• Investigation •

Trends of delayed healthcare access in ocular injuries: a multicenter study in community hospitals, Central Thailand

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Abstract

● **AIM:** To determine the annual trends and risk factors for delayed access to care in community hospitals across Central Thailand—an area with high occupational injury risk.

● **METHODS:** This retrospective cross-sectional study analyzed data from four community hospitals in Central Thailand over six years (October 1, 2018–September 17, 2024). Patients aged ≥20y with ocular injuries, identified *via* International Classification of Diseases-10 (ICD-10) codes, were included. Demographics, injury characteristics, and care-seeking behaviors were recorded. Delayed access was defined as presentation >24h post-injury. Linear and logistic regression models were used to identify associated risk factors. Annual fiscal trends were analyzed to assess year-to-year patterns in delayed healthcare access.

● **RESULTS:** Among 6571 ocular injury cases, 4034 (61.4%) were male, with median age 43y [interquartile range (IQR) 31–57y], and 3983 (79.3%) were manual laborers. Delayed healthcare access was observed in 2426 cases (36.9%). Significant risk factors included age ≥60y [aOR: 1.55; 95% confidence interval (CI): 1.32–1.82], visits to F2-level hospitals [adjusted odds ratio (aOR): 2.03; 95%CI: 1.73–2.38], and outpatient visits (aOR: 14.01; 95%CI: 12.18–16.12). In F2 hospitals, subgroup analysis revealed a U-shaped reduction in delayed healthcare access for ocular injuries during the COVID-19 pandemic (2019–2021), adjusted for age and gender.

● **CONCLUSION:** This first in-depth study of ocular injuries in Central Thailand's community hospitals found persistently high delayed presentations, with older age, F2 hospital visits, and outpatient department (OPD) attendance as key contributing factors. The trend during the COVID-19 pandemic highlights the important role of lower-tier community hospitals in providing prompt and accessible care for patients. Strengthening healthcare infrastructure and public awareness is essential to ensure timely care and reduce preventable vision-related complications.

● **KEYWORDS:** ocular injuries; delayed healthcare access; rural; community hospital; trends; risk factors; Thailand

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INTRODUCTION

Ocular injuries are a significant global cause of visual impairment, with an estimated 55 million cases annually[1]. The incidence of eye trauma continues to rise, reflecting its growing public health impact[2]. In Southeast Asia, the burden of eye injuries has notably increased, as years lived with disability (YLDs) rose from 18.62 thousand [95% confidence interval (CI): 5.86, 37.02] in 1990 to 25.18 thousand (95%CI: 7.66, 50.71) in 2019[2]. Beyond individual suffering, ocular injuries contribute to substantial economic costs and decreased workforce productivity, posing both medical and socioeconomic challenges[2]. Timely healthcare access is vital after ocular injury, as early evaluation and treatment can improve outcomes[3].

Delayed medical attention following ocular trauma can result in suboptimal treatment, significantly increasing the risk of sight-threatening complications such as corneal ulcers[4], traumatic

glaucoma[5], and endophthalmitis[6]. These complications can severely compromise long-term visual outcomes[1], yet studies consistently show that patients frequently seek care more than 24h after an injury occurs[7]. This delay is often driven by a combination of individual and systemic factors. Personal characteristics, particularly being male, middle-aged, or employed in industrial sectors, have been strongly associated with late presentation[8-9]. Furthermore, structural barriers—such as significant distances to specialized facilities and fragmented healthcare infrastructure—limit timely access[10-11]. Temporal challenges, most notably the disruptions caused by the COVID-19 pandemic, have further exacerbated these delays[12-13]. Collectively, these personal, spatial, and temporal factors create significant barriers to prompt ophthalmic care across diverse clinical settings.

In rural Central Thailand, individuals working in industrial and agricultural sectors are at elevated risk of ocular injuries and often face challenges in accessing appropriate medical care[14]. Geographic isolation and an underdeveloped healthcare infrastructure in these areas further hinder timely treatment. Additionally, cultural beliefs and reliance on self-treatment frequently delay hospital visits, worsening outcomes[15]. Despite growing awareness, limited research addresses how these personal, environmental, and temporal factors contribute to delayed care.

Current data on the timing and risk factors associated with delayed healthcare access after ocular injury remain limited, hindering efforts to understand patient behavior and guide healthcare system development. This study aims to identify key risk factors and examine trends in delayed access to care through a multicenter, retrospective cross-sectional analysis of community hospitals in Central Thailand. The findings will help highlight critical gaps and inform strategies to enhance timely and effective eye care services in these settings.

