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Pattern and Trends of Traumatic Occupational Injury among Employees' State Insurance Corporation Beneficiaries: A Retrospective Observational Study

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ABSTRACT

Background: Traumatic occupational injuries are an important preventable cause of morbidity among industrial workers. Data describing their temporal and clinical patterns among Employees' State Insurance Corporation (ESIC) beneficiaries are limited. Objective: To describe the pattern and trend of traumatic occupational injuries sustained during working hours among ESIC beneficiaries reporting to ESIC Model Hospital, Jaipur. **Methods:** This was a single-centre retrospective observational registry-based study using de-identified secondary registry data from Accident and Emergency Department records, medico-legal records and inpatient case-sheets. All eligible ESIC beneficiaries presenting with traumatic occupational injury sustained during working hours from 1 August 2022 to 30 April 2025 were included. Descriptive statistics, chi-square test for trend and Poisson regression with observation time as an offset were applied. **Results:** A total of 200 traumatic occupational injury cases were recorded. The mean age was 35.1 ± 12.3 years, and 96.0% were males. The largest age group was 20-29 years (37.5%). Upper-extremity injuries were most frequent (119/200; 59.5%), followed by lower-extremity injuries (42/200; 21.0%). The annual distribution was 26 cases in 2022, 57 in 2023, 91 in 2024 and 26 in the first four months of 2025. A significant increasing trend was observed by a chi-square test for trend ($\chi 2 = 6.22$; $p = 0.013$). Poisson regression adjusted for partial-year observation showed an annual increase in registry presentations (IRR 1.18; 95% CI 1.01-1.38; $p = 0.039$). July and August together accounted for 48 injuries; seasonal Poisson analysis showed higher presentation rates during these peak months than other observed months (IRR 1.77; 95% CI 1.28-2.45; $p = 0.001$). **Conclusion:** Occupational traumatic injuries among ESIC beneficiaries at Jaipur predominantly affected young male workers, with upper limbs as the most common injury site and a monsoon-season peak. These findings support targeted engineering, administrative and behavioural interventions, especially for young workers and during high-risk months.

Keywords: Traumatic occupational injuries; Occupational health; Injury trends; ESIC beneficiaries; Workplace safety; Registry-based study.

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Introduction

Occupational injury is defined as any physical harm occurring in the course of employment, including injuries sustained on the employer's premises or during work-related travel. Occupational trauma is a preventable but frequently under-recognised public-health issue. The International Labour Organization estimates that about 374 million non-fatal work-related injuries occur globally each year, and Indian evidence suggests a substantial national burden of non-fatal occupational injury among male workers.[1,2]

Rapid industrialization has diversified the occupational risk landscape in India. Construction, manufacturing, transportation and health-care settings show different injury profiles. Hospital-based evidence from South India has linked shift work, long working hours and inadequate machine guarding with emergency visits for upper-limb injuries. At the same time, studies from Kancheepuram and among health-care workers have demonstrated sector-specific patterns such as machinery-related trauma and sharps injuries.[3-5]

Despite the burden, long-term occupational injury trend data from organised social-insurance health systems remain limited. Earlier trauma audits have described general hospital trauma patterns, but have not consistently linked occupational injuries with compensation pathways, rehabilitation planning or ESIC-based surveillance.[6]

The Employees' State Insurance Corporation is a major social security and health care system for insured workers and their families in India. ESIC has recently emphasised occupational disease and injury surveillance through a hub-and-spoke model, creating an opportunity to use hospital registry data for prevention planning.[7,8]

Jaipur is an important industrial centre with engineering, manufacturing, textile-processing and allied industrial units. However, local registry-based evidence on traumatic occupational injury among ESIC beneficiaries is limited. Therefore, the present study analysed routinely collected hospital records from ESIC Model Hospital, Jaipur, to describe demographic characteristics, anatomical pattern, mechanism of injury where recorded, clinical disposition and temporal trends of traumatic occupational injuries among ESIC beneficiaries.

Materials and Methods

***Study design and setting*:** This was a single-centre retrospective observational study conducted at ESIC Model Hospital, Jaipur, Rajasthan, India. The hospital is a tertiary-care ESIC facility providing outpatient, emergency and inpatient services to ESIC-insured workers and their dependants. The study used routinely maintained secondary registry and case-record data.

***Study population and period*:** All ESIC beneficiaries who presented to the Accident and Emergency Department with traumatic occupational injury sustained during working hours between 1 August 2022 and 30 April 2025 were eligible for inclusion. Records not related to occupational traumatic injury, injuries not sustained during working hours, duplicate records and records with inadequate information to classify the event as occupational trauma were excluded.

***Data sources and variables*:** Secondary data were extracted from Accident and Emergency registers, medico-legal case forms and inpatient case-sheets using a structured data abstraction format. The variables collected included age, sex, date of injury, calendar year, calendar month, work shift, anatomical site of injury, number of body sites involved, mechanism of injury where documented, type of tissue damage where available, outpatient or inpatient management, duration of hospital stay among admitted cases, referral status and in-hospital outcome.

***Study size*:** All eligible records available during the defined study period were included. No formal sample-size calculation was performed because this was a retrospective complete-enumeration registry-based study.

***Data management and statistical analysis*:** Data were entered in Microsoft Excel 365, cleaned for duplicates and incomplete entries, and analysed using SPSS software version 26 and validated statistical calculations. Continuous variables were summarized as mean ± standard deviation or median with interquartile range as appropriate. Categorical variables were presented as frequency, percentage and 95% confidence interval where relevant. Proportional confidence intervals were calculated using Wilson methods, and Poisson confidence intervals were calculated using exact methods.

Year-wise trends were assessed using the chi-square test for trend and Poisson regression. Because 2022 and 2025 were partial observation years, Poisson regression was performed with calendar year as a continuous predictor and observation time as an offset. Seasonal variation was analysed in two ways: first, July-August peak months were compared with all other observed months using Poisson regression with observed calendar-month exposure as an offset; second, a month-as-categorical Poisson model was used to estimate monthly incidence rate ratios using January as the

reference month. Results are reported as incidence rate ratios (IRR) with 95% confidence intervals. A p value <0.05 was considered statistically significant.

***Ethical considerations*:** The study was conducted after exemption from the Institutional Ethics Committee of ESIC Model Hospital, Jaipur, Rajasthan, India. As this was a retrospective registry-based study using de-identified secondary data, the requirement for individual informed consent was waived by the Institutional Ethics Committee. Confidentiality of all records was maintained throughout data extraction, analysis and reporting.

Results

During the study period, hospital emergency, medico-legal and inpatient records from 1 August 2022 to 30 April 2025 were screened for traumatic occupational injuries among ESIC beneficiaries. After removing duplicate/non-eligible records and records not fulfilling the definition of injury sustained during working hours, 200 eligible traumatic occupational-injury cases were included in the final analysis.

***Socio-demographic characteristics*:** A total of 200 traumatic occupational-injury cases were recorded between 1st August 2022 and 30th April 2025. The mean age of injured workers was 35.1±12.3 years, with an age range of 17 to 70 years. Young adults aged 20-29 years constituted the largest proportion (37.5%) of cases. Males predominated, accounting for 96.0% (n = 192) of the total study population.

***Temporal trends*:** The year-wise distribution showed 26 cases during the partial year 2022, 57 cases in 2023, 91 cases in 2024 and 26 cases during the first four months of 2025. After annualization to account for partial observation periods, the estimated annualized case counts were 62.4 cases/year in 2022, 57.0 cases/year in 2023, 91.0 cases/ year in 2024 and 78.0 cases/year in 2025. Chi-square test for trend showed a significant upward trend (χ^2=6.22; p=0.013). Poisson regression adjusted for observation time showed a significant annual increase in registry presentations (IRR 1.18; 95% CI 1.01-1.38; p = 0.039).

Table- 1: Distribution of cases according to age group

Age group (years)	No.	%
<20	10	5.0
20-29	75	37.5
30-39	47	23.5
40-49	39	19.5
50+	29	14.5

Table- 2: Distribution of cases according to sex (N=200).

Sex	No.	%
Male	192	96.0
Female	8	4.0

Table- 3: Annual distribution and annualized traumatic occupational injury presentations

Year	Observation period	No.	Annualized cases/ year	95% Poisson CI
2022	Aug-Dec (5 months)	26	62.4	40.8-91.4
2023	Jan-Dec (12 months)	57	57.0	43.2-73.9
2024	Jan-Dec (12 months)	91	91.0	73.3-111.7
2025	Jan-Apr (4 months)	26	78.0	51.0-114.3

The monthly distribution showed a monsoon-season peak, with July and August each recording 24 injuries. Month-wise case counts from the master chart are shown in Figure 1. When July-August were compared with all other observed months using Poisson regression with observed calendar-month exposure as the offset, the rate of injury presentations was significantly higher during the peak months (IRR 1.77; 95% CI 1.28-2.45; p=0.001). The month-as-categorical Poisson model is presented in Table-10.

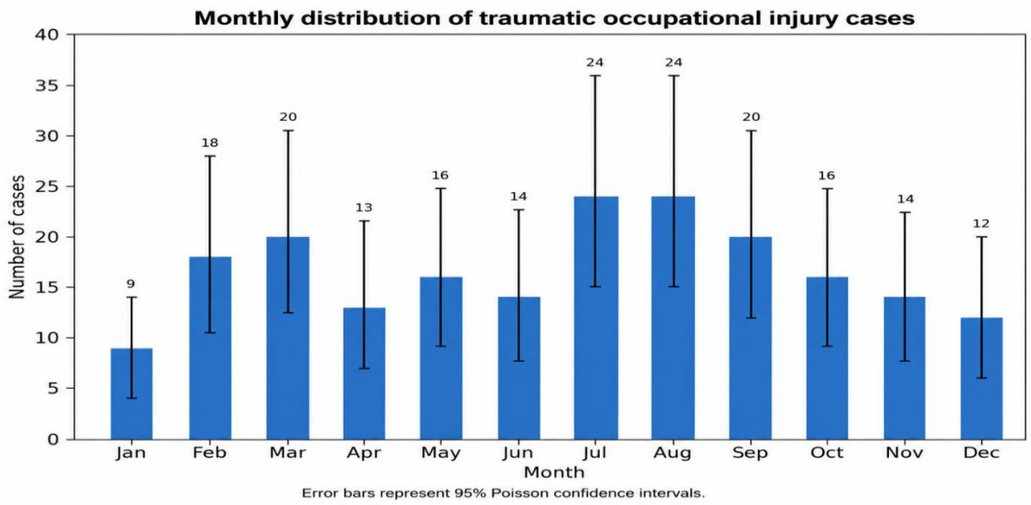


Figure -1: Monthly distribution of traumatic occupational injury cases with exact case numbers on bars and 95% Poisson confidence interval error bars. The y-axis shows the number of cases and the x-axis shows calendar month. May-July had two observed years, while the remaining months had three observed years during the study period.

Anatomical site and multiplicity of injury: Upper-extremity injuries were the most common anatomical site of injury 119/200 (59.5%), followed by lower-extremity injuries 42/200 (21.0%). The distribution of anatomical sites is shown in Table 4. Because some workers sustained trauma to more than one anatomical site, site-specific totals exceed 200.

Table -4: Distribution of cases according to anatomical site of injury

Anatomical site of injury	No.	%	95% CI
Upper extremity	119	59.5	52.6-66.1
Lower extremity	42	21.0	15.9-27.2
Trunk	10	5.0	2.7-9.0
Eye	13	6.5	3.8-10.8
Burn	11	5.5	3.1-9.6
Head/face	9	4.5	2.4-8.3
Internal injury	4	2.0	0.8-5.0
Other	10	5.0	2.7-9.0
Percentages are calculated using total cases (n = 200) as the denominator. Totals exceed 200 because some workers sustained trauma to more than one anatomical site			

Most injured workers had trauma involving a single anatomical region (185/200; 92.5%). Thirteen workers had two injured regions and two workers had three or more injured regions, suggesting a smaller subgroup of high-energy trauma events.

Table-5: Multiplicity of anatomical sites involved

Number of body sites	No.	%	95% CI
1 site	185	92.5	88.0-95.4
2 sites	13	6.5	3.8-10.8
>=3 sites	2	1.0	0.3-3.6
Total	200	100.0	-

Mechanism of injury: The table 6 depicts the distribution of traumatic occupational injuries according to their mechanism of occurrence among the study participants. Machinery-related crush injuries were the most common specific mechanism, accounting for 68 cases (34.0%; 95% CI: 27.8–40.8%). The remaining 132 cases (66.0%; 95% CI: 59.2–72.2%) were attributed to other mechanisms of injury, including falls, sharp-object injuries, blunt trauma, burns, eye injuries, and other workplace accidents recorded in the hospital registry.

Table- 6: Distribution according to mechanism of injury

Mechanism of injury	No.	%	95% CI
Machinery/crush injury	68	34.0	27.8-40.8
Other mechanisms	132	66.0	59.2-72.2
Total	200	100.0	-

Injuries during work shifts: Among records with available shift information (n = 200), over half of the injuries occurred during the general shift (08:00-16:00), accounting for 52.0% of cases. The morning shift (06:00-14:00) contributed 32.0% of injuries, the night shift (20:00-08:00) 10.5%, and the evening shift (14:00-20:00) 5.5% (Table-7).

Table -7: Distribution of injuries according to work shift

Work shift	No.	%
General shift (08:00-16:00)	104	52.0
Morning shift (06:00-14:00)	64	32.0
Night shift (20:00-08:00)	21	10.5
Evening shift (14:00-20:00)	11	5.5
Total	**200**	**100.0**

Clinical disposition: More than half of injured workers were managed on an outpatient basis (110/200; 55.0%), while 84 (42.0%) required inpatient admission. The median hospital stay among admitted cases was 4 days (IQR: 3-6 days). Six patients (3.0%) were referred to a higher centre for further management. No in-hospital deaths were recorded during the study period (Table-8).

Table-8: Clinical disposition and outcome

Clinical disposition/outcome	No.	%
Outpatient management	110	55.0
Inpatient admission	84	42.0
Referral to higher centre	6	3.0
In-hospital death	0	0.0

Age group and anatomical site cross-tabulation: The cross-tabulation based on anatomical-site entries is presented in Table 9. Upper-extremity injuries remained the dominant anatomical site across all age groups. Exploratory chi-square analysis based on 218 anatomical-site entries did not show a statistically significant association between age group and anatomical-site distribution ($\chi^2 = 33.71$; df = 28; p = 0.211).

Table -9: Age group and anatomical site cross-tabulation

Age group (case n)	Head/ Face	Trunk	Lower extremity	Upper extremity	Burn	Eye	Internal injury	Other	Total site entries
<20 (n=10)	1 (9.1)	0 (0.0)	5 (45.5)	4 (36.4)	0 (0.0)	1 (9.1)	0 (0.0)	0 (0.0)	11
20-29 (n=75)	1 (1.3)	3 (3.9)	13 (16.9)	46 (59.7)	5 (6.5)	5 (6.5)	2 (2.6)	2 (2.6)	77
30-39 (n=47)	4 (7.7)	1 (1.9)	11 (21.2)	28 (53.8)	3 (5.8)	3 (5.8)	0 (0.0)	2 (3.8)	52
40-49 (n=39)	0 (0.0)	5 (10.4)	6 (12.5)	27 (56.2)	1 (2.1)	2 (4.2)	1 (2.1)	6 (12.5)	48
50+ (n=29)	3 (10.0)	1 (3.3)	7 (23.3)	14 (46.7)	2 (6.7)	2 (6.7)	1 (3.3)	0 (0.0)	30
Total site entries	9	10	42	119	11	13	4	10	218

Table-10: Month-wise Poisson regression for calendar-month variation in traumatic occupational injury presentations

Month	No. of Cases	Observed month-years	Rate	IRR	95% CI	p value
January	9	3	3.0	1.00	Reference	Reference
February	18	3	6.0	2.00	0.90-4.45	0.090
March	20	3	6.7	2.22	1.01-4.88	0.047
April	13	3	4.3	1.44	0.62-3.38	0.396
May	16	2	8.0	2.67	1.18-6.03	0.019
June	14	2	7.0	2.33	1.01-5.39	0.047
July	24	2	12.0	4.00	1.86-8.61	<0.001
August	24	3	8.0	2.67	1.24-5.74	0.012
September	20	3	6.7	2.22	1.01-4.88	0.047
October	16	3	5.3	1.78	0.79-4.02	0.167
November	14	3	4.7	1.56	0.67-3.59	0.301
December	12	3	4.0	1.33	0.56-3.16	0.514

Rate is cases per observed calendar-month. IRR values were estimated using month-as-categorical Poisson regression with observed calendar-month exposure as an offset and January as the reference month. Because this is a registry presentation dataset without workforce denominator data, IRR values represent relative rates of hospital presentations, not true worker-level incidence.

Discussion

The present retrospective registry-based study describes the pattern and temporal trend of traumatic occupational injuries among ESIC beneficiaries reporting to ESIC Model Hospital, Jaipur. The major findings were that injured workers were predominantly young males, upper-extremity trauma was the most frequent anatomical pattern, general and morning shifts contributed most cases, and injury presentations showed both an increasing annual trend and a monsoon-season peak. These observations are relevant for local workplace safety planning because they identify the worker groups, injury sites and high-risk time periods that may benefit most from targeted interventions.

Young adults aged 20-29 years formed the largest proportion of injured workers in the present study. This pattern is consistent with other Indian hospital-based studies in which working-age males contributed the major share of occupational injuries. Young workers may have greater exposure to physically demanding tasks, machine operation and production-floor activities, and may also have less cumulative experience in hazard recognition and safe work practices.

The marked male predominance observed in this study was expected in the context of heavy industrial and manufacturing work. The proportion of males in our study was higher than that reported in some tertiary-care occupational injury series.[3,4] This may reflect the labour-force composition of industries served by ESIC Model Hospital, Jaipur, where women may be less represented in high-risk engineering and machine-based work. However, the small number of female cases should not be interpreted as absence of risk among women; rather, it may reflect workforce participation, job allocation and care-seeking patterns.

Upper-extremity injuries were the leading anatomical pattern, accounting for 119 cases (59.5%). This finding is biologically plausible because hands and forearms are directly exposed during machine handling, cutting, lifting and manual material processing. The predominance of upper-limb injuries also supports prevention strategies focused on machine guarding, lock-out procedures, safe material handling and appropriate hand protection.

Temporal analysis demonstrated an increase in traumatic occupational injury presentations over the study period. The absolute number of cases increased from 57 in 2023 to 91 in 2024, and Poisson regression adjusting for partial observation time showed a significant annual increase (IRR 1.18; 95% CI 1.01-1.38; p=0.039). However, because denominator data such as the total number of insured workers, worker-hours or factory-specific workforce size were not available, these results should be interpreted as hospital registry presentation trends rather than true incidence rates.

The seasonal analysis suggested clustering during the monsoon peak months. July and August together accounted for 48 injuries and had higher presentation rates than the remaining observed months (IRR 1.77; 95% CI 1.28-2.45; p = 0.001). In the month-as-categorical model, July showed the highest relative rate compared with January (IRR 4.00; 95% CI 1.86-8.61; p<0.001), followed by August (IRR 2.67; 95% CI 1.24-5.74; p = 0.012). Wet floors, slippery industrial yards, poor visibility, electrical hazards and hurried work during production cycles may contribute to this pattern. Pre-monsoon safety audits, anti-slip footwear, housekeeping checks and toolbox talks should therefore be prioritized before July.

The mechanism of injury is important for prevention because it allows translation of descriptive findings into engineering and administrative controls. Machinery/crush injuries accounted for 34.0% of cases in the available manuscript records, supporting interventions such as machine guarding, emergency stop systems, work-permit procedures, preventive maintenance and supervision during high-risk operations. However, detailed mechanism categories were not available in the analyzable master chart, and future registry strengthening should ensure mandatory coding of mechanism of injury.

More than half of cases were managed on an outpatient basis, but 42.0% required inpatient admission, indicating that a substantial proportion of occupational injuries were clinically significant. The median hospital stay of four days among admitted cases reflects the service burden on ESIC facilities and the indirect economic burden due to loss of workdays. Integration of injury registry data with rehabilitation and compensation pathways could help identify cases requiring early physiotherapy, occupational therapy and return-to-work planning.

***Strengths and limitations*:** The major strength of this study is its exclusive ESIC cohort, which gives direct policy relevance for an organised worker health-insurance system. The 33-month observation window allowed assessment of short-term temporal trends and seasonal variