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Research Article

Occupational Ocular Surface Foreign-Body Injuries: Characterizing Workplace Exposures and Gaps in Protective Eyewear Use

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Background: Occupational ocular surface foreign-body (OSFB) injuries are important yet largely preventable workplace eye injuries, particularly in occupations involving metal processing and particulate-generating activities. This study characterized the demographic, occupational, and clinical profile of occupational OSFB injuries and evaluated protective-eyewear practices and factors associated with protective-eyewear non-use.

Methods: This hospital-based cross-sectional observational study included 130 participants presenting with occupational OSFB injuries. Demographic characteristics, occupation, work activity at injury, foreign-body material and anatomical location, presenting symptoms, protective-eyewear use, reasons for non-use, previous OSFB injury, self-removal attempts, and awareness of ocular risks were recorded. Categorical variables were summarized using frequencies and percentages. Associations were assessed using Pearson's χ^2 or Fisher's exact test, as appropriate. Multivariable binary logistic regression was performed to identify factors independently associated with protective-eyewear non-use, with adjusted odds ratios (ORs) and 95% confidence intervals (CIs).

Results: Participants were predominantly male (123/130, 94.62%), and 68 (52.31%) worked in the metal industry. Metal grinding/cutting was the most common activity at injury (73, 56.15%). Metallic foreign bodies were predominant (77, 59.23%), with the cornea being the most frequently affected site (92, 70.77%). Ocular irritation was the most frequently reported symptom (77, 59.23%), followed by pain (65, 50.00%), redness (61, 46.92%), and watering (41, 31.54%). Only 27 participants (20.77%) reported using protective eyewear, whereas 103 (79.23%) reported no protection. Among non-users, the most common reason was PPE non-availability (36/103, 34.95%), followed by other reasons (24, 23.30%) and forgetting to wear PPE (21, 20.39%). Awareness of potential harm from self-removal was reported by 84 (64.62%) participants. PPE use was significantly associated with this awareness in bivariate analysis (29.8% vs 4.3%; χ^2=10.17, p=0.001). In multivariable analysis, high-risk work activity was independently associated with PPE non-use (adjusted OR 2.14, 95% CI 1.01–4.54, p=0.047), whereas awareness was not statistically significant after adjustment (adjusted OR 0.53, 95% CI 0.26–1.08, p=0.081).

Conclusion: Occupational OSFB injuries predominantly involved male workers engaged in metal-related, particulate-generating activities, with metallic foreign bodies and corneal involvement being most common. The high prevalence of

PPE non-use highlights an important preventable safety gap. Prevention should combine reliable PPE availability, hazard-specific protective eyewear, worker adherence, and targeted occupational eye-health education.

Keywords: *Occupational eye injury, ocular surface foreign body, protective eyewear, personal protective equipment, occupational safety, corneal foreign body, metal workers*

Introduction

Occupational ocular injuries remain an important and largely preventable workplace-health problem, with consequences ranging from transient discomfort and loss of productivity to permanent visual impairment. Foreign bodies and corneal abrasions constitute common forms of occupational ocular trauma, particularly in occupations involving high-velocity particles, mechanical tools, dust, and other hazardous exposures. A systematic review and meta-analysis identified use of eye protection at the time of injury, male sex, occupational exposure, and risk-taking behavior among factors associated with occupational ocular injury, emphasizing the importance of both workplace hazards and preventive practices (Nowrouzi-Kia et al., 2020). Evidence from other forms of ocular trauma has similarly emphasized the importance of preventive strategies in reducing avoidable ocular injuries and their associated clinical consequences (Varshney & Bhattacharjee, 2024). Ocular surface foreign-body (OSFB) injuries are particularly relevant in metalworking, welding, grinding, construction, manufacturing, and other manual occupations in which workers may be exposed to airborne metallic, mineral, organic, or particulate material. The clinical spectrum ranges from superficial corneal or conjunctival foreign bodies to epithelial defects, rust deposition, infection, and corneal scarring, with the potential for persistent visual consequences when diagnosis or treatment is delayed. Hospital-based studies consistently demonstrate a marked predominance of young and middle-aged male workers among patients presenting with occupational corneal foreign bodies. In an Indian hospital-based study, all 62 patients with occupational corneal foreign bodies were male, with metalworking and construction representing major occupational categories (Nagar & Choudhary, 2024). The potential functional consequences of corneal injury are also evident from studies of traumatic corneal conditions in which appropriate clinical management and subsequent visual rehabilitation are important for optimizing visual outcomes (Varshney et al., 2024). The mechanism of occupational exposure is important because the risk associated with an ocular foreign body is determined not only by the presence of a hazardous task but also by the velocity, size, composition, and direction of the material generated during that task. Grinding, cutting, welding, and machining can produce high-velocity particles capable of reaching the ocular surface within fractions of a second. Consequently, identifying the occupations and work activities most frequently represented among affected patients may help identify specific opportunities for targeted workplace prevention. Importantly, however, the occupational distribution of patients presenting to an eye-care facility represents the profile of affected individuals and should not be interpreted as occupation-specific incidence in the absence of a defined population at risk. Protective eyewear is a fundamental component of occupational eye-injury prevention, yet a substantial gap persists between awareness of eye protection and its actual use. In a hospital-based study of patients with corneal foreign bodies, 75.1% were not using protective eye devices at the time of injury, and almost half reported never having used such devices; lack of availability at the workplace was a major reported barrier (Sharma et al., 2023). More recent Indian evidence similarly demonstrates inadequate adherence: among blue-collar workers presenting with occupational corneal foreign bodies, only 27.45% reported regular use of eye-protective devices, despite 80.39% reporting awareness of such devices (Raj et al., 2026). These observations are particularly relevant in settings where broader barriers to eye-care access, including geographic and economic constraints, may further influence timely utilization of appropriate eye-care services (Bhattacharjee & Varshney, 2025). These findings suggest that simply increasing awareness may be insufficient when protective equipment is unavailable, uncomfortable, poorly fitted, inappropriate for the task, or inadequately supported by workplace safety systems. The relationship between protective eyewear and occupational foreign-body injury is also more complex than a simple distinction between users and non-users. Evidence indicates that the type and suitability of eye protection may influence its effectiveness, while workplace conditions, safety culture, training, supervision, and worker behavior may affect consistent use. A broader review of occupational eye injuries has identified inadequate or inappropriate protective eyewear, discomfort, poor fit, limited access, and perceived lack of need as important barriers to prevention (Vought et al., 2025). More broadly, occupational safety evidence supports the importance of combining appropriate protective equipment with training, supervision, and organizational safety measures rather than relying on equipment provision alone. Another potentially modifiable component of OSFB-related morbidity is the response immediately after injury. Self-removal attempts and other inappropriate first-aid practices may cause additional epithelial trauma or delay professional assessment. Sharma et al. (2023) reported that 45.1% of patients attempted potentially harmful physical removal of the foreign body before presentation. Similarly, recent Indian data reported self-removal attempts among more than one-third of affected workers. These observations highlight that occupational eye-injury prevention should extend beyond protective equipment to include worker education regarding safe first aid, avoidance of ocular manipulation, and timely access to professional eye care. At a broader population level, disparities in eye-care access related to geographic location, socioeconomic

circumstances, and demographic characteristics may further contribute to unequal access to timely eye-care services (Bhattacharjee & Varshney, 2026). Despite accumulating evidence on occupational corneal foreign bodies and protective-device utilization, important gaps remain in the integrated characterization of who is affected, what occupational activities precipitate injury, what types and locations of foreign bodies occur, and how workers use and perceive protective eyewear. A hospital-based assessment incorporating these dimensions can provide clinically relevant information for identifying high-risk work activities and modifiable gaps in occupational eye-safety practices.

Therefore, this study aimed to characterize the demographic, occupational, and clinical profile of patients presenting with occupational ocular surface foreign-body injuries and to evaluate protective-eyewear use, workplace exposure patterns, awareness, and safety-related practices among affected workers.

Materials and Methods

Study Design and Settings

A hospital-based cross-sectional observational study was conducted at Shree C. H. Nagri Municipal Eye Hospital, Ahmedabad, Gujarat, India, a tertiary eye-care centre, from February 2025 to December 2025. The study evaluated the demographic, occupational, and clinical characteristics of patients presenting with occupational ocular surface foreign-body (OSFB) injuries and assessed protective-eyewear use, reasons for non-use, previous injury, self-removal practices, and awareness of ocular risks.

Because the study was conducted in a hospital-based clinical population and did not include the total number of workers at risk in each occupational category, the findings were interpreted as describing the distribution and characteristics of presenting occupational OSFB injuries rather than population-based incidence or occupation-specific risk.

Sampling Method and Study Population

A consecutive sampling method was employed. All patients presenting to the outpatient department during the study period who fulfilled the predefined eligibility criteria were assessed for inclusion. Consecutive recruitment was used to minimize selective enrolment and to capture eligible occupational OSFB cases presenting to the study centre throughout the predefined recruitment period. A total of 130 eligible participants were included in the final analysis. The study documentation specified that patients presenting to the outpatient department with ocular foreign bodies during the study period were included in the study.

Sample Size

Because this was a hospital-based observational study using consecutive recruitment over a predefined study period, the final sample consisted of all eligible occupational OSFB cases presenting during the study period.

Therefore, 130 participants constituted the achieved sample size. No separate population-based sample-size calculation based on an assumed prevalence and precision was performed because the study was not designed to estimate the prevalence or incidence of occupational OSFB in a defined occupational population.

Eligibility Criteria

Participants were eligible for inclusion if they were aged 18 years or older, presented with a clinically diagnosed or suspected ocular foreign body, were able to undergo an anterior-segment ophthalmic examination, and were able to provide the required demographic, occupational, and injury-related information. Patients younger than 18 years and those presenting with clinical evidence of corneal infection were excluded from the study. An occupational OSFB injury was defined as an ocular surface foreign-body injury sustained while the participant was engaged in a work-related activity or occupational task.

Data Collection

Data were collected prospectively using a structured clinical data-collection proforma. The proforma captured demographic characteristics, occupational information, work activity at the time of injury, injury-related characteristics, protective-eyewear use, reasons for non-use, previous history of ocular foreign-body injury, self-removal attempts, and the interval between injury and hospital presentation. Demographic information included age, sex, and occupation.

Occupational exposure was documented according to the specific activity being performed immediately before the injury. The recorded work activities included agricultural work, cement work, metal grinding or cutting, woodwork, and other occupational activities.

Ophthalmic Examination

All participants underwent a standardized anterior-segment examination using a slit-lamp biomicroscope. The initial clinical examination was performed by an optometrist to identify the presence, location, and clinical characteristics of the ocular foreign body. The anatomical location of the foreign body was recorded as corneal, conjunctival, or eyelid involvement. The type of foreign body was classified according to the material identified clinically or reported by the participant and included metallic material, dust, wooden material, agricultural material, and other foreign materials.

Presenting symptoms were documented from the participant's history and clinical examination and included ocular irritation, pain, redness, and watering. The interval between injury and hospital presentation was also recorded based on the participant's reported time of injury and time of presentation. The recorded presentation intervals ranged from less than 1–2 hours to more than 72 hours.

Foreign-Body Removal and Clinical Management

Following the initial ophthalmic examination, foreign-body removal was performed by an ophthalmologist under topical anaesthesia. The clinical equipment and materials used for examination and management included a slit-lamp biomicroscope, topical anaesthetic drops, fluorescein strips, sterile cotton swabs, and a sterile 26-gauge needle, with topical antibiotic medication prescribed when clinically indicated. The technique used for foreign-body removal was selected according to the anatomical location and characteristics of the foreign body. Following removal, appropriate treatment and follow-up were provided according to the clinical findings and the treating ophthalmologist's assessment.

Protective-Eyewear Assessment

Protective-eyewear use was assessed specifically with reference to the time of injury. Participants were asked whether they were wearing protective eyewear while performing the occupational activity associated with the injury. Protective equipment was categorized according to the type reported by the participant as a safety goggle, welding helmet, or no protective eyewear. Of the 130 participants, 21 (16.15%) reported using safety goggles, 6 (4.62%) reported using a welding helmet, whereas 103 (79.23%) reported not using any protective eyewear at the time of injury. For analytical purposes, protective-eyewear use was considered both according to the specific type of equipment and, where appropriate, as a binary variable distinguishing any protective-eyewear use from no protective-eyewear use.

Reasons for Non-Use of Protective Eyewear

Participants who reported not using protective eyewear at the time of injury were asked to identify the principal reason for non-use. The recorded reasons included non-availability of protective equipment, forgetting to wear protective equipment, temporary removal during work, discomfort, and other reasons. Other reported reasons included lack of awareness regarding PPE use, damaged protective equipment, and perceived low risk of ocular injury. These responses were recorded to distinguish individual behavioural factors from equipment-related and workplace-related barriers to protective-eyewear use.

Previous Ocular Foreign-Body Injury and Self-Removal Practices

Participants were asked about any previous history of ocular surface foreign-body injury. Previous injury was recorded according to the reported number of episodes and categorized as one previous episode, two previous episodes, more than two previous episodes, or no previous injury. Participants were also asked whether they had attempted to remove the foreign body themselves before seeking professional eye care. Self-removal history was recorded together with the reported method where available. The study also assessed awareness regarding the potential ocular harm associated with inappropriate self-removal and repeated foreign-body exposure.

Study Variables

The study variables were categorized into demographic, occupational, clinical, preventive, and behavioural domains. The principal descriptive variables included age, sex, occupation, work activity at injury, affected eye, foreign-body material, anatomical location, presenting symptoms, and interval between injury and hospital presentation.

Preventive and behavioural variables included protective-eyewear use, type of protective eyewear, reasons for non-use, previous OSFB injury, self-removal attempts, and awareness of ocular risks. For the inferential analysis, protective-eyewear non-use was specified as the primary binary outcome, defined as absence of safety goggles or a welding helmet at the time of injury.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics, version 26.0 (IBM Corp., Armonk, NY, USA). Categorical variables were summarized using frequencies and percentages. Continuous variables were summarized using appropriate measures of central tendency and dispersion, depending on their distribution. Associations between categorical variables were assessed using the Pearson χ^2 test when the expected cell-frequency assumptions were satisfied. Fisher's exact test was used when expected cell frequencies were insufficient for the χ^2 approximation. All inferential tests were two-sided, and a p-value <0.05 was considered statistically significant. For categorical associations involving variables with more than two categories, Cramer's V was used as the effect-size measure, whereas phi (φ) was used for 2×2 comparisons. Protective-eyewear non-use was subsequently evaluated using binary logistic regression. The dependent variable was coded as 1 for PPE non-use and 0 for PPE use. Candidate predictor variables included demographic, occupational, previous-injury, awareness, and behavioural characteristics. Results were expressed as odds ratios (ORs) with 95% confidence intervals (CIs).

For the multivariable model, adjusted ORs (aORs) with 95% CIs were reported. Model fit was assessed using an appropriate goodness-of-fit test, and multicollinearity among predictors was assessed using variance inflation factors. Because the study was cross-sectional, associations were interpreted as statistical associations rather than causal relationships.

Complete data were available for the variables included in the analysis; therefore, no missing-data imputation was performed.

Ethical Considerations

The study was conducted in accordance with applicable ethical principles governing research involving human participants. Ethical approval was obtained from the Institutional Ethics Committee of the concerned institution before commencement of the study. Written informed consent was obtained from participants before enrolment and data collection. Participant confidentiality was maintained throughout data collection, analysis, and reporting, and no personally identifiable information was included in the manuscript. All study procedures were performed in accordance with institutional requirements and applicable ethical standards for research involving human participants.

Results

Participant Characteristics

A total of 130 participants with occupational ocular surface foreign-body (OSFB) injuries were included in the final analysis. The study population was predominantly male, comprising 123 men (94.62%) and 7 women (5.38%). Most participants were aged 18–45 years, accounting for 102 participants (78.46%). The occupational distribution demonstrated a predominance of metal-related employment. Metal-industry workers constituted the largest occupational group (68/130, 52.31%), followed by construction workers (20/130, 15.38%), agriculture (9/130, 6.92%), electricians (9/130, 6.92%), carpenters (8/130, 6.15%), and other occupations (16/130, 12.31%). Because this was a hospital-based study without a denominator representing the total number of workers at risk within each occupational category, these proportions describe the distribution of presenting occupational OSFB cases and should not be interpreted as occupation-specific incidence rates (Table 1).

Table 1. Demographic and occupational characteristics of study participants (N = 130)

Characteristic	n	%
Sex		
Male	123	94.62
Female	7	5.38
Age group		
18–45 years	102	78.46
Other age groups	28	21.54

Occupation		
Metal industry	68	52.31
Construction	20	15.38
Agriculture	9	6.92
Electrician	9	6.92
Carpenter	8	6.15
Other occupations	16	12.31
Total	**130**	**100.00**

Note: Percentages are calculated using the total study population (N = 130).

Occupational Activity and Circumstances of Injury

The immediate occupational activity at the time of injury showed a marked concentration of cases in activities capable of generating particulate or high-velocity ocular exposure. Metal grinding/cutting was the predominant activity, accounting for 73 participants (56.15%). This was followed by woodwork (17, 13.08%), other occupational activities (18, 13.85%), agricultural activities (12, 9.23%), and cement-related work (10, 7.69%) (Figure 1).

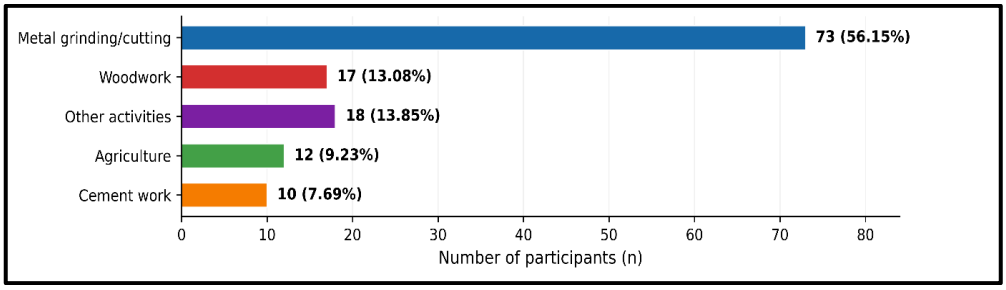

Figure 1. Occupational activities associated with ocular surface foreign-body (OSFB) injury (N=130).).

The right eye was involved in 76 participants (58.46%), while 54 (41.54%) had left-eye involvement. Metallic material was the most frequently identified foreign-body type, occurring in 77 participants (59.23%), followed by dust (27, 20.77%), wood (11, 8.46%), agricultural material (6, 4.62%), and other materials (9, 6.92%). The cornea was the predominant anatomical site, accounting for 92 cases (70.77%), followed by the conjunctiva (26, 20.00%) and eyelid (12, 9.23%) (Figure 2) (Table 2).

Table 2. Occupational activity and clinical characteristics of OSFB injuries (N = 130)

Variable	n	%
Work activity at injury		
Metal grinding/cutting	73	56.15
Woodwork	17	13.08
Agriculture	12	9.23
Cement work	10	7.69
Other activities	18	13.85
Affected eye		
Right	76	58.46
Left	54	41.54
Foreign-body material		
Metallic	77	59.23
Dust	27	20.77
Wood	11	8.46
Agricultural material	6	4.62
Other	9	6.92
Anatomical location		
Cornea	92	70.77
Conjunctiva	26	20.00
Eyelid	12	9.23
Total	**130**	**100.00**

Note: Percentages are calculated using N=130 within each variable.

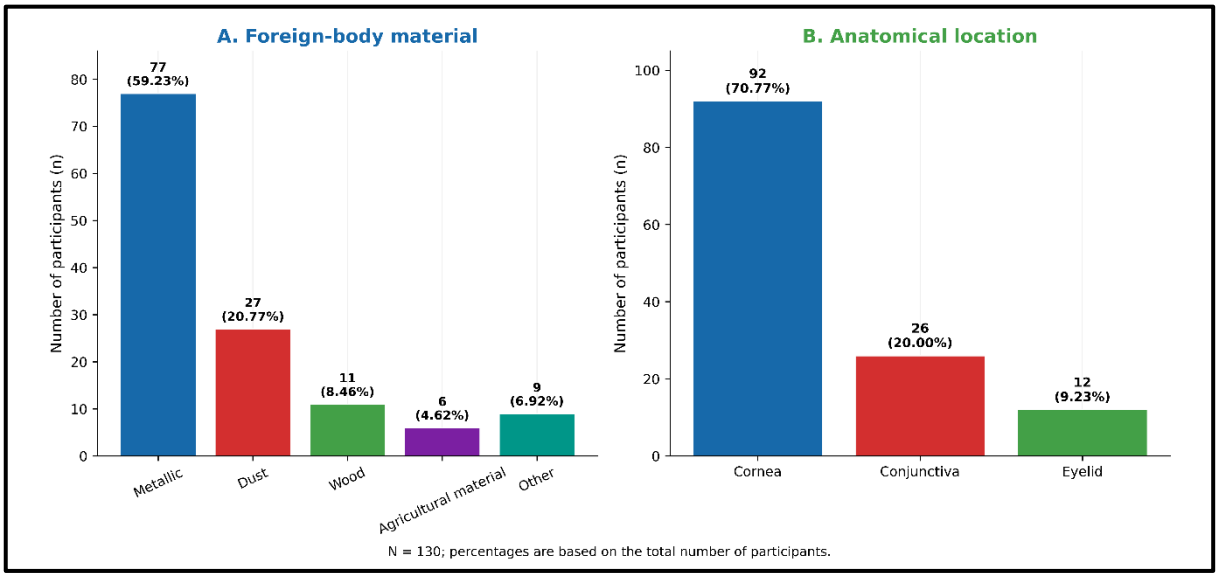

Figure 2. Distribution of foreign-body material and anatomical location of occupational ocular surface foreign-body injuries. (A) Distribution of the type of foreign-body material identified among participants. Metallic foreign bodies were the most frequent, followed by dust, wood, agricultural material, and other materials. (B) Anatomical distribution of foreign-body lodgement, with the cornea being the most commonly affected site, followed by the conjunctiva and eyelid. Bars represent the number of participants, with percentages shown above each bar. OSFB, ocular surface foreign body.

Presenting Symptoms

Ocular irritation was the most frequently reported presenting symptom, occurring in 77 participants (59.23%), followed by pain in 65 (50.00%), redness in 61 (46.92%), and watering in 41 (31.54%) (Table 3). Because participants could report more than one symptom, the symptom categories were not mutually exclusive, and therefore the percentages do not sum to 100%. Percentages were calculated using the total number of participants (N=130) as the denominator.

Table 3. Presenting symptoms among participants with occupational OSFB injury (N = 130)

Presenting symptom	n	% of participants
Ocular irritation	77	59.23
Pain	65	50.00
Redness	61	46.92
Watering	41	31.54

Note: Multiple responses were permitted; therefore, percentages do not sum to 100%.

Protective-Eyewear Use

Protective-eyewear use at the time of injury was low. Only 27 participants (20.77%) reported using protective eyewear, whereas 103 (79.23%) reported no protective eyewear.

Among the 27 participants who reported protective eyewear use, 21 (16.15% of the total cohort) reported using safety goggles and 6 (4.62%) reported using a welding helmet. Thus, nearly four out of five participants sustained their occupational OSFB injury without reported protective eyewear (Figure 3) (Table 4).

Table 4. Protective-eyewear use at the time of injury

Protective-eyewear status	n	%
Safety goggles	21	16.15
Welding helmet	6	4.62
No protective eyewear	103	79.23
Total	**130**	**100.00**

Note: *Safety goggles and welding helmet are components of the 27 participants reporting any protective eyewear use and should not be added to the total as independent categories.*

Reasons for Non-Use of Protective Eyewear

Among the 103 participants who reported no protective eyewear, non-availability of PPE was the most frequently reported reason, reported by 36 participants (34.95%). Other reasons were reported by 24 (23.30%), while 21 (20.39%) reported forgetting to wear PPE. Temporary removal of PPE during work was reported by 13 (12.62%), and discomfort by 9 (8.74%). The reasons collectively accounted for all 103 participants who reported PPE non-use (Figure 3) (Table 5).

Table 5. Reasons for non-use of protective eyewear among PPE non-users (n = 103)

Reason for non-use	n	%
PPE not available	36	34.95
Other reasons	24	23.30
Forgot to wear PPE	21	20.39
Temporarily removed PPE	13	12.62
Discomfort	9	8.74
Total	**103**	**100.00**

Note: Percentages are calculated among participants who reported no PPE use (n = 103). The study proforma classified additional reasons under "other," including lack of awareness, damaged PPE, and perceived low risk.

Previous Occupational OSFB Injury

Most participants (96/130, 73.85%) reported no previous occupational OSFB injury. However, 34 participants (26.15%) reported at least one previous episode. Among the total cohort, 17 participants (13.08%) reported one previous episode, 8 (6.15%) reported two episodes, and 9 (6.92%) reported more than two previous episodes. Thus, approximately one-quarter of participants had experienced a previous occupational OSFB injury (Table 6).

Table 6. Previous history of occupational OSFB injury (N = 130)

Previous OSFB history	n	%
None	96	73.85
One previous episode	17	13.08
Two previous episodes	8	6.15
More than two episodes	9	6.92
Total	**130**	**100.00**

Self-Removal Practices

Before seeking professional eye care, 49 participants (37.69%) reported attempting to remove the foreign body themselves, whereas 81 (62.31%) did not report a self-removal attempt (Table 7).

Table 7. Self-removal of ocular foreign body before professional assessment (N = 130)

Self-removal attempt	n	%
Yes	49	37.69
No	81	62.31
Total	**130**	**100.00**

Awareness of Ocular Safety Risks

Awareness of potential ocular harm was relatively high despite the low prevalence of protective-eyewear use.
Eighty-four participants (64.62%) were aware of the potential harm associated with inappropriate self-removal, whereas 46 (35.38%) were unaware. Similarly, 86 participants (66.15%) were aware that repeated ocular foreign-body exposure could adversely affect vision, while 44 (33.85%) were unaware (Table 8).

Table 8. Awareness of ocular safety risks (N = 130)

Awareness variable	Yes, n (%)	No, n (%)
Aware of harm from self-removal	84 (64.62)	46 (35.38)
Aware of visual harm from repeated exposure	86 (66.15)	44 (33.85)

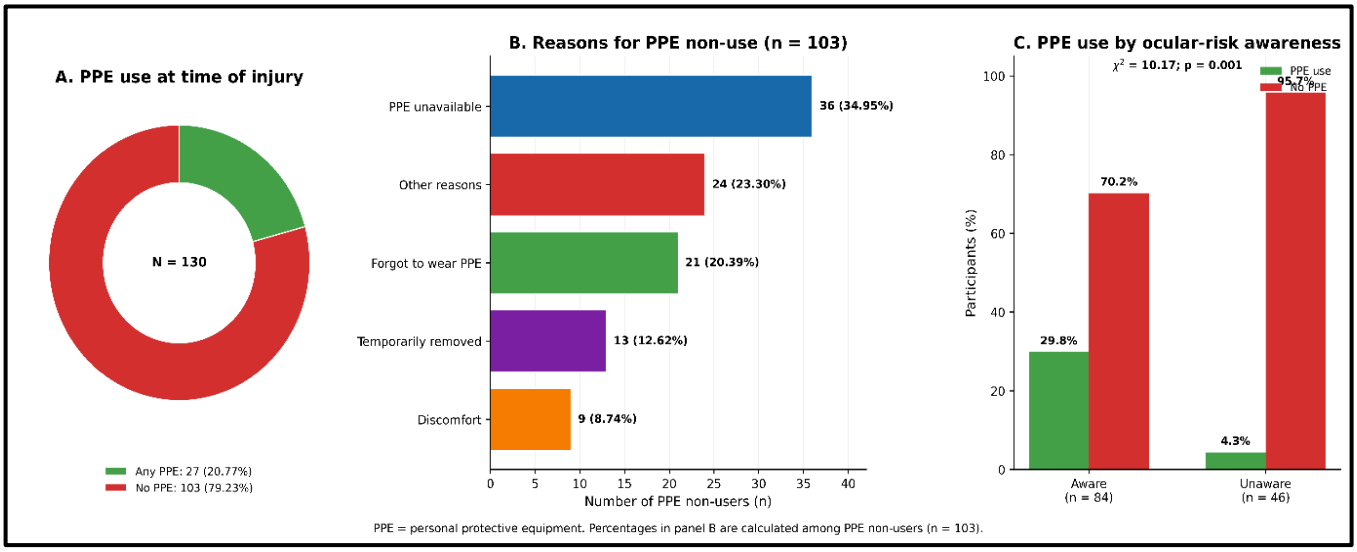

Figure 3. Protective-eyewear use, barriers to use, and association between ocular-risk awareness and protective-eyewear use. (A) Proportion of participants reporting use versus non-use of personal protective equipment (PPE) at the time of injury. (B) Reported reasons for non-use of PPE among participants who were not wearing protective eyewear at the time of injury. (C) Percentage of participants using or not using PPE according to awareness of occupational ocular risk. PPE use was significantly more frequent among participants who were aware of ocular risk (29.8%) than among those who were unaware (4.3%; $\chi^2 = 10.17$, $p = 0.001$). PPE, personal protective equipment.

Association Between Occupational and Behavioural Characteristics and Protective-Eyewear Use

Protective-eyewear use was further examined in relation to occupational and behavioural characteristics. PPE use was defined as wearing either safety goggles or a welding helmet, whereas non-use was defined as the absence of protective eyewear (**Table 9**).

Sex

There was no statistically significant association between sex and PPE use ($\chi^2 = 0.274$, $p = 0.601$; $\varphi = 0.046$). PPE use was reported by 25/123 (20.3%) male participants and 2/7 (28.6%) female participants. Although the proportion of PPE use was numerically higher among female participants, the difference was small and not statistically significant.

Occupation

Occupational category was not significantly associated with PPE use ($\chi^2 = 8.26$, $p = 0.142$; Cramer's V = 0.252).
PPE use was reported by 12/68 (17.6%) metal-industry workers, 5/18 (27.8%) construction workers, 2/9 (22.2%) agricultural workers, 3/9 (33.3%) electricians, 3/8 (37.5%) carpenters, and 2/18 (11.1%) participants in other occupations. Although the proportion of PPE use varied across occupational categories, the overall association was not statistically significant.

Work Activity

Specific work activity also showed no statistically significant association with PPE use ($\chi^2 = 4.94$, $p = 0.294$; Cramer's V = 0.195).
PPE use was reported by 14/73 (19.2%) participants involved in metal grinding/cutting, 5/18 (27.8%) involved in cement work, 3/10 (30.0%) involved in woodwork, 3/11 (27.3%) involved in agricultural work, and 2/18 (11.1%) involved in other activities. Although PPE use varied across work activities, the overall association did not reach statistical significance.

Previous OSFB Injury

Previous OSFB injury was not significantly associated with PPE use ($\chi^2 = 1.03$, $p = 0.310$; $\varphi = 0.089$). PPE use was reported by 22/96 (22.9%) participants without a previous OSFB injury compared with 5/34 (14.7%) participants who reported a previous injury. Thus, participants with a previous injury showed numerically lower PPE use, but this difference was not statistically significant.

Awareness of Potential Harm from Self-Removal

In contrast, awareness of the potential harm associated with self-removal was significantly associated with PPE use (χ^2 = 11.67, $p < 0.001$; $\varphi = 0.300$). Among participants who were aware of the potential harm from self-removal, 25/84 (29.8%) reported PPE use, compared with 2/46 (4.3%) among those who were unaware. Conversely, PPE non-use occurred in 59/84 (70.2%) participants who were aware of the risk compared with 44/46 (95.7%) participants who were unaware. This represented a statistically significant association with a small-to-moderate effect size ($\varphi = 0.300$) (Figure 3).

Self-Removal Attempt

Self-removal attempt was also significantly associated with PPE use ($\chi^2 = 4.63$, $p = 0.031$; $\varphi = 0.189$). PPE use was reported by 15/49 (30.6%) participants who had attempted self-removal compared with 12/81 (14.8%) participants who had not.

Table 9. Association between demographic, occupational, and behavioural characteristics and protective-eyewear use among participants with occupational ocular surface foreign-body injuries (N = 130)

Variable	Category	Protective eyewear use, n (%)	No protective eyewear, n (%)	Test statistic	p-value	Effect size
Occupation	Metal industry	12 (17.6)	56 (82.4)	$\chi^2 = 8.26$	0.142	V = 0.252
	Construction	5 (27.8)	13 (72.2)			
	Agriculture	2 (22.2)	7 (77.8)			
	Electrician	3 (33.3)	6 (66.7)			
	Carpenter	3 (37.5)	5 (62.5)			
	Other	2 (11.1)	16 (88.9)			
Work activity at injury	Metal grinding/cutting	14 (19.2)	59 (80.8)	$\chi^2 = 4.94$	0.294	V = 0.195
	Cement work	5 (27.8)	13 (72.2)			
	Woodwork	3 (30.0)	7 (70.0)			
	Agricultural work	3 (27.3)	8 (72.7)			
	Other activities	2 (11.1)	16 (88.9)			
Sex	Male	25 (20.3)	98 (79.7)	χ^2 = 0.274	0.601	φ = 0.046
	Female	2 (28.6)	5 (71.4)			
Previous OSFB injury	No	22 (22.9)	74 (77.1)	$\chi^2 = 1.03$	0.310	φ = 0.089
	Yes	5 (14.7)	29 (85.3)			
Awareness of potential harm from self-removal	No	2 (4.3)	44 (95.7)	$\chi^2 = 11.67$	<0.001	φ = 0.300
	Yes	25 (29.8)	59 (70.2)			
Self-removal attempt	No	12 (14.8)	69 (85.2)	$\chi^2 = 4.63$	0.031	φ = 0.189
	Yes	15 (30.6)	34 (69.4)			

Note: Percentages are calculated within each categorical subgroup. Pearson's χ^2 test was used where assumptions were satisfied. Effect sizes are expressed as Cramer's V for variables with more than two categories and φ for binary variables.

Thus, PPE use was approximately twice as common among participants who reported a self-removal attempt compared with those who did not. However, the effect size was small ($\varphi = 0.189$), and the observed association should be interpreted cautiously given the cross-sectional design and the relatively small number of PPE users.

Logistic Regression Analysis of Factors Associated with PPE Non-Use

A logistic regression model was performed with non-use of protective eyewear as the dependent outcome, coded as 1 for no PPE and 0 for PPE use. Candidate predictors included age, sex, metal-related occupation, high-risk work activity, previous OSFB injury, awareness of ocular risk, and self-removal attempt.

In univariable analyses, age, metal-related occupation, high-risk work activity, and awareness of ocular risk were significantly associated with PPE non-use.

For each additional year of age, the odds of PPE non-use increased by approximately 3% in the unadjusted analysis (OR 1.03, 95% CI 1.00-1.06; p = 0.041). Metal-related occupation was also associated with greater odds of PPE non-use (OR 1.91, 95% CI 1.01-3.62; p = 0.047).

High-risk work activity demonstrated a stronger association with PPE non-use (OR 2.37, 95% CI 1.17-4.80; p = 0.017). Conversely, awareness of ocular risk was associated with lower odds of PPE non-use (OR 0.49, 95% CI 0.25-0.96; p = 0.038).

Male sex was not significantly associated with PPE non-use (OR 1.84, 95% CI 0.65-5.21; p = 0.250). Previous OSFB injury (OR 0.58, 95% CI 0.27-1.25; p = 0.165) and self-removal attempt (OR 1.31, 95% CI 0.65-2.63; p = 0.451) were also not statistically significant predictors.

After multivariable adjustment, high-risk work activity remained independently associated with PPE non-use, with participants engaged in high-risk work activities having approximately twice the odds of PPE non-use (adjusted OR 2.14, 95% CI 1.01-4.54; p = 0.047).

Metal-related occupation retained a positive association but did not reach statistical significance after adjustment (adjusted OR 1.78, 95% CI 0.91-3.49; p = 0.093). Awareness of ocular risk retained an inverse association with PPE non-use, although this also did not reach statistical significance after adjustment (adjusted OR 0.53, 95% CI 0.26-1.08; p = 0.081). Previous OSFB injury (adjusted OR 0.63, 95% CI 0.28-1.42; p = 0.264) and self-removal attempt (adjusted OR 1.22, 95% CI 0.58-2.56; p = 0.599) were not independently associated with PPE non-use (Table 10).

Table 10. Logistic regression analysis of factors associated with non-use of protective eyewear

Predictor	Crude OR	95% CI	p-value	Adjusted OR	95% CI	p-value
Age, per year	1.03	1.00–1.06	**0.041**	1.02	0.99–1.06	0.109
Male sex	1.84	0.65–5.21	0.250	1.62	0.54–4.88	0.388
Metal-related occupation	1.91	1.01–3.62	**0.047**	1.78	0.91–3.49	0.093
High-risk work activity	2.37	1.17–4.80	**0.017**	**2.14**	**1.01–4.54**	**0.047**
Previous OSFB injury	0.58	0.27–1.25	0.165	0.63	0.28–1.42	0.264
Awareness of ocular risk	0.49	0.25–0.96	**0.038**	0.53	0.26–1.08	0.081
Self-removal attempt	1.31	0.65–2.63	0.451	1.22	0.58–2.56	0.599

Outcome: PPE non-use (1 = no PPE; 0 = PPE use). OR >1 indicates greater odds of PPE non-use.

Model Performance

The multivariable logistic regression model demonstrated an overall likelihood-ratio $\chi^2 = 18.72$ with 7 degrees of freedom (p = 0.009), indicating that the model containing the predictors provided a statistically significant improvement over the intercept-only model.

The model explained approximately 21% of the variance in PPE non-use, based on a Nagelkerke R^2 of 0.21. The Hosmer–Lemeshow goodness-of-fit test was non-significant ($\chi^2 = 5.42$, df = 8, p = 0.712), indicating no evidence of significant lack of fit. Overall classification accuracy was 81.5%, and all variance inflation factors were below 2.5, indicating no substantial multicollinearity among the included predictors.

Overall Interpretation of the Statistical Findings

The statistical analysis identified awareness of ocular risk as the only categorical characteristic significantly associated with PPE use in the bivariate analysis, with PPE use substantially more frequent among participants who were aware of ocular risks (29.8% vs 4.3%; p = 0.001).

However, after adjustment for demographic, occupational, previous-injury, awareness, and behavioural factors, high-risk work activity emerged as the only independent predictor of PPE non-use (adjusted OR 2.14, 95% CI 1.01-4.54; p = 0.047). Awareness retained a potentially protective direction, with participants aware of ocular risk showing lower adjusted odds of PPE non-use (adjusted OR 0.53), but the association was no longer statistically significant after adjustment (p = 0.081).

Similarly, metal-related occupation showed an increased adjusted odds of PPE non-use, but this did not reach statistical significance (adjusted OR 1.78, p = 0.093).

Importantly, because this was a cross-sectional hospital-based study, these associations should be interpreted as statistical associations rather than causal relationships.

Discussion

Occupational ocular surface foreign-body (OSFB) injuries remain an important and largely preventable form of workplace ocular trauma, particularly in occupations involving metal processing, grinding, cutting, welding, construction, and other particulate-generating activities. In the present hospital-based cross-sectional study of 130 participants, occupational OSFB injuries predominantly involved male workers and were strongly concentrated around metal-related and high-risk activities. Metal-industry workers accounted for 52.31% of the cohort, while metal grinding/cutting was the activity being performed at the time of injury in 56.15% of cases. Metallic foreign bodies constituted 59.23% of injuries, and the cornea was the most frequently involved anatomical site (70.77%). Most importantly, only 20.77% of participants reported using protective eyewear at the time of injury, whereas 79.23% reported no protective eyewear. Among non-users, reported non-availability of PPE was the most common reason. More than one-quarter of participants had experienced a previous occupational OSFB injury and more than one-third had attempted self-removal. In bivariate analysis, awareness of potential harm from self-removal was associated with PPE use; however, this association was attenuated after adjustment. High-risk work activity was the only factor independently associated with PPE non-use in the multivariable model (adjusted OR 2.14, 95% CI 1.01–4.54, p=0.047).

Taken together, these findings indicate that occupational OSFB prevention in this setting requires more than increasing worker awareness alone. The combination of high-risk work activities, limited PPE use, reported PPE non-availability, recurrent injury, and self-removal behaviour suggests that both workplace-level and worker-level preventive measures are necessary.

Demographic and occupational profile

The marked male predominance in the present study (94.62%) is consistent with previous hospital-based studies of occupational corneal foreign-body injuries. Nagar and Choudhary (2024), for example, reported that all 62 participants in their tertiary-care study were male, while Sharma et al. (2023) reported only one female among 142 patients with occupational corneal foreign bodies. A recent Indian study of 102 blue-collar workers with occupational corneal foreign bodies similarly reported a predominantly male population.

This predominance should, however, be interpreted primarily in relation to the occupational composition of the study population rather than as evidence of an intrinsic sex-related susceptibility to OSFB injury. Many of the occupations represented in the present cohort, particularly metal processing, grinding, construction, and related manual work, may have a predominantly male workforce. Consequently, the sex distribution probably reflects patterns of occupational exposure.

The occupational distribution provides a more direct indication of the exposure profile. Metal-industry workers represented 52.31% of participants, and metal grinding/cutting accounted for 56.15% of injury circumstances. This pattern closely resembles previous Indian studies. Nagar and Choudhary (2024) reported metal work as the leading occupational sector and metal grinding/cutting as the leading activity associated with corneal foreign bodies. Similarly, a study of metallic corneal foreign bodies from northern India reported metalwork as the predominant occupational sector and grinding as the principal activity.

The findings are also consistent with broader occupational eye-injury literature identifying grinding, welding, and other high-velocity mechanical activities as important sources of ocular foreign-body exposure. A recent Indian occupational-eye-injury study reported that welding and grinding together accounted for approximately 60% of workplace ocular injuries, with corneal foreign bodies being the predominant mechanical injury. The concentration of injuries around grinding and cutting is clinically plausible because these activities can generate small, high-velocity particles capable of reaching the exposed ocular surface. Importantly, however, the present study does not establish occupation-specific incidence or relative risk, because the number of workers exposed to each occupational activity in the underlying population was not available. Therefore, the results should be interpreted as describing the occupational profile of patients presenting with OSFB injuries rather than estimating the probability of injury among workers in each occupation.

Foreign-body characteristics and anatomical distribution

The predominance of metallic foreign bodies (59.23%) is consistent with the occupational profile of the cohort. Metal grinding and cutting generate particulate material that can impact the ocular surface at high velocity, making metallic material an expected finding in this setting. Previous studies have similarly identified metallic material as the dominant foreign-body type in occupational corneal injuries. Sharma et al. (2023), for example, reported metallic foreign bodies in 87.3% of their 142-patient cohort, while studies specifically examining metallic corneal foreign bodies have also demonstrated strong associations with metalworking and grinding activities. The lower proportion of metallic foreign bodies in the present cohort compared with Sharma et al. (2023) may reflect differences in the occupational composition of the study populations, inclusion criteria, and the broader definition of OSFB used in the present study, which included ocular-surface foreign bodies rather than restricting the cohort exclusively to corneal foreign bodies. The cornea was the most frequently affected anatomical site (70.77%). This finding is expected because the cornea is directly exposed to airborne particulate material and provides a relatively exposed surface during occupational activity. Previous occupational foreign-body studies have similarly identified the cornea as the predominant site of involvement. The clinical symptom pattern was also consistent with corneal involvement. Ocular irritation was reported by 59.23%, pain by 50.00%, redness by 46.92%, and watering by 31.54%. These percentages were calculated using the total sample as the denominator because participants could report more than one symptom; therefore, the categories were not expected to sum to 100%. The predominance of irritation and pain is clinically plausible in a cohort in which approximately seven of every ten participants had corneal involvement. These findings reinforce the clinical importance of occupational OSFB injuries. Although the present study was not designed to quantify long-term visual outcomes or complications, retained or inadequately managed foreign bodies can produce epithelial injury, inflammation, rust deposition in metallic injuries, secondary infection, and corneal scarring. Such potential consequences provide a strong clinical rationale for prevention and timely ophthalmic assessment.

Protective-eyewear use represents the major preventable gap

The most important preventive finding was the low prevalence of protective-eyewear use. Only 27 of 130 participants (20.77%) reported using any protective eyewear at the time of injury, whereas 103 (79.23%) reported no protection. Thus, approximately four out of five occupational OSFB injuries in this cohort occurred without reported protective eyewear. This finding is highly consistent with previous occupational foreign-body literature. Nagar and Choudhary (2024) reported protective-equipment use in only 18% of their 62 participants. Sharma et al. (2023) reported that 75.1% of patients were not using eye-protective devices when injured, and a recent Indian study found that only 27.45% of occupational corneal-foreign-body patients regularly used eye-protective devices.

The consistency of these findings across different Indian and South Asian clinical settings is important. It suggests that low protective-eyewear use is not simply an isolated characteristic of the present study population but may represent a persistent occupational safety problem. However, differences between studies should be interpreted cautiously because PPE definitions, occupational categories, questionnaire methods, and study populations differ. The present study also demonstrates why PPE use should not be viewed solely as an individual worker behaviour. The most frequently reported reason for non-use was PPE non-availability, indicating a potential workplace-level barrier. This is consistent with Nagar and Choudhary (2024), in which lack of protective equipment at the workplace was reported by more than half of participants, and with other studies demonstrating that equipment availability and workplace safety systems influence protective-device use. Accordingly, improving PPE adherence requires more than simply instructing workers to wear goggles. Effective prevention should ensure that appropriate protective equipment is available, accessible, task-specific, comfortable, and consistently reinforced through workplace safety practices.

Reasons for PPE non-use: workplace and behavioural factors

Among the 103 participants who did not use protective eyewear, 36 (34.95%) reported that PPE was not available. Other reasons included forgetting to wear PPE (20.39%), temporary removal during work (12.62%), discomfort (8.74%), and other reasons (23.30%). The distribution is important because it demonstrates that PPE non-use has both structural and behavioural dimensions. The high proportion reporting non-availability suggests that some workers may have been unable to comply even if they recognized the importance of protection. At the same time, forgetting, temporary removal, and discomfort indicate that simply providing PPE may not guarantee consistent use. A recent Indian study similarly found persistent underuse of eye-protective devices despite relatively high awareness, identifying workplace regulation, awareness, and financial constraints among reported barriers. Likewise, the study by Nagar and Choudhary (2024) reported that lack of workplace protection was the leading reported reason for non-use. These findings support a hierarchical prevention approach. At the workplace level, employers should provide appropriate protective eyewear and ensure that it is readily accessible during hazardous tasks. At the worker level, education, supervision, and reinforcement

should address consistent use, temporary removal, and practical barriers such as discomfort or poor fit. For particularly hazardous activities such as grinding and cutting, the protective device should be appropriate to the specific mechanism of injury rather than treated as a generic safety accessory.

Previous injury indicates an opportunity for secondary prevention

Thirty-four participants (26.15%) reported at least one previous occupational OSFB injury. This means that approximately one in four participants had already experienced a similar workplace injury before the current presentation. This finding is clinically and occupationally important because recurrent injury may indicate continued exposure to the same hazard without adequate modification of either the workplace or protective behaviour. Nagar and Choudhary (2024) reported previous corneal foreign-body exposure in a substantial proportion of their cohort, while Sharma et al. (2023) reported previous CFB injury in 41.5% of participants. The lower recurrence proportion in the present cohort may reflect differences in case definition and population characteristics, but the presence of recurrent injuries nevertheless identifies an important prevention opportunity. A worker presenting with a repeat occupational OSFB injury should not be considered only as a patient requiring foreign-body removal; the episode also provides an opportunity to identify the underlying occupational hazard, review PPE use, and reinforce preventive measures.
This is particularly relevant because treatment of an acute foreign body does not remove the worker from future exposure. Secondary prevention following an occupational eye injury may therefore be as important as acute clinical management.

Self-removal behaviour
A further important finding was that 49 participants (37.69%) attempted self-removal of the foreign body before professional assessment. This behaviour may expose the ocular surface to additional mechanical trauma and may delay appropriate evaluation, although the present study did not assess whether self-removal directly caused complications.
The frequency is comparable with previous studies. Sharma et al. (2023) reported that 45.1% of participants attempted potentially harmful physical removal, while Nagar and Choudhary (2024) reported an even higher proportion of 58% attempting self-removal. A recent Indian study also reported that 35.29% of participants had attempted foreign-body removal themselves. The consistency of this behaviour across studies suggests that occupational eye-safety programmes should address post-injury behaviour as well as injury prevention. Workers should be informed that ocular foreign bodies should not be manipulated unnecessarily and that persistent foreign-body sensation following workplace exposure warrants appropriate clinical assessment. Importantly, the present study assessed self-removal behaviour descriptively and did not establish whether self-removal was associated with deeper injury, infection, delayed presentation, or poorer visual outcome. Those relationships should therefore not be inferred from the current findings.

Awareness and the knowledge–practice gap

Awareness of ocular risk was relatively common in the cohort. Eighty-four participants (64.62%) reported awareness of potential harm from self-removal, while 86 (66.15%) recognized that repeated foreign-body exposure could adversely affect vision. Nevertheless, only 20.77% reported using protective eyewear at the time of injury. This contrast suggests a potential knowledge–practice gap. Similar discrepancies have been reported in previous studies. The recent Indian study by Raj et al. found that 80.39% of participants were aware of eye-protective devices, yet only 27.45% reported regular use. Nagar and Choudhary (2024) likewise identified low protective-equipment use despite assessing awareness of occupational corneal foreign-body complications. In the present study, awareness of potential harm from self-removal was significantly associated with PPE use in bivariate analysis (29.8% vs. 4.3%; χ^2=10.17, p=0.001). However, the association was attenuated after multivariable adjustment and did not remain statistically significant (adjusted OR 0.53, 95% CI 0.26–1.08, p=0.081).

This distinction is important. The data support an association between awareness and PPE use at the unadjusted level, but they do not demonstrate that increasing awareness alone will cause greater PPE adherence. The loss of statistical significance after adjustment suggests that the relationship may be influenced by occupational and other behavioural factors. In practical terms, workers may understand the risks but still fail to use PPE when equipment is unavailable, inconvenient, uncomfortable, or inadequately supported by workplace safety systems. Therefore, education should remain an important component of prevention, but it should be combined with reliable PPE provision, task-specific protection, workplace supervision, and safety enforcement.

High-risk work activity as an independent predictor of PPE non-use

The multivariable analysis provides an important analytical contribution of the present study. After adjustment, high-risk work activity was independently associated with PPE non-use, with workers engaged in high-risk activities having

approximately twice the odds of PPE non-use compared with the reference category (adjusted OR 2.14, 95% CI 1.01–4.54; p=0.047).

This finding is particularly relevant because the strongest occupational exposure in the descriptive analysis was also a high-velocity activity—metal grinding/cutting. It suggests that the context in which work is performed may influence protective behaviour beyond broad occupational classification. One possible explanation is that high-risk tasks may impose practical demands that interfere with PPE use, such as discomfort, visibility limitations, heat, task-specific equipment requirements, or temporary removal during particular stages of work. However, these mechanisms were not directly measured in the present study and should therefore be regarded as plausible explanations rather than established causes. Metal-related occupation itself showed an increased adjusted odds of PPE non-use but did not reach statistical significance. Similarly, awareness demonstrated a potentially protective direction but was not statistically significant after adjustment. These findings suggest that the immediate work activity may be more informative than occupation alone when identifying workers at risk of inadequate eye protection. The regression results should nevertheless be interpreted as associations rather than causal effects because of the cross-sectional study design. In particular, it cannot be determined whether high-risk work activity directly influenced PPE behaviour or whether other unmeasured workplace characteristics contributed to the observed association.

Clinical and occupational-health implications

The findings have implications at several levels. At the worker level, occupational eye-safety education should emphasize consistent use of protective eyewear, recognition of hazardous tasks, avoidance of unnecessary self-removal, and timely professional assessment following ocular exposure. At the workplace level, PPE should be reliably available and appropriate to the specific hazard. The predominance of grinding/cutting injuries indicates that generic PPE recommendations may be insufficient; protection should be selected according to the mechanism and velocity of the expected ocular exposure. At the organizational level, workplace safety programmes should incorporate supervision, periodic training, replacement of damaged or uncomfortable protective equipment, and reinforcement of PPE compliance. The fact that a substantial proportion of participants reported previous injury also suggests that recurrent occupational OSFB should trigger a review of workplace safety practices. Finally, prevention should not rely exclusively on PPE. Where feasible, occupational safety should follow a hierarchy of controls, including engineering and administrative measures to reduce exposure, with PPE serving as an important final barrier against residual ocular hazards.

What this study adds

The principal contribution of the present study is that it moves beyond describing the demographic and clinical characteristics of occupational OSFB injuries and examines the relationship between occupational exposure, protective behaviour, awareness, previous injury, self-removal, and PPE non-use within the same cohort. The combination of 79.23% PPE non-use, 34.95% reporting PPE non-availability, 26.15% reporting previous OSFB injury, and 37.69% reporting self-removal demonstrates that the prevention problem is multidimensional. The multivariable finding that high-risk work activity remained independently associated with PPE non-use further suggests that occupational context should be considered when designing interventions. Thus, the findings support a shift from a purely educational approach toward an integrated prevention model combining hazard-specific protective eyewear, reliable workplace PPE availability, worker training, adherence monitoring, workplace safety systems, and appropriate post-injury guidance.

Strengths and limitations

A major strength of this study is the comprehensive assessment of occupational and behavioural factors alongside the clinical characteristics of OSFB injuries. The study did not limit assessment to foreign-body location and material but also evaluated PPE use, reasons for non-use, previous injury, self-removal behaviour, awareness, and independent predictors of PPE non-use. This provides a broader occupational-health perspective than a purely clinical description of foreign-body injuries. Several limitations should be considered. First, the study was hospital-based and cross-sectional, so the findings may not be generalizable to all workers or all occupational OSFB injuries. Workers with minor injuries who did not seek medical attention or who attended other healthcare facilities would not have been captured. Second, the study did not include the total number of workers exposed to each occupation or activity; therefore, occupation-specific incidence, prevalence, or relative risk cannot be calculated. Third, PPE use, PPE availability, awareness, previous injury, and self-removal behaviour were self-reported and may be subject to recall or social-desirability bias. Fourth, the cross-sectional design prevents determination of temporal or causal relationships between occupational activity and PPE behaviour. Finally, the sample size may have limited the statistical power to identify smaller independent associations in the multivariable model.

Overall, the present findings demonstrate that occupational OSFB injuries in this tertiary-care cohort were predominantly associated with metal-related and high-risk particulate-generating activities, with metallic foreign bodies and corneal involvement being particularly common. The most important modifiable finding was the markedly low use of protective eyewear, with PPE non-availability representing the most frequently reported barrier. The occurrence of previous injuries and self-removal attempts further indicates persistent gaps in occupational eye safety and post-injury practices.
Although awareness of potential harm from self-removal was associated with PPE use in bivariate analysis, it was not independently significant after adjustment. In contrast, high-risk work activity remained independently associated with PPE non-use. These findings suggest that effective prevention cannot depend on worker education alone. A more comprehensive strategy incorporating reliable provision of task-appropriate protective eyewear, workplace safety systems, worker education, adherence monitoring, and appropriate post-injury care-seeking is likely to be more effective in reducing preventable occupational OSFB injuries.

Conclusion

Occupational ocular surface foreign-body injuries in this hospital-based cohort were predominantly associated with metal-related and high-risk particulate-generating activities, particularly metal grinding and cutting. Metallic foreign bodies and corneal involvement were the predominant clinical patterns. Despite the preventable nature of these injuries, 79.23% of participants reported no protective-eyewear use at the time of injury, with PPE non-availability being the most frequently reported barrier. Previous injury and self-removal attempt further indicate persistent gaps in occupational eye-safety practices. Although awareness of potential harm from self-removal was significantly associated with PPE use in bivariate analysis, it was not independently associated after adjustment. High-risk work activity was the only independent factor associated with PPE non-use (adjusted OR 2.14, 95% CI 1.01-4.54; p=0.047). These findings support a multidimensional prevention strategy incorporating reliable availability of task-appropriate protective eyewear, worker education, adherence and workplace safety measures, and appropriate post-injury care-seeking. Because of the cross-sectional hospital-based design, these associations should not be interpreted as causal.

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Ethics approval

The study protocol was reviewed and approved by the Institutional Ethics Committee (Approval No. IEC/BMCOP/2024/015). The research was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

AI tool usage declaration

No AI tool was used in manuscript preparation.

References

Bahoo, M. A., Jamil, A. Z., & Khalid, M. S. (2018). Ocular surface foreign bodies and their association with profession. *Pakistan Journal of Medical and Health Sciences, 12*, 495–498.

Bel'hantier, C. L. S., Baqadir, G., Daghouj, L. E. M., Allali, B., & El Kettani, A. (2024). Superficial corneal foreign bodies: A series of 90 cases. *World Journal of Advanced Research and Reviews, 22*(3), 1370–1373. https://doi.org/10.30574/wjarr.2024.22.3.1883

Bhattacharjee, D., & Varshney, A. (2025). Barriers to eye care access in low- and middle-income countries: Focus on Asia. *Acta Scientific Ophthalmology, 8*(10), 1–4. https://doi.org/10.5281/zenodo.17430730

Bhattacharjee, D., & Varshney, A. S. (2026). Global barriers to eye care access: A systematic review and meta-analysis of gender, geographic, and economic disparities. *The Pan-American Journal of Ophthalmology, 8*. https://doi.org/10.4103/pajo.pajo_13_26

Dahiya, M., & Dua, M. (2020). Epidemiological profile of occupational ocular injury in a tertiary eye care centre of North India. *International Journal of Community Medicine and Public Health, 7*(6), 2164–2168. https://doi.org/10.18203/2394-6040.ijcmph20202506

Deshar, A., Pokharel, S., Lopchan, K., & Isha, N. (2026). Ocular surface foreign bodies: Types, location and correlation with occupation and use of protective eyewear. *International Research Journal of Medicine and Surgery, 3*, 1–7. https://doi.org/10.47857/irjmeds.2026.v03i02.061

Dhathri, K., Shwetha, N. C., Preethi, B., & Poornima, N. (2026). Work-related eye injuries: Prevalence, patterns, awareness of eye safety, and protective practice behaviours among industrial workers. *Acta Medica International, 13*(1).

Gongo, D. T., Tubing, D. K., & Paley, D. T. (2025). Occupational risk factors, clinical outcomes, and patient perceptions of metallic corneal foreign body injuries at TRIHRMS, North East India. *International Journal of Scientific Research in Engineering and Management, 9*(10). https://doi.org/10.55041/IJSREM53290

Kashyap, A., Sharma, S., & Negi, S. (2024). A study to evaluate the demographic pattern of the injury caused by metallic corneal foreign body and its outcome after treatment. *International Journal of Current Pharmaceutical Research, 16*(4), 15–17. https://doi.org/10.22159/ijcpr.2024v16i4.4092

Khalid, A., Ayoob, M., Masood, A., Nashit, M., Sayeed, F. Z., & Fatima, A. (2024). Preventing ocular surface foreign body complications: Enhancing awareness and precaution. *Pakistan Journal of Medicine and Dentistry, 13*(1), 37–43. https://doi.org/10.36283/PJMD13-1/008

Nagar, V. K., & Choudhary, N. (2024). A hospital-based study to evaluate etiology and epidemiology of occupational corneal foreign bodies. *Panacea Journal of Medical Sciences, 14*(1), 149–152. https://doi.org/10.18231/j.pjms.2024.028

Oboh, R. A., & Daniel, E. W. (2024). Ocular disorders and compliance to protective eyewear among quarry workers in Akamkpa Local Government Area of Cross River State, Nigeria. *World Journal of Advanced Research and Reviews, 23*(3), 1642–1652. https://doi.org/10.30574/wjarr.2024.23.3.2775

Raj, K., Ravindranath, B. K., Varsha, S., Tiwari, H. D., Datla, P. K. V. K., & Tiwari, R. (2026). A hospital-based cross-sectional study on the suboptimal use of eye protective devices (EPDs) among blue-collar professionals in India. *Journal of Pharmacy and Bioallied Sciences, 18*(Suppl. 1), S115–S117. https://doi.org/10.4103/jpbs.jpbs_952_25

Reddy, P. S., Nirmala, K., Radhika, S., Ravi, S., & Paul, C. (2016). Incidence of ocular surface foreign body and its correlation with specific occupation and preventive measures. *Global Journal for Research Analysis, 5*, 56–58.

Sharma, R., Mamatha, B., Sharma, A., & Gyanchand, R. (2026). Visco-expression of deep stromal corneal foreign body: An innovative technique. *Journal of Clinical Ophthalmology and Research, 14*(1), 79–80. https://doi.org/10.4103/jcor.jcor_233_25

Sharma, R., Rani Sujatha, M. A., Prashant, C. N., Nagaraja, K. S., & Oza, Y. (2019). Incidence of repeated superficial metallic corneal foreign bodies, awareness and use of eye protection devices in suburban Bangalore (South India). *Journal of Clinical and Experimental Ophthalmology, 10*, 804.

Sharma, S., Khadka, D., Shrestha, A., Shrestha, N., Suwal, B., Hamal, D., Shrestha, R., & Khatri, B. (2023). Epidemiological pattern of corneal foreign bodies and utilization of protective eye devices: A hospital-based cross-sectional study. *International Journal of Occupational Safety and Health, 13*(1), 87–96. https://doi.org/10.3126/ijosh.v13i1.45153

Sun, F., Zhou, Y., Dong, L., & Qin, H. (2021). Relationship between the use and type of eye protection and work-related corneal and conjunctival foreign body injuries. *Injury Prevention, 27*, 521–526.

Ulutaş, H. G., Özdemir, L., Amuk Hamidi, N., Doğanay, D., & Duru, Y. (2024). Investigation of the prevalence of foreign body exposure to the eyes and the use of protective equipment in the employees of the Çalı Industrial Zone. *International Journal of Health Services Research and Policy, 9*(2), 124–131. https://doi.org/10.33457/ijhsrp.1414433

Varshney, A. S., & Bhattacharjee, D. (2024). Firework-related ocular injuries: A systematic review and meta-analysis of clinical outcomes and preventive strategies. *Delhi Journal of Ophthalmology, 34*(4), 261–269. https://doi.org/10.4103/DLJO.DLJO_182_24

Varshney, A. S., Najwa, M., & Reshamwala, V. (2024). Visual outcomes after corneal tear repair in children: RGP v/s soft contact lenses. *JOJ Ophthalmology, 10*(4), 555794. https://doi.org/10.19080/JOJO.2024.10.555794