift in healthcare access from ER to OPD has been observed, underscoring the need for a flexible healthcare system that can adapt to changing health-seeking behaviors.

Keywords: foreign body-associated ocular injury; ocular injury; factor association; community hospital

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Introduction

Ocular injury is one of the most common eye diseases, leading to visual impairments, ocular morbidity, and hospitalization.[1] An estimated 59 million eye injuries occur annually worldwide.[2] Although the incidence of eye injuries has decreased over the past three decades, the absolute number of cases continues to rise.[3] Additionally, ocular injury imposes a significant socioeconomic burden, particularly in low- and middle-income countries.[4] A study conducted in Southeast Asia reported that ocular injuries occur in approximately 1 out of every 20 people.[5] While these injuries can severely affect vision, most cases are preventable before complications arise.

Among the various types of ocular injuries, foreign body-related injuries are the most common, accounting for approximately 40%.[6] Particles, such as metal or wood, that accidentally enter the eye can cause serious infections and ocular complications.[7] Several studies have shown that ocular foreign body injuries are more frequently associated with males, working age, those in charge of ironwork, community areas, and those of low to middle socioeconomic status.[8,9] In Thailand, both urban and community settings report that foreign bodies are the most common cause of ocular injuries.[10] However, the prevalence and associated factors of this condition in community areas, particularly in central Thailand, remain unidentified.

Most ocular emergency cases were handled by general practitioners in emergency departments, where there are often limitations in effectively managing ocular injuries.[11,12] Ideally, ocular foreign bodies should be removed within 24 hours of the injury. Several reports indicate that undetected or delayed removal of corneal foreign bodies can lead to deeper corneal penetration and complicate management.[13] Despite these challenges, there are limited resources and no definitive clinical practice guidelines for managing ocular injuries in the community of Thailand, including those associated with foreign bodies.

Understanding the prevalence, characteristics, and factors of foreign body-related ocular injuries in community hospitals is important. These cases are often managed by general practitioners with limited resources. The findings support the development of better prevention and management strategies. This study seeks to address this gap by investigating the prevalence and risk factors associated with foreign body ocular injuries among patients in community hospitals in central Thailand.

Methods

Study design and subjects

A cross-sectional study was conducted from October 1, 2018, to September 17, 2024. This multicenter study was conducted across four community hospitals in central Thailand: Sanam Chai Khet Hospital and Phanom Sarakham Hospital in Chachoengsao Province, as well as Tha Luang Hospital and Tha Wung Hospital in Lopburi Province. These hospitals can be classified into two types of community hospitals, according to the Service Plan framework of the Ministry of Public Health: mild-level referral (M2) and first-level referral (F2) hospitals.[14] M2 hospitals are secondary care facilities with 120 or more beds and offer services in six primary specialties: internal medicine, surgery, obstetrics and gynecology, pediatrics, orthopedics, and anesthesiology. They support primary care and help reduce referrals to tertiary centers. F2 hospitals are smaller, with 60–90 beds, typically staffed

by 2–5 general practitioners or family medicine physicians, and have limited specialist services. In both settings, patients with ocular injuries were first triaged by nurses. General practitioners then perform examinations and provide initial care, such as eye irrigation. Ophthalmologists might be scheduled for more complex cases, followed by follow-up appointments.

The inclusion criteria were patients with a history of ocular injury. The exclusion criteria were: (1) confirmed misdiagnosis based on the patient's history of present illness, (2) age under 20 years, as individuals in this group are less likely to be involved in industrial work, and (3) the follow-up visit. The sample size was calculated based on the prevalence of ocular foreign bodies among patients with ocular injuries, which stands at 39.41% among ocular diagnoses in eye emergency departments. A multicenter study yields a result of at least 591 with a 5% margin of error and 80% power.[15]

Data collection

Patients with ocular injury were identified with reference to the International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM). The included codes are shown in **Supplementary Table 1.** Then, the patients' medical records—particularly the section on the present illness—were reviewed to identify ocular injuries that occurred during the study period. A keyword search approach was employed using R Studio, with terms such as "foreign body into the eye" and "hit the eye" to screen relevant cases. To ensure data accuracy, researchers randomly rechecked 10% of the records, and any discrepancies were resolved through a consensus process. Procedure records with different details but identical time, department, and hospital number (HN) within the same visit were considered duplicates. In cases where ocular injuries affected one or both eyes during the same visit, these were treated as a single event, with only one record retained for analysis. The follow-up cases were excluded. The total number of eligible observations was 7,189. All data were de-identified before analysis. The study flow of all patients is demonstrated in **Figure 1.**

The primary outcome of this study, FB-associated ocular injury, was defined as any ocular trauma in which either the patient's history or physical examination indicated a foreign body as the causative agent; this included injuries caused by any external object that penetrated or contacted the eye, as documented in patient records during the study period.

The factors associated with FB-associated ocular injury were divided into two sections. The former section provides information about patient characteristics and FB-associated ocular injuries, including demographic details, activities at the time of injury, causative object, mechanism of injury, location of the ocular injury, onset of injury, and ophthalmological findings. The latter section focused on healthcare access, including hospital capacity, visit date, visit time, visit department, emergency severity index level, and treatment status.

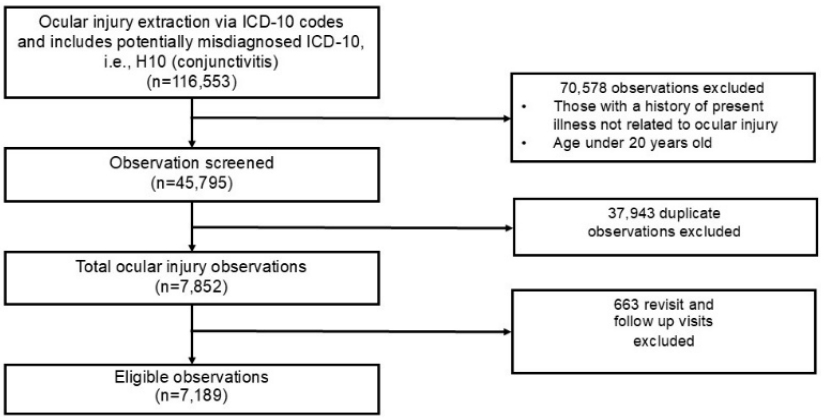

Figure 1. The study flow and data management

Covariate classification

The study data were classified according to clinical relevance and patient characteristics to explore risk factors and assess outcomes of FB-associated ocular injuries.

Occupation and activities at the time of injury

The manual labor group comprises workers in various fields, including construction, mechanics, agriculture, and other unspecified occupations. On the contrary, non–manual labor comprises teachers, healthcare workers, managers, public service employees, household maids, the unemployed, and the retired.

Mechanism and causative objects of ocular injury

Ocular injuries were classified by mechanism into sharp and blunt trauma. Sharp injuries involved small objects that could penetrate the eye, identified by keywords such as "into the eye," "splashed into eyes," or "blown into the eye," and causative agents like "metal," "stone," or "particle." Blunt injuries were identified using terms like "beat" or "hit," and typically involved larger objects, such as a "wood stick" or a "tree branch." Both types of trauma may contribute to open-globe injuries, which often require urgent surgical intervention by an ophthalmologist.[1]

Causative objects were categorized into four types: metal/stone, thermal/chemical, wood, and organic compounds. Metal and stone were commonly associated with penetrating injuries and intraocular foreign bodies.[7] Thermal and chemical agents primarily affected the ocular surface,[16] while wood and organic materials were more often linked to blunt trauma and globe rupture due to an inside-out pressure mechanism.[17]

Onset and day of injury

The onset of injury was classified into three groups: less than 1 hour, within 24 hours, or after 24 hours, reflecting the urgency of care. Immediate treatment was required for injuries like chemical burns or globe ruptures, while ophthalmologists had treated ocular foreign bodies or lacrimal lacerations within 24 hours.[18] Delays had indicated poor health-seeking behavior.

Emergency severity index

The Emergency Severity Index (ESI) classifications were divided into three categories: resuscitation/emergency (ESI-1 and ESI-2), covering major trauma or chemical eye injuries; urgent (ESI-3), for open-globe injuries; and non-emergencies (ESI-4 and ESI-5), representing less severe conditions.[18]

Statistical analysis

All analyses were performed using StataCorp, 2021, Stata Statistical Software: Release 17. College Station, TX: StataCorp LLC. A frequency distribution of demographic characteristics was employed to describe the study subjects. Categorical data were expressed as percentages, while continuous variables were presented as means with standard deviations (SD) or medians with interquartile ranges (IQR), depending on whether the data were normally distributed. The analysis accounted for non-normal distributions and violations of the linearity assumption. For trend analysis, years were divided according to the fiscal calendar, spanning from October 1 to September 30, with the final period ending on September 17, 2024.