PARTICIPANTS AND METHODS

Ethical Approval The study was approved by the Medical Department Ethics Review Committee for Research in Human Subjects, Institutional Review Board, RTA (approval no. M010h/67_Exp), by 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 using secondary data, a waiver of documentation of informed consent was utilized, and the Institutional Review Board, RTA Medical Department, granted the waiver for informed consent.

Study Design and Subjects This retrospective cross-sectional study collected data from four rural community hospitals in Central Thailand from October 1, 2018, to September 17, 2024. Patients with ocular injuries were included from Sanam Chai Khet Hospital and Phanom Sarakham Hospital in Chachoengsao Province, as well as Tha Luang Hospital and Tha Wung Hospital in Lopburi Province. Inclusion criteria consisted of patients diagnosed with ocular injuries, while exclusion criteria were: 1) confirmed misdiagnosis based on history of present illness, 2) age under 20y, 3) presentation for revisit or follow-up. Using single proportion estimation, the sample size was calculated to require at least 899 patients, with 80% power and a 5% margin of error[7].

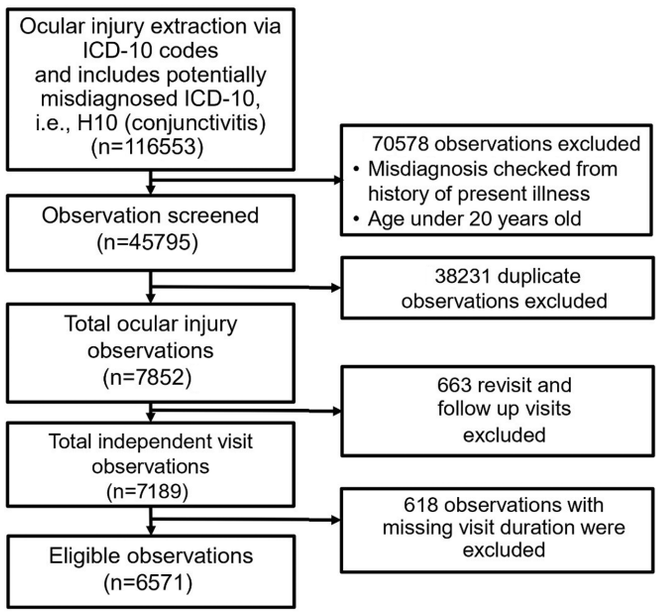


Figure 1 Data extraction and management flow.

Data Collection The International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) identified patients with ocular injuries[16], including traumatic conditions (S00, S01, S05.6, T15, T26) and associated ocular disorders (H05, H11, H16, H44, H57). Subsequently, patients' medical records, particularly the "present illness" section, were systematically reviewed to identify ocular injuries occurring during the study period. A keyword search strategy was applied in R Studio, using common phrases such as "hit the eye", "blown in the eye", and "splash into the eye", combined with timing-related words including "day", "hour", and "minutes" to capture when the injury occurred prior to hospital presentation. To ensure data accuracy, 10% of records were randomly selected for independent verification by researchers, and any discrepancies were resolved through consensus, ensuring consistency and reliability of the dataset. Cases involving non-ocular injuries, revisits, follow-up visits, and observation with missing visit duration were excluded. The study flow for all patients is illustrated in Figure 1.

International Classification of Diseases-10 Delayed healthcare access in this study is defined as a time interval of 24h or more from the occurrence of the ocular injury to the initial healthcare visit. This cut-off point was selected based

on previous research indicating that open globe injuries—considered among the most severe types of ocular trauma according to the Birmingham Eye Trauma Terminology (BETT) classification[17]—require urgent surgical intervention. Timely surgery, ideally within 24h of the injury, has been shown to reduce the risk of endophthalmitis[18], and improve visual outcomes[3,19]. Therefore, prompt ophthalmic evaluation following ocular injury is essential for accurately determining the type of injury, formulating appropriate management strategies, and optimizing patient outcomes.

Risk factors for ocular injuries were categorized into two groups: 1) patient and injury-related factors, including demographics, activity during injury, causative object, mechanism, and injury location; 2) healthcare access factors, such as hospital capacity, visit timing, and department visited.

Data were collected using two methods: demographic information (gender, age, occupation) was retrieved from hospital registry, while clinical details—including chief complaint, history of present illness, activity during injury, workplace occurrence, mechanism, causative object, time of onset, and presence of foreign body (FB)-related injuries—were extracted from medical records.

Covariate Selection and Classification The data in this study were categorized by clinical significance and patient characteristics to identify risk factors and understand the delayed healthcare access of ocular injuries[18-20].

Occupation and Activities During Injury Manual labor included workers in construction, mechanics, agriculture, and general labor. Non-manual labor comprised roles in education, healthcare, management, public service, household work, as well as unemployed and retired individuals. Industrial activity refers to tasks involved in goods or service production, including manufacturing, assembly, research and development, storage, transport, and construction.

