ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 21(7): 1804-1807 (2025)

BIOINFORMATION
Discovery at the interface of physical and biological sciences
BIOMEDICAL INFORMATICS
www.bioinformation.net
Volume 21(7)
Research Article

Received July 1, 2025; Revised July 31, 2025; Accepted July 31, 2025, Published July 31, 2025
DOI: 10.6026/973206300211804

SJIF 2025 (Scientific Journal Impact Factor for 2025) = 8.478
2022 Impact Factor (2023 Clarivate Inc. release) is 1.9

Edited by P Babaji
E-mail: babajipedo@gmail.com
Citation: Kumar *et al.* Bioinformation 21(7): 1804-1807 (2025)

Clinical and visual profile of ocular trauma in rural India: A cross-sectional descriptive study

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ISSN 0973-2063 (online) 0973-8894 (print)

Bioinformation 21(7): 1804-1807 (2025)

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Abstract:

Rural Indian communities are particularly vulnerable owing to agriculture-related hazards, delayed access to care, and limited eye-health literacy**.** Consecutive patients presenting with fresh or previously untreated mechanical ocular injury were enrolled. Clinical findings and initial/un-corrected visual acuity (VA) were recorded using the Birmingham Eye Trauma Terminology (BETT) and Ocular Trauma Score (OTS) frameworks. Community-level first-aid, rapid referral pathways and protective-eye-wear education substantially reduce blindness from eye injuries in rural settings.

Keywords: Ocular trauma; rural health; visual acuity; open-globe injury; birmingham eye trauma terminology; India

Background:

Ocular trauma accounts for an estimated 1.6 million cases of bilateral blindness and up to 19 million cases of unilateral visual loss worldwide **[1]**. In India, population-based surveys indicate a lifetime prevalence of 3-5 % for eye injuries, with higher rates in agrarian districts **[1 - 3]**. Multicentre analyses further demonstrate that young adult males sustain the greatest burden, often at the workplace or farm **[2,4]**. The World Health Organization emphasises that 90 % of eye injuries are preventable through environmental modification and personal protective equipment [**5,6**]. Despite these insights, regional heterogeneity persists regarding mechanisms of injury, clinical spectrum, and visual outcomes. Data specific to rural communities remain sparse, even though India's rural population constitutes nearly 65 % of the national demographic. Limited infrastructure, dependence on manual agricultural labour, and delays in accessing tertiary ophthalmic care may shape a distinct injury profile and outcome trajectory **[5].** Standardised taxonomies such as BETT and quantitative prognostication tools like the Ocular Trauma Score (OTS) have enhanced the comparability of ocular-trauma research **[7 - 10]**. Yet few Indian studies utilise these frameworks comprehensively, and fewer still include both open- and closed-globe injuries across all age groups. Building such evidence is crucial for planning context-appropriate preventive and rehabilitative strategies. Therefore, it is of interest to report to delineate the demographic, clinical and visual profile of ocular trauma among patients attending a rural secondary-level eye hospital in northern India.

Materials and Methods:

A hospital-based cross-sectional study was conducted at Chhindwara Institute of Medical Sciences, Chhindwara, MP, India, a tertiary care teaching institution, after approval from Institutional Ethics Committee [Ref. No. CIMS/EC/2024/14608].All consecutive patients of any age and sex presenting with mechanical ocular trauma between 1 January 2023 and 31 December 2024 were screened. Exclusion criteria were: injury > 1 month old, chemical/thermal injury, prior ocular surgery, or refusal of consent. For minors, guardian consent was obtained. Approval was secured from the Institutional Ethics Committee [Ref. No. CIMS/EC/2024/14608]. The study adhered to the Declaration of Helsinki. Trained ophthalmology residents recorded demographics, injury setting, interval to presentation, and first-aid measures using a pre-tested proforma. Ocular examination included slit-lamp biomicroscopy, intra-ocular pressure (Tono-Pen®), dilated funduscopy, and B-scan ultrasonography when media opacity precluded retinal view. Injuries were coded per BETT categories. Visual acuity was measured with Snellen charts at 6 m (or child-appropriate Lea charts). The OTS was calculated from initial VA and presence of globe-rupture, endophthalmitis, perforation, retinal detachment or RAPD. Primary outcome was distribution of injury types and presenting VA. Secondary analyses explored associations between demographic/clinical variables and poor VA (≤ 20/200) using χ^2 tests and multivariate logistic regression. Analyses were performed in Stata 17; $p < 0.05$ was significant.

Table 1: Demographic characteristics of patients with ocular trauma (n = 412).

Characteristic	N	%
Age (years)		
≤ 15	74	18
16-30	132	32
31-50	140	34
> 50	66	16
Sex		
Male	292	71
Female	120	29
Occupation		
Farmer/labourer	210	51
Student	78	19
Homemaker	60	15
Others	64	15

Table 2: Type and mechanism of ocular injury.

Injury category	N (%)	Principal mechanism
Closed-globe contusion	195 (47.3)	Blunt stick, cow hoof, stone
Closed-globe lamellar laceration	102 (24.8)	Sharp vegetative matter
Open-globe laceration	58 (14.1)	Metallic wire/knife
Open-globe rupture	32 (7.8)	Road-traffic accident
Intra-ocular foreign body	18 (4.4)	Hammering metal
Adnexal (lid/orbit) injury	7 (1.7)	Assault

Table 3: Distribution of ocular trauma score (ots) categories and presenting visual acuity.

OTS category	Eyes (n)	Presenting VA median (Snellen)
1 (0-44)	58	CF at 1 m
2 (45-65)	90	20/400
3 (66-80)	108	20/125
4 (81-91)	96	20/60
5 (92-100)	60	20/30

Table 4: Multivariate predictors of poor presenting vision (va ≤ 20/200).

Variable	Adjusted OR	95 % CI	p-value
Open-globe vs closed-globe	3.8	2.1-6.7	< 0.001
Delay > 24 h	2.4	1.4-4.0	0.002
Age > 50 years	1.9	1.1-3.4	0.026

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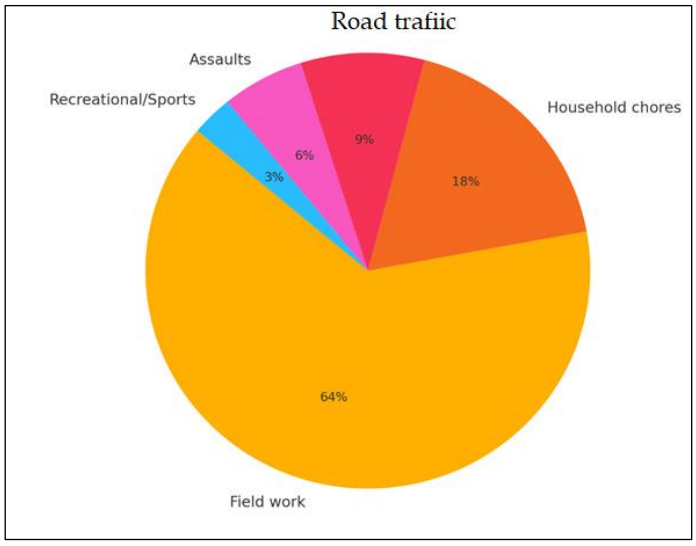

Figure 1: Distribution of activity at the time of injury among rural patients (pie chart)

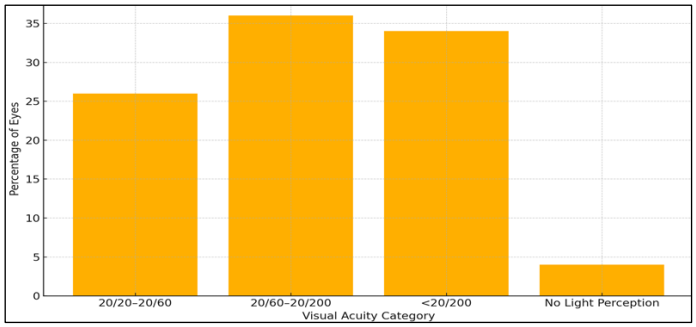

Figure 2: Spectrum of presenting visual acuity (bar graph)

Results:

Four-hundred-twelve patients met inclusion criteria. Most injuries (64 %) occurred during field work involving hand tools or vegetative matter; household chores accounted for 18 %, road-traffic incidents 9 %, assaults 6 %, and recreational/sports 3 % (**Figure 1**). The modal age group was 21-30 years (32%), followed by children ≤ 15 years (18%). Males predominated (71 %; **Table 1**). Open-globe injuries (n = 90) were chiefly lacerations from metallic wires or thorny branches, whereas closed-globe injuries (n = 297) included contusions from sticks, stones and cattle hooves. Intra-ocular foreign bodies were detected in 12 %. The cornea (37%) and sclera (19%) were the most common sites of impact (**Table 2**). Median delay to presentation was 19 h (IQR 6-48 h); 41 % sought care > 24 h post-injury. Presenting VA ranged from 20/20 to no light perception (NLP). Overall, 26 % presented with mild/no impairment (20/20-20/60), 36 % moderate (20/60-20/200), 34 % severe or worse (< 20/200), and 4 % NLP (**Figure 2**). OTS categories 1 and 2 constituted 14 % and 22 % of eyes, respectively (**Table 3**). Multivariate analysis identified open-globe injury (adjusted OR 3.8, 95 % CI 2.1-6.7), presentation delay > 24 h (OR 2.4, 95 % CI 1.4-4.0) and age > 50 years (OR 1.9, 95 % CI 1.1-3.4) as independent predictors of poor VA. The model explained 41 % of variance (Nagelkerke $R^2 = 0.41$) **(Table 4).**

Discussion:

The present study provides contemporary data on ocular trauma within a rural Indian milieu, complementing prior work from teaching hospitals and urban eye-care networks **[1-4]**. Consistent with national and global trends, young working-age males predominated and agricultural activities were the single largest context for injury **[2, 7]**. The proportion of open-globe injuries (22 %) is comparable to reports from West Uttar Pradesh **[1]** and South Kerala **[8]**, yet lower than figures from urban tertiary centres where high-velocity industrial wounds are common **[9]**. This underscores the need for context-specific preventive strategies.Our finding that presentation delay exceeding 24 h doubled the odds of severe visual loss echoes observations by Wisse *et al*. **[10]**. The median delay (19 h) reflects transport difficulties and low risk perception in rural districts. Community-based first-responder training and tele-ophthalmology triage could mitigate such delays.Visual outcome correlates strongly with structural damage; open-globe trauma was a fourfold predictor of poor VA. The OTS proved useful in quantifying injury severity, congruent with Kuhn's original validation [**11**] and subsequent Indian adaptations. However, nearly one-third of closed-globe injuries still presented with VA < 20/200. Early surgical management of lens opacities and secondary glaucoma screening should therefore integrate into rural trauma protocols. A notable 18 % of victims were children, often injured while assisting with farm chores without supervision. Eye-injury education should target both school curricula and farming cooperatives. The WHO's *Integrated People-Centred Eye-Care* agenda **[10]** advocates such inter-sectoral community engagement. The study's strengths include rigorous use of BETT/OTS, comprehensive enrolment over two calendar years, and multivariate modelling of risk factors. Limitations comprise its single-centre design, absence of follow-up visual outcomes, and potential referral bias towards more severe cases **[12]**. Future prospective cohorts should evaluate final VA at 6 months and cost-effectiveness of community prevention. Globally, the burden of eye injuries remains substantial; *Clinical Medicine* analysis estimated 6.3 million DALYs attributable to eye trauma annually **[13]**. Rural populations in low-resource settings shoulder a disproportionate share yet have the least access to emergency ophthalmic care. Our findings bolster the argument for strengthening district-level surgical capacity and subsidising protective eyewear for agricultural workers **[14]**.

Conclusion:

Ocular trauma in rural India is dominated by agriculture-related closed-globe injuries among young adult males, but open-globe wounds and delayed presentation drive the greatest visual loss. Systematic community education, timely referral pathways, and affordable protective eyewear could avert a significant proportion of rural blindness. Implementation of BETT/OTS protocols at secondary-level hospitals aids risk stratification and resource allocation. Thus, multicentre longitudinal studies

evaluating intervention effectiveness are warranted to advance rural eye-injury control.

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