To examine the associations between risk factors and the primary outcome, prevalence ratios (PRs) with 95% confidence intervals (CIs) were estimated using Poisson regression with robust variance estimation. This approach was chosen instead of logistic regression to avoid the overestimation associated with odds ratios in the context of a common outcome (prevalence > %).[19] All statistical tests were two-sided, and a p-value <0.05 was considered statistically significant.

The final model handled missing data using multiple imputations by chained equations (MICE).[20] The variable occupation, derived from the hospital database, was sometimes missing at registration, resulting in over 20% missing values. Therefore, an analysis was also performed to determine the type of missing data. The imputation model included age, gender, pre-arrival timing, mechanism of injury, causative objects (metal/stone, chemical/thermal, wood stick, organic compound), and the outcome of FB-associated ocular injury. Poisson regression

with robust variance was applied to each of the 50 imputed datasets, and the results were pooled using Rubin's rules.[21]

Ethics approval and consent to participate

The study was approved by the Medical Department Ethic Review Committee for Research in Human Subjects, Institutional Review Board, RTA (approval no. M010h/67_Exp), in accordance with the international guidelines including the Declaration of Helsinki, the Belmont Report, CIOMS Guidelines, and the International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use–Good Clinical Practice (ICH-GCP). Due to the use of secondary data, the authors obtained a waiver of documentation of informed consent. The Institutional Review Board of the RTA Medical Department granted the waiver.

Table 1. Characteristics of patients presented with ocular injuries at community hospitals in central Thailand

Characteristics	n (%)
Gender	
Male	4,373 (60.8)
Female	2,816 (39.2)
Age (years old)	
Median (IQR)	43 (31-57)
Mean ± SD	45 ± 17
Occupation (n=5,205)	
Manual Labor	4,141 (79.6)
Public Service/Military	141 (2.7)
Agriculture	95 (1.8)
Managers/Professionals	39 (0.8)
Healthcare Workers	37 (0.7)
Education	17 (0.3)
Unemployed/Retired	735 (14.1)
Community hospital level	
M2	4,685 (65.2)
F2	2,504 (34.8)
Visit department (n=7,188)	
Emergency Room	3,883 (54.0)
OPD GP	3,156 (43.9)
OPD eye	93 (1.3)
OPD Specialist	56 (0.8)
ESI level (n=5,173)	
Resuscitation	23 (0.5)
Emergency	172 (3.5)
Urgency	4,222 (85.0)
Less Urgency	456 (9.2)
Non Urgency	95 (1.9)

IQR; interquartile range, SD; standard deviation, OPD; outpatient department, GP; general practice doctor, ESI; emergency severity index

Results

Characteristics of the patients

Between October 1, 2018, and September 17, 2024, a total of 7,189 patients presented with ocular injuries at community hospitals in central Thailand. The male-to-female ratio was 1.55:1, and the median age was 43 years (IQR 31–57). Most patients (4,141; 79.6%) were manual laborers. Regarding healthcare access, 3,883 (54.0%) visited the emergency department, while 3,156 (43.9%) attended the outpatient department managed by general practitioners. Injury severity, classified by ESI, showed that 4,222 (85.0%) cases were categorized as having an urgency level **(Table 1).**

Prevalence and relationship with patients' characteristics, nature of injury, and healthcare access of foreign body-associated ocular injury

Table 2 displays the patients with ocular injuries, showing that the prevalence of FB-associated ocular injury was 62.0% (n = 4,456). The prevalence was higher in males, at 2,970 cases (67.9%, $p < 0.001$), compared to females. Manual laborers were more likely to present with FB-associated ocular injury, with 3,120 observations (74.3%), compared to non-manual laborers, who had 749 observations (67.8%) ($p < 0.001$). Notably, 437 cases occurred during work (87.4%) ($p < 0.001$), and sharp objects were the cause of injury in 1,297 observations (97.0%) ($p < 0.001$).

Figure 2 demonstrates an overall increasing trend in the adjusted prevalence of FB-associated ocular injuries from 2018 to 2023, after adjustment for age and gender. A significant non-linear trend was observed ($p = 0.001$). In 2019, patients with FB-associated injuries were more likely to present to the ER compared with the OPD. However, from 2020 onward, this pattern reversed, with OPD visits exceeding ER visits and maintaining a steady predominance in the following years.

Figure 3 displays causative objects, showing that metal/stone has the highest proportion (97.9%) of FB-associated ocular injury compared to other objects. Additionally, most patients, regardless of whether their symptoms had persisted for less than or more than one day, sought care between 7:00 and 8:00 AM **(Figure 4).**

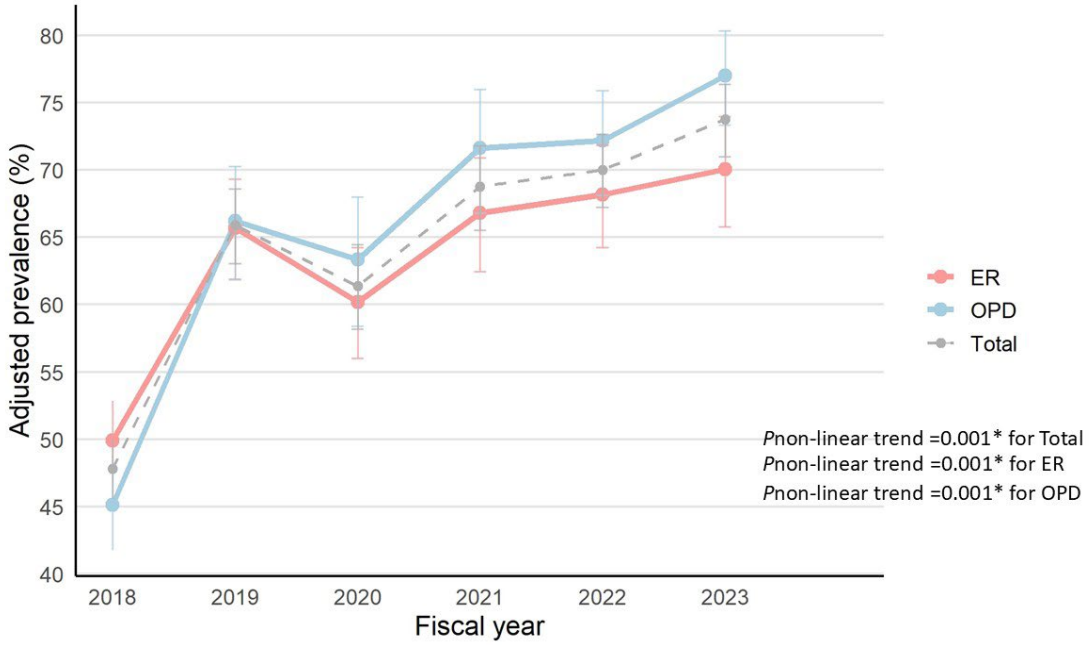

Figure 2. Gender- and age-adjusted proportion of FB-associated ocular injury across fiscal years

Table 2. Factors comparing FB-associated ocular injuries among ocular injury patients at community hospitals in central Thailand.

Characteristics	Non-FB associated ocular injury	FB-associated ocular injury	*p*-value
	n (%)	n (%)	
No. of participants	2,733 (38.0)	4,456 (62.0)	
Gender			<0.001[c]*
Male	1,403 (32.1)	2,970 (67.9)	
Female	1,330 (47.2)	1,486 (52.8)	
Age (years old)			
Mean ± SD	48 ± 17	43 ± 15	<0.001[t]*
Occupation			<0.001[c]*
Manual labor	1,077 (25.7)	3,120 (74.3)	
Non-manual labor	356 (32.2)	749 (67.8)	
Community hospital level			<0.001[c]*
M2	1,182 (25.2)	3,503 (74.8)	
F2	1,551 (61.9)	953 (38.1)	
Visit department (n=7,188)			0.129[c]*
Emergency Room	1,507 (38.8)	2,376 (61.2)	
OPD	1,225 (37.1)	2,080 (62.9)	
Injury in workplace (n=500)	63 (12.6)	437 (87.4)	<0.001[c]*
Mechanism of injury			<0.001[c]*
Blunt	106 (75.2)	35 (24.8)	
Sharp	40 (3.0)	1,297 (97.0)	
Unknown	2,587 (45.3)	3,124 (54.7)	
Onset of injury (hour)			<0.001[c]*
Less than 1	783 (53.9)	671 (46.2)	
1 to less than 24	1,054 (25.0)	3,168 (75.0)	
More than 24	1,247 (36.4)	2,178 (63.6)	

Table 2. Factors comparing FB-associated ocular injuries among ocular injury patients at community hospitals in central Thailand. (Cont.)

Characteristics	Non-FB associated ocular injury	FB-associated ocular injury	*p*-value
	n (%)	n (%)	
ESI group (n=4,968)			<0.001[c]*
Resuscitation/Emergency	81 (41.5)	114 (58.5)	
Urgency	1,117 (25.5)	3,265 (74.5)	
Less Urgency/Non-Urgency	372 (67.5)	179 (32.5)	

IQR; interquartile range, OPD; outpatient department, GP; general practice doctor, ESI; emergency severity index, ER; emergency Room, *statistical significant (*p*-value <0.05), [c]Chi-square, [t] t-test

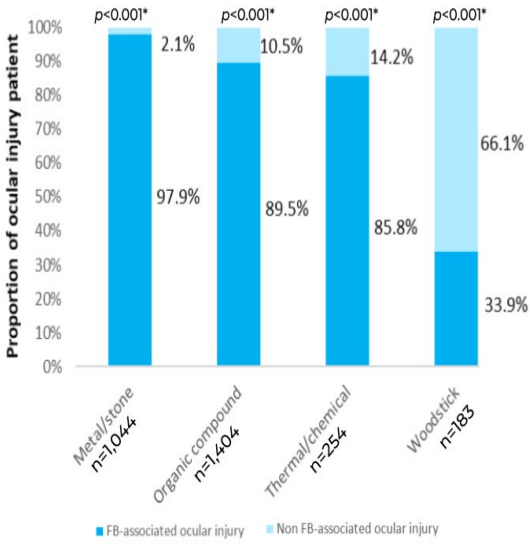

Figure 3. Causative objects of ocular injuries

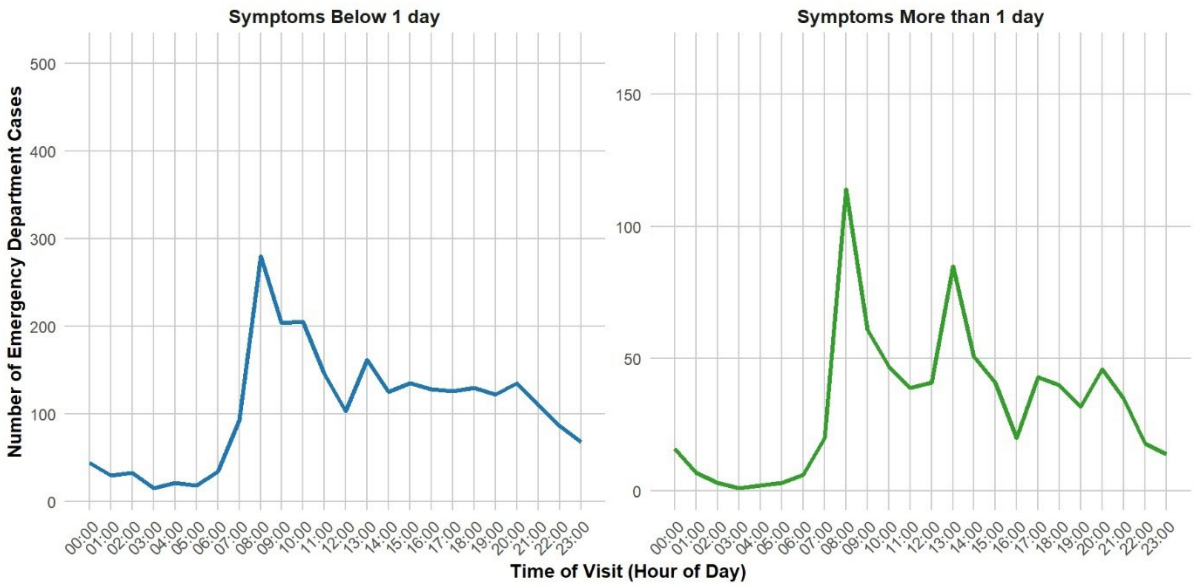

Figure 4. Number of ocular injury cases visiting the emergency department and time of visit, categorized by duration of symptoms

Factors associated with FB-associated ocular injury

Table 3 shows the Poisson regression with robust variance analysis of factors associated with FB-associated ocular injury. The proportion of missing data for occupation variables was 26.2%. Comparisons between records with and without missing values showed significant differences, suggesting that missing data were likely missing at random (MAR). Therefore, the MICE method can be used in the final model analysis.

The model was adjusted for gender, age, occupational group, hospital levels, visiting department, onset of injury, mechanism of injury, and causative objects. Factors associated with increased risk of FB-associated ocular injury were identified, including being male (aPR: 1.12, 95% CI: 1.08, 1.16), injuries resulting from sharp mechanisms (aPR: 2.70, 95% CI: 2.04, 3.57), and injuries caused by metal or stone (aPR: 1.53, 95% CI: 1.46, 1.59). In addition, M2 hospital visit (aPR 1.73, 95% CI: 1.65, 1.83), arriving between 1 hour and 24 hours (aPR 1.27, 95% CI: 1.20, 1.34)

Table 3. Univariable and multivariable analysis of factors associated with FB-associated ocular injury among ocular injury patients at community hospitals in Thailand.

Characteristics	Non-FB-associated ocular injury	FB-associated ocular injury	cPR	95%CI	*p*-value	aPR	95%CI	*p*-value
	n (%)	n (%)						
Gender								
Male	1,403 (32.1)	2,970 (67.9)	1.29	1.24, 1.34	<0.001*	1.12	1.08, 1.16	<0.001*
Female	1,330 (47.2)	1,486 (52.8)	ref			ref		
Age (years old)								
Median (IQR)	47 (34-61)	42 (31-55)	0.99	0.99, 0.99	<0.001*	1.00	0.99, 1.00	0.545
Occupation (n=5,302)								
Manual labor	1,077 (25.7)	3,120 (74.3)	1.15	1.08, 1.22	<0.001*	1.04	0.99, 1.09	0.134
Non-manual labor	356 (32.2)	749 (67.8)	ref			ref		
Hospital level								
M2	1,182 (25.2)	3,503 (74.8)	1.96	1.87, 2.07	<0.001*	1.73	1.65, 1.83	<0.001*
F2	1,551 (61.9)	953 (38.1)	ref			ref		
Visit department (n=7,188)								
Emergency Room	1,507 (38.8)	2,376 (61.2)	ref			ref		
OPD	1,225 (37.1)	2,080 (62.9)	1.03	0.99, 1.07	0.126	0.95	0.91, 0.99	0.031*
Onset of injury (hour)								
Less than 1	783 (53.9)	671 (46.2)	ref			ref		
1 to less than 24	1,054 (25.0)	3,168 (75.0)	1.51	1.42, 1.60	<0.001*	1.27	1.20, 1.34	<0.001*
Equal or more than 24	1,247 (36.4)	2,178 (63.6)	1.38	1.30, 1.46	<0.001*	1.24	1.17, 1.32	<0.001*
Mechanism of injury								
Blunt	106 (75.2)	35 (24.8)	ref			ref		
Sharp	40 (3.0)	1,297 (97.0)	3.91	2.93, 5.21	<0.001*	2.70	2.04, 3.57	<0.001*
Unknown	2,587 (45.3)	3,124 (54.7)	2.20	1.65, 2.94	<0.001*	2.47	1.87, 3.27	<0.001*

Table 3. Univariable and multivariable analysis of factors associated with FB-associated ocular injury among ocular injury patients at community hospitals in Thailand. (Cont.)

Characteristics	Non-FB-associated ocular injury	FB-associated ocular injury	cPR	95%CI	*p*-value	aPR	95%CI	*p*-value
	n (%)	n (%)						
Causative objects								
Metal/stone	22 (2.1)	1,022 (97.9)	1.75	1.71, 1.79	<0.001*	1.53	1.46, 1.59	<0.001*
Thermal/chemical agent	36 (14.2)	218 (85.8)	1.41	1.33, 1.48	<0.001*	1.18	1.10, 1.26	0.001*
Wood stick	121 (66.1)	62 (33.9)	0.54	0.44, 0.66	<0.001*	0.69	0.57, 0.83	<0.001*
Organic compound	147 (10.5)	1,257 (89.5)	1.62	1.57, 1.67	<0.001*	1.63	1.58, 1.69	<0.001*

OPD; outpatient department, * Statistical significant

or more than 24 hours after injury (aPR: 1.24, 95% CI: 1.17, 1.32) were statistically significant to FB-associated ocular injury. On the contrary, the injury by a wood stick was the protective factor of FB-associated ocular injury (aPR: 0.69, 95% CI: 0.57, 0.83). Additionally, in the final analysis, patients visiting the OPD were less likely to present with FB-associated ocular injury compared to those visiting the ER (aPR = 0.95; 95% CI: 0.91–0.99).

In sensitivity analyses stratified by department (ER vs. OPD), the associations of male gender, higher hospital level, sharp/unknown injury mechanism, and causative objects (metal/stone, organic compounds) with FB-associated ocular injury remained significant in both groups, although effect sizes varied. Hospital level (M2 vs F2) showed a stronger association in the OPD (aPR 2.63, 95% CI: 2.24–3.08) than in the ER (aPR 1.46, 95% CI: 1.32–1.62). Wood stick injuries were protective in both settings, more pronounced in ER (aPR 0.63, 95% CI: 0.46–0.87) than OPD (aPR 0.81, 95% CI: 0.54–1.23). Further details are provided in **Supplementary Table 2.**

Discussion

This study enrolled 7,189 patients with ocular injuries in community hospitals in central Thailand to investigate the prevalence and associated factors of FB-associated ocular injuries. The prevalence of FB-associated ocular injuries in this study was higher compared to previous studies.[22–24] Factors significantly associated with an increased risk of FB-related injuries included male gender, injuries caused by sharp mechanisms, and causative objects like metal or stone. Analysis of healthcare access revealed that presenting to M2 hospitals and visiting onset beyond 24 hours were related to FB-associated ocular injury cases. Notably, this is the first multicenter study in Thailand involving community hospitals, whereas previous research has primarily focused on tertiary care centers. Healthcare access characteristics and patient behaviors specific to community populations were also identified, highlighting the unique context of ocular injury management in these settings.

This study revealed a 62.0% prevalence of FB-associated ocular injuries among patients with ocular injuries, a rate that is relatively high compared to previous studies, which reported rates of approximately 40%.[24,25] This elevated prevalence may be attributed to the community setting, where the population is at a higher risk due to factors such as male gender, middle age, and occupations involving mechanical activities and tasks, such as metal grinding. These risk factors align with those identified in prior research.[22,24,26,27] In contrast, tertiary care centers are more likely to see a wider variety of ocular injury cases, and patients with ocular foreign bodies may be less likely to present to tertiary centers than to secondary or primary care facilities.

In the current study, several factors significantly increased the risk of FB-associated ocular injuries, emphasizing the unique risks present in community hospital settings. These risk factors included male gender, middle age, injuries caused by sharp mechanisms, and exposure to thermal, chemical, or organic compounds. The predominance of workplace-related injuries—87.4% (n=437) of FB-associated cases—further highlights the occupational hazards faced by individuals in these settings. Given this high prevalence, as suggested in previous studies, industrial sectors should prioritize providing proper eye protection for workers and emphasize a 'safety first' approach.[28–31] The high prevalence of FB-associated ocular injuries may reflect the inadequate use of protective eyewear among laborers in Thailand, as mentioned in previous research.[32,33] In contrast, injuries involving wood sticks and blunt mechanisms were identified as protective factors; this could be attributed to the larger size of these objects relative to the orbit, preventing them from entering the eye and causing FB-related injuries.[34–36]

Interestingly, our study did not find a statistically significant association between occupation and FB-associated ocular injuries, contrasting with some prior research. One possible explanation for this discrepancy is that the occupational data was extracted from a hospital database, which typically only indicates general manual

labor without detailing the specific type of work or tasks involved. Moreover, the occupation listed on the hospital database may not reflect the individual's current job. However, the activities reported during the injuries—such as metal grinding or mechanical work—were frequently mentioned, providing valuable insights into how these injuries occurred in the workplace. This finding aligns with those from other studies, which have similarly reported that a significant proportion of ocular injuries arise in occupational settings.[33,37]

Concerning behaviors related to healthcare access among patients with FB-associated ocular injuries were observed, highlighting a lack of awareness and knowledge regarding the urgent need for specialized medical attention. Notably, more than 24 hours elapsed between the occurrence of the FB injury and the patient's hospital treatment, with 2,178 individuals (63.6%) falling into this category. This duration contradicts the ocular injury management recommendations, which suggest that patients with ocular foreign bodies should seek definitive removal and management within 24 hours after the injury.[38] Delayed medical seeking for ocular injuries has also been observed in research conducted in low socioeconomic communities.[39,40] Interestingly, the timing of hospital visits predominantly clustered around 7-8 AM, irrespective of whether the injury occurred within or beyond the 24-hour threshold. This pattern suggests that patients may prioritize convenience over urgency, potentially jeopardizing their ocular health and increasing the risk of poor prognoses. Some literature indicates that individuals might perceive ocular foreign bodies as less critical or manageable, often attempting self-removal before seeking professional care.[41,42]

Furthermore, in the final analysis, patients with FB-associated ocular injuries were initially less likely to present to the OPD compared with those presenting to the ER. However, trend analysis revealed that after 2019, coinciding with the COVID-19 pandemic, the proportion of OPD visits increased despite an overall decline in case numbers.[43] Sensitivity analysis confirmed that this pattern was consistent across subgroups, with the association between higher hospital level and FB-associated ocular injury being stronger in the OPD than in the ER. This shift may be explained by patients avoiding large hospitals due to fear of infection, mobility restrictions, limited transportation, and the prioritization of critical cases in emergency rooms, which redirected less severe injuries to outpatient departments. These findings underscore the importance of adaptable healthcare services during times of crisis.[45]

This study found a high prevalence of FB-associated ocular injuries, often with delayed care. Timely treatment within 24 hours, especially immediate irrigation for chemical injuries, is essential to prevent complications.[46,47] Late presentation reflects limited awareness.[48–50] To address this, targeted active health education campaigns are crucial for high-risk populations.[51] Training general practitioners for after-hours care and implementing clear, context-specific national guidelines are crucial for improving timely management and patient outcomes.[52, 53]

Future research should focus on several areas to build upon the findings of this study. First, a detailed analysis of treatment delays among patients with ocular injuries is warranted, as this study identified significant delays in seeking care. Second, exploring recurrent cases of ocular injuries may provide valuable insights into risk factors and inform preventive strategies for this population. Finally, examining follow-up cases could reveal changes in visual outcomes and potential complications associated with FB-related ocular injuries, thereby enhancing our understanding of the long-term impacts and care needs.

To our knowledge, this study represents the first multicenter investigation conducted in community hospitals across central Thailand, involving four facilities. It emphasizes the high prevalence of FB-associated ocular injuries among this vulnerable, high-risk group of patients. Importantly, our findings shed light on healthcare access behaviors within this population, highlighting critical gaps that warrant intervention to reduce the prevalence of FB-associated ocular injuries, a preventable cause of blindness.

However, this study encountered several limitations. First, as a cross-sectional study, it could only identify associations rather than causal relationships. Second, the use of secondary data might affect the accuracy and completeness of certain records, as it depended on healthcare providers' documentation rather than direct assessment by the research team. Furthermore, comprehensive ophthalmologic examinations might be limited, as general practitioners often have less experience in performing detailed eye evaluations. Nonetheless, the straightforward nature of ocular injury documentation enhanced the reliability of the recorded risk factor data.

The study's observational design resulted in 40.8% missing data. While the overall sample size (n = 7,189) is well above the minimum required for estimating prevalence, missing data may limit the reliability of analyses examining associated factors. To address this, we used MICE to create complete datasets. However, MICE assumes that data are missing at random and, when combined with Poisson regression using robust variance, may slightly underestimate standard errors and confidence intervals. Results should therefore be interpreted with caution. Third, the population studied was confined to central Thailand, which may affect the external validity and generalizability of the findings to other regions. Fourth, this study considered bilateral ocular injuries occurring within the same visit as a single event due to limitations in data recording. Consequently, the analysis assumes independence of events, which may not fully capture the potential correlation between injuries in both eyes.

Conclusion

This study demonstrated a high prevalence of FB-associated ocular injuries in community hospitals, with male gender, mechanical work, metallic objects, and delayed healthcare access (>24 hours) identified as significant risk factors. Preventive strategies are crucial to reducing injury burden and improving outcomes, such as promoting protective measures in industrial sectors and strengthening health education on the importance of early medical attention. Notably, a shift in healthcare access from ER to OPD was observed after 2019, likely influenced by the COVID-19 pandemic. These findings underscore the need for a flexible healthcare system that can adapt to shifting health-seeking behaviors, ensuring timely and appropriate care.

Competing interests

During the preparation of this work, the authors utilized ChatGPT to check certain grammatical aspects. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Availability of data and materials

The data and materials are available upon reasonable request to the corresponding author via email at panrawees@pcm.ac.th.

Abbreviations

FB-associated ocular injury: foreign body-associated ocular injury, ER: emergency room, OPD: outpatient department, ESI: emergency severity index, GP: general practices, aPR: adjusted prevalence ratio, CI: confidence interval, IQR: interquartile range, SD: standard deviation

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