Mechanism of Injury Sharp injuries are analyzed separately due to their high risk for severe ocular damage[17]. These injuries can range from lamellar lacerations in closed-globe trauma to penetrating or perforating wounds, often involving intraocular foreign bodies (IOFB)[21]. Such mechanisms frequently result in open-globe injuries that typically necessitate urgent surgical repair[18].

Causative Objects Causative objects were classified as metal/stone, thermal/chemical, wood, and organic compounds. Metal and stone are commonly associated with penetrating injuries and IOFB[22], often leading to endophthalmitis, retinal detachment, or vitreous hemorrhage. Thermal and chemical agents, especially alkalis and acids, can severely damage the ocular surface through tissue penetration or protein denaturation[23]. Wood injuries typically cause blunt trauma and may lead to globe rupture *via* inside-out pressure due to orbital confinement[21,24].

Timing, Season, and Year of Healthcare Visit Visit days were classified as weekdays (Monday to Friday) and weekends (Saturday and Sunday), as these may influence healthcare access and response time[25]. Seasonal variation was also analyzed, given its potential impact on the timing of visits for ocular injuries[26-27]. Seasons in Thailand were categorized into summer (March–May), rainy (June–October), and winter (November–February). 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.

Hospital-Level This study was conducted at two M2 and two F2 community hospitals. M2 hospitals serve as intermediate-level referral centers, each with 120 bed-size and core specialist services in internal medicine, surgery, obstetrics, pediatrics, orthopedics, and anesthesiology. They also support primary care and help reduce referrals to tertiary hospitals. In contrast, F2 hospitals are first-level referral facilities with 60–90 beds, typically staffed by 2–5 general practitioners or family physicians and generally lack specialist services[28].

Statistical Analysis Data analysis was conducted using Stata Statistical Software, Release 17 (StataCorp, 2021; College Station, TX: StataCorp LLC, USA), and organized into four primary components: baseline characteristics, linear regression, logistic regression, and trend analysis of delayed healthcare access for ocular injuries.

Descriptive statistics were used to summarize baseline characteristics. Continuous variables were reported as means with standard deviations (SD) or medians with interquartile ranges (IQR), as appropriate. Categorical variables were presented as percentages. Group comparisons were performed using the Chi-square test for categorical variables and either the independent *t*-test or the Mann-Whitney *U* test for continuous variables, based on data distribution. Each event was treated as an independent observation for patients with multiple events.

Logistic regression was applied to identify factors associated with delayed healthcare access. Multivariable models were used to estimate adjusted odds ratios (ORs) with 95%CIs. As the assumption of linearity was violated (non-normal distribution) for the time to hospital visit, linear regression was performed using log-transformed values of the variable. Age- and gender-adjusted mean hospital visit times were calculated annually to examine trends. Linear regression was used to assess the statistical significance of both linear and nonlinear trends, with nonlinear trends initially tested by including a quadratic term; if nonsignificant, linear trends were evaluated. Logistic regression was applied to age- and gender-adjusted proportions. Trend analyses across fiscal years were adjusted for age and gender, with subgroup analyses stratified by

Table 1 Characteristics of patients presenting with ocular injuries at community hospitals in Central Thailand, comparing delayed and non-delayed healthcare access *n* (%)

Variables	Total ocular injuries	Non-delayed healthcare access	Delayed healthcare access	*P*
Total observations	6571 (100.0)	4145 (63.1)	2426 (36.9)	
Gender				<0.001[a]
Male	4034 (61.4)	2648 (65.6)	1386 (34.4)	
Female	2537 (38.6)	1497 (59.0)	1040 (41.0)	
Age (y)				<0.001[a]
20–39	2807 (42.7)	1874 (66.8)	933 (33.2)	
40–59	2426 (36.9)	1541 (63.5)	885 (36.5)	
Equal to more than 60	1338 (20.4)	730 (54.6)	608 (45.4)	
Occupation				0.919
Manual Labor	3983 (79.3)	2630 (66.0)	1353 (34.0)	
Non manual labor	1037 (20.7)	683 (65.9)	354 (34.1)	
Activity during injury				<0.001[a]
Industrial work	1052 (71.4)	723 (68.7)	329 (31.3)	
Agricultural	26 (1.8)	8 (30.8)	18 (69.2)	
Household activity	28 (1.9)	23 (82.1)	5 (17.9)	
Road accident	271 (18.4)	236 (87.1)	35 (12.9)	
Other accident	80 (5.4)	73 (91.3)	7 (8.8)	
Other activity	17 (1.2)	13 (76.5)	4 (23.5)	
Injury in workplace	476 (7.2)	315 (66.2)	161 (33.8)	0.146
Mechanism of injury				<0.001[a]
Blunt	132 (2.0)	105 (79.6)	27 (20.5)	
Sharp	1257 (19.1)	848 (67.5)	409 (32.5)	
Unknown	5182 (78.9)	3192 (61.6)	1990 (38.4)	
Causative objects				<0.001[a]
Metal/stone	222 (12.2)	170 (76.6)	52 (23.4)	
Thermal/chemical agent	119 (6.5)	88 (74.0)	31 (26.1)	
Wood stick	158 (8.7)	133 (84.2)	25 (15.8)	
Organic compound	1328 (72.7)	880 (66.3)	448 (33.7)	
FB-associated ocular injuries	4176 (63.6)	2676 (64.1)	1500 (35.9)	0.027[a]
Visit day				<0.001[a]
Weekdays	5198 (79.1)	3134 (60.3)	2064 (39.7)	
Weekends	1373 (20.9)	1011 (73.6)	362 (26.4)	
Community hospital				0.049[a]
M2	4412 (67.1)	2747 (62.3)	1665 (37.7)	
F2	2159 (32.9)	1398 (64.8)	761 (35.3)	
Visit department				<0.001[a]
ER	3640 (55.4)	3106 (85.3)	534 (14.7)	
OPD	2931 (44.6)	1039 (35.5)	1892 (64.6)	

ER: Emergency Room; OPD: Outpatient Department; FB: Foreign body; IQR: Interquartile range. [a]Statistically significant (P<0.05).

hospital level. Statistical significance was defined as a two-sided P<0.05.

RESULTS

Characteristics of the Patients Table 1 presents the characteristics of patients with ocular injuries treated at community hospitals in Central Thailand. Among 6571 observations, 4034 (61.4%) involved male patients, with a median age of 43y (IQR: 31–57). Most patients (79.3%) were manual laborers, and industrial work was the most common activity at the time of injury (71.4%). Neither manual labor nor workplace-related injuries were significantly associated with delayed healthcare access (P=0.919 and 0.146, respectively). Delayed access was observed in roughly one-third of patients visiting M2 and F2 hospitals (37.7% and 35.3%, respectively), while significantly more delays occurred among those seen in Outpatient Departments (OPD; 64.6%; P<0.001).

The seasonal distribution of delayed healthcare access remained relatively consistent (Figure 2). Notably, while the summer months recorded the lowest overall volume of ocular injuries (n=1790), they accounted for the highest proportion of delayed access (38.9%), a trend that was statistically significant (P=0.038). Conversely, the rainy season saw the highest absolute number of injury cases (n=2411) but a lower delay rate of 37.2%, while the winter season recorded the lowest delay rate at 35.1% (n=2370).

Linear regression analysis of risk factors associated with increased duration of healthcare access among ocular injury patients. The median duration from injury to hospital visit was 1d (IQR: 0.125–2d). Table 2 summarizes the factors associated with prolonged healthcare access among patients with ocular injuries. After adjusting for potential confounders, including gender, age group, industrial activity during injury, injury mechanism, causative objects, FB-associated injuries, day of visit, hospital level, and department visited, the following variables were significantly associated with longer delays: age over 60y (adjusted β=0.21, 95%CI: 0.10–0.32), FB-associated ocular injuries (adjusted β=0.27, 95%CI: 0.17–0.36), visits to F2-level hospitals (adjusted β=0.45, 95%CI: 0.35–0.55), and OPD visits (adjusted β=2.44, 95%CI: 2.35–2.53). In contrast, male gender (adjusted β=-0.09, 95%CI: -0.18 to -0.01) and injuries caused by sharp objects (adjusted β=-0.20, 95%CI: -0.35 to -0.05) were associated with shorter durations before accessing care.

Logistic Regression Analysis of Risk Factors Associated with Delayed Healthcare Access Among Patients with Ocular Injuries Table 3 presents the prevalence of delayed healthcare access among ocular injury cases, with 2436 observations (36.9%). After adjusting for confounders, factors associated with an increased risk of delay included age≥40y, injuries involving metal, visits to F2-level hospitals, and OPD visits. In contrast, industrial-related injuries were found to be a protective factor.

Trends Analysis of Timing of Healthcare Access Among Ocular Injury Patient The adjusted mean duration before hospital arrival and the proportion of delayed access were analyzed across fiscal years, adjusting for gender and age. The adjusted mean duration ranged from 2.4 to 3.9d (Figure 3), while the adjusted proportion of delayed access ranged from 32% to 42% (Figure 4). The total number of cases declined during 2020–2021, accompanied by a reduction in delayed access. Subgroup analysis by hospital level revealed statistically significant non-linear trends. At M2 hospitals, the mean duration before arrival increased from approximately 2 to 3d after 2021 (P-value for non-linear trend=0.045). At F2 hospitals, a U-shaped trend was observed: the mean duration was lower during 2019–2022 compared with 2018 and 2023

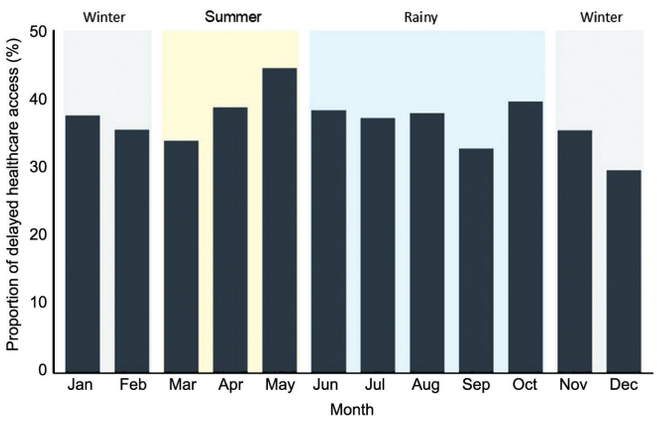


Figure 2 Seasonal variation in the proportion of delayed healthcare access Pearson Chi-square=6.566. P=0.038.

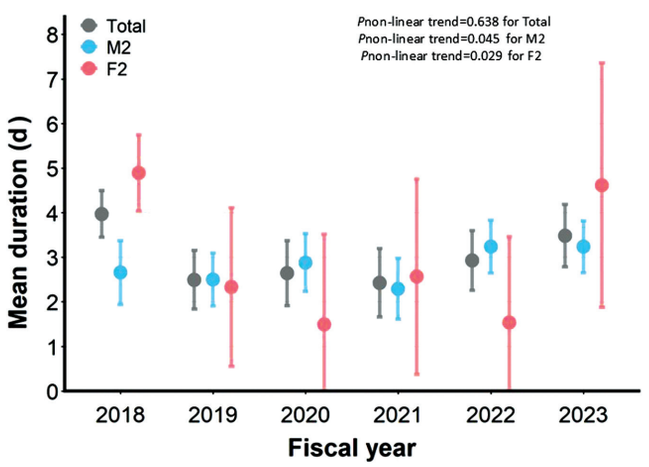


Figure 3 Gender- and age-adjusted mean of duration prior to arrival across fiscal years.

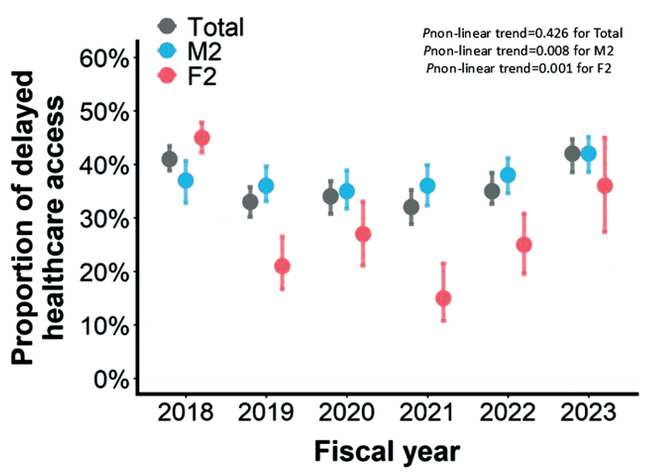


Figure 4 Gender- and age-adjusted proportion of delayed healthcare access among ocular injury patient across fiscal years.

(P-value for non-linear trend=0.029; Figure 3). This U-shaped trend among F2 hospital patients mirrored the temporal pattern observed in M2 hospitals. Similarly, subgroup analysis of delayed access showed the lowest rates in 2020 at M2 hospitals (35%) and in 2021 at F2 hospitals, followed by a rebound in both groups (P-value for non-linear trend=0.008 for M2; P<0.001 for F2; Figure 4).

Table 2 Univariable and multivariable linear regression analysis of log-transformed duration of event until healthcare access among ocular injury patients in community hospitals, Central Thailand

Variables	Univariable			Multivariable		
	β coefficient	95%CI	*P*	β coefficient	95%CI	*P*
Gender						
Female	ref			ref		
Male	-0.34	-0.44, -0.24	<0.001[a]	-0.09	-0.18, -0.01	0.038[a]
Age (y)						
20–39	ref			ref		
40–59	0.06	-0.05, 0.17	0.261	0.09	0.00, 0.18	0.061
Equal to more than 60	0.34	0.21, 0.47	<0.001[a]	0.21	0.10, 0.32	<0.001[a]
Industrial work during injury	0.08	-0.06, 0.21	0.250	0.24	0.08, 0.40	0.004[a]
Mechanism of injury						
Non-sharp	ref			ref		
Sharp	-0.13	-0.26, -0.01	0.037[a]	-0.20	-0.35, -0.05	0.007[a]
Causative objects						
Metal/stone	0.02	-0.12, 0.16	0.814	0.28	0.12, 0.44	0.001[a]
Thermal/chemical agent	-0.45	-0.71, -0.18	0.001[a]	-0.13	-0.36, 0.09	0.234
FB-associated ocular injuries	0.23	0.12, 0.33	<0.001[a]	0.27	0.17, 0.36	<0.001[a]
Visit day						
Weekdays	ref			ref		
Weekends	-0.56	-0.68, -0.44	<0.001[a]	0.05	-0.05, 0.15	0.343
Community hospital						
M2	ref			ref		
F2	-0.31	-0.41, -0.20	<0.001[a]	0.45	0.35, 0.55	<0.001[a]
Visit department						
ER	ref			ref		
OPD	2.34	2.26, 2.42	<0.001[a]	2.44	2.35, 2.53	<0.001[a]

[a]Statistically significant (*P*<0.05). ER: Emergency Room; OPD: Outpatient Department; CI: Confidence interval; FB: Foreign body; IQR: Interquartile range.

DISCUSSION

To our knowledge, this is the first study to comprehensively assess delayed healthcare access in ocular injuries across community hospitals in Central Thailand over a six-fiscal-year period (2018–2023). We found that approximately one-third of patients presented more than 24h after injury, with a median delay of 2–3d. This proportion aligns with studies from other developing countries, suggesting a persistent pattern of delayed access in similar healthcare settings[1]. Importantly, the current study reveals the significant risk factors included advanced age (≥60y), visits to lower-tier hospitals (F2 level), and presentation to OPD settings. Furthermore, seasonal trends and healthcare disruptions during the COVID-19 pandemic also influenced access timing. These findings highlight the complex interplay of personal, structural, and contextual factors that influence care-seeking behavior and provide a critical foundation for developing targeted public health interventions, especially in decentralized or under-resourced regions.

Delayed presentation and limited access to specialized healthcare remain critical factors in the progression of ocular injuries. In developing regions, agricultural trauma involving soil or plant matter is a primary driver of *Acanthamoeba* keratitis. Previous studies from tertiary centers have reported a diagnostic lag ranging from 7 to 38d (mean 19.3±9.3d)[29], often stemming from the difficulty of recognizing specialized clinical patterns in a primary care setting. Within medical facilities, such diagnostic challenges are an understandable limitation of the existing healthcare infrastructure. Therefore, the current study emphasizes the need to improve community awareness regarding the urgency of eye injuries. Encouraging patients to seek medical evaluation immediately after trauma can help bridge the gap between initial injury and specialist management, ultimately preventing the deterioration of eye conditions[30].

The current study identified advanced age (≥60y) as a significant independent predictor of delayed presentation. This finding is consistent with previous research showing that elderly individuals, particularly those in rural or community settings, often face unique barriers to timely healthcare access[31], such as limited transportation, absence of caregivers,

Table 3 Univariable and multivariable logistic regression analysis of factors associated with delayed healthcare access among ocular injury patients at community hospitals, Central Thailand

Variables	Non-delayed healthcare access, *n* (%)	Delayed healthcare access, *n* (%)	cOR	95%CI	*P*	aOR	95%CI	*P*
Total observations	4145 (63.1)	2426 (36.9)						
Gender								
Female	1497 (59.0)	1040 (41.0)	ref			ref		
Male	2648 (65.6)	1386 (34.4)	0.75	0.68, 0.83	<0.001[a]	1.08	0.95, 1.23	0.239
Age (y)								
20–39	1874 (66.8)	933 (33.2)	ref			ref		
40–59	1541 (63.5)	885 (36.5)	1.15	1.03, 1.29	0.014[a]	1.19	1.04, 1.36	0.011[a]
Equal to more than 60	730 (54.6)	608 (45.4)	1.67	1.46, 1.91	<0.001[a]	1.55	1.32, 1.82	<0.001[a]
Industrial work during injury	730 (68.8)	331 (31.2)	0.74	0.64, 0.85	<0.001[a]	0.70	0.55, 0.90	0.005[a]
Mechanism of injury								
Non-sharp	3297 (62.0)	2017 (38.0)	ref			ref		
Sharp	848 (67.5)	409 (32.5)	0.79	0.69, 0.90	<0.001[a]	1.19	0.95, 1.49	0.128
Causative objects								
Metal/stone	668 (68.0)	315 (32.0)	0.78	0.67, 0.90	0.001[a]	1.30	1.02, 1.65	0.032[a]
Thermal/chemical agent	168 (71.5)	67 (28.5)	0.67	0.50, 0.90	0.007[a]	0.85	0.60, 1.20	0.350
FB-associated ocular injuries	2676 (64.1)	1500 (35.9)	0.89	0.80, 0.99	0.027[a]	0.95	0.82, 1.09	0.440
Visit day								
Weekdays	3134 (60.3)	2064 (39.7)	ref			ref		
Weekends	1011 (73.6)	362 (26.4)	0.54	0.48, 0.62	<0.001[a]	1.00	0.86, 1.17	0.988
Community hospital								
M2	2747 (62.3)	1665 (37.7)	ref			ref		
F2	1398 (64.8)	761 (35.3)	0.90	0.81, 1.00	0.049[a]	2.03	1.73, 2.38	<0.001[a]
Visit department								
ER	3106 (85.3)	534 (14.7)	ref			ref		
OPD	1039 (35.5)	1892 (64.6)	10.59	9.40, 11.93	<0.001[a]	14.01	12.18, 16.12	<0.001[a]

[a]Statistically significant (*P*<0.05). CI: Confidence interval; FB: Foreign body. ER: Emergency room; OPD: Outpatient department; aOR: Adjusted odds ratio; cOR: Crude odds ratio.

financial hardship, and physical limitations[32]. Additionally, older adults may underestimate the severity of ocular injuries or encounter challenges in navigating the healthcare system[33-34]. Recent studies also highlight a rising trend of ocular injuries caused by low-level falls, which are becoming increasingly common in the aging population[2,35-37]. Delays in care among this group are especially concerning, as they increase the risk of infection, prolonged inflammation, and irreversible visual impairment[38]. These sequelae may also lead to secondary impacts such as increased fall risk, reduced independence, and diminished quality of life[2,38]. Therefore, elderly individuals should be prioritized in both clinical care and public health interventions, emphasizing physiological vulnerability and environmental safety improvements.

While previous studies have linked male gender and labor-intensive occupations with higher risk involved in ocular trauma[9], this study found no significant association between gender and delayed healthcare access. This may reflect the local context in Central Thailand, where both men and women are equally represented in manual labor roles. Notably, industrial-related injuries emerged as a protective factor, possibly due to workplace safety policies or employer-facilitated healthcare referrals[39]. These findings suggest that structured occupational environments can help mitigate delays in care, offering a valuable perspective on how workplace health governance can improve outcomes in community settings of developing countries.

Institutional settings, particularly the hospital tier and department visited, significantly influenced delay patterns[40]. Patients who sought care at lower-tier F2 hospitals experienced longer delays compared to those treated at higher-tier M2 hospitals. This discrepancy likely reflects resource imbalances; F2 hospitals often lack dedicated ophthalmology services, relying on rotating general practitioners and minimal diagnostic tools, which may delay recognition and escalation of care[41]. In contrast, M2 hospitals typically have consistent ophthalmic coverage and more structured triage systems, contributing to earlier intervention and narrower delay intervals. Previous studies also identified the systems problems, including unclear referral systems and opening times, frequent staff absence and unqualified staff deputizing in developing countries[42].

In addition, patients presenting to the OPD were more likely to delay seeking care. This behavior may stem from an initial perception that the injury was not severe enough to warrant urgent treatment. Such misjudgment is especially common in closed-globe injuries or when ocular symptoms are subtle, leading patients to defer professional evaluation until symptoms worsen[43]. The lack of urgent ophthalmologic triage in OPD settings may also contribute to under-referral and inadequate early assessment. Additionally, the absence of a standardized ophthalmology urgency pathway can lead to subjective triage decisions, potentially delaying the prioritization of critical cases[44]. These findings underline the need to enhance community education on ocular trauma and to equip OPD providers with clear referral pathways and decision-support tools.

The current study identified distinct seasonal variations in delayed healthcare access. While the patterns align with previous research, the specific timing differs based on local agricultural cycles. For instance, studies in the United States often report a peak in ocular injuries during the summer, which corresponds to their primary agricultural season[26]. In Central Thailand, however, the peak agricultural phase occurs during the rainy season. Interestingly, although summer in Thailand is an arid period where agricultural activity declines, it recorded higher rates of delayed presentation. This may be because injuries occurring outside the main farming season are perceived as minor by patients, leading to a lower sense of urgency. These findings suggest that healthcare promotion and prevention strategies must be tailored to the specific occupational and cultural characteristics of the community[27].

The COVID-19 pandemic influenced healthcare-seeking behavior in various ways over time. A decline in ocular injury cases presenting to hospitals was observed, consistent with previous research[45], likely due to quarantine-related behavioral changes and reduced trauma exposure. Unlike global reports showing delays in emergency care for life-threatening conditions such as myocardial infarction and stroke during lockdowns due to fear of infection[46-47], this study found a relative improvement in timely access for ocular injuries. This divergence may be attributed to local factors such as stricter workplace health surveillance, effective public health messaging, and increased health risk awareness. Additionally, patients with severe symptoms or higher socioeconomic status may have continued to seek care promptly, reflecting a stratified shift in access[48]. These findings highlight the importance of context-specific evaluations during global crises, particularly in developing regions with distinct motivators and barriers to care.

In contrast to the overall pattern of longer delays at F2 hospitals, a different dynamic emerged during the COVID-19 pandemic. Patients with ocular injuries presented to F2 hospitals with shorter delays, showing a U-shaped trend that mirrored the higher delays observed at M2 hospitals. Several factors may explain this shift. First, mobility restrictions were implemented to limit viral spread[49]. Second, higher-level hospitals reduced non-urgent services, were reserved for severe emergencies, and were often more crowded, which may have discouraged patients from seeking care there[50]. Consequently, patients were more likely to choose nearby F2 hospitals, whose proximity to rural communities made them the most immediate and accessible option for acute ocular injuries. These pandemic-specific dynamics underscore the critical role of F2 hospitals in maintaining timely access to ocular emergency services.

This study has several strengths, most notably being the first to report on delayed healthcare access in ocular trauma while comprehensively examining its demographic, institutional, and temporal determinants. Understanding these patterns is essential for developing multifaceted interventions: enhancing ophthalmologic infrastructure and continuity of care in F2 hospitals[51]; implementing rapid triage and education protocols in OPD settings[52]; promoting seasonal readiness strategies; and ensuring accessible trauma care during public health emergencies[47]. Tailored outreach to elderly and underserved populations[53], alongside mass education campaigns on the urgency of ocular trauma, can further reduce preventable delays[34]. Our findings, derived from a community-based setting in a developing country, offer valuable insights into how localized systems and behaviors interact with broader health dynamics, providing a model for similar contexts aiming to improve ocular injury care and outcomes.

This study has several important limitations. First, the use of secondary data may affect the accuracy and completeness of some variables, as the analysis relied on documentation by healthcare providers rather than direct observation by the research team. General practitioners made most diagnoses, which could have resulted in underdiagnosis or misclassification. Information such as the causative object or activity at the time of injury depended solely on physician-recorded notes, which may have led to missing or incomplete data. Nonetheless, ocular injury documentation is typically straightforward, lending reasonable confidence to the recorded risk factors. Second, as with many observational studies, missing data was a potential issue. However, the large sample size (n=6571), well above the calculated minimum (n=899), reduces the likelihood that missing data substantially influenced the results. Third, minor ocular injuries that did not prompt hospital visits may be underrepresented, potentially leading to underestimating the overall incidence. Still, the dataset likely captures more clinically significant cases. Finally,

since the study was limited to four community hospitals in central rural Thailand, the findings may not be generalizable to urban settings or other regions, underscoring the need for external validation.

Future research should explore how the timing of hospital presentation relates to specific ocular diagnoses, which may shed light on the clinical profiles of patients who delay care. Analytical approaches could be valuable in defining evidence-based time thresholds to guide triage and management protocols. Furthermore, qualitative studies may help identify patient-level barriers, contextual factors, and behavioral aspects from a social science perspective that contribute to delayed healthcare access, providing insights to guide more effective, population-specific interventions.

This study is the first in-depth investigation of delayed healthcare access for ocular injuries in community hospitals across Central Thailand, revealing a persistently high rate of delayed presentations. Older age (≥60y), visits to lower-tier (F2) hospitals, and OPD attendance were identified as significant contributing factors. These patterns point to opportunities for system improvement, particularly through enhanced service accessibility and targeted public education on the urgency of ocular trauma—especially among the elderly, now the predominant at-risk group in an aging society. While healthcare-seeking awareness appears to have improved, delays remain common. Effective health communication, particularly during times of system disruption, must not only uphold care standards but also reduce public anxiety and hesitation. Emphasizing the importance of every point of care, particularly lower-tier hospitals, is crucial, as these facilities play a key role in providing prompt and accessible management for patients. Addressing these multifactorial barriers through context-specific, targeted interventions is essential to improving outcomes and reducing preventable vision-related morbidity.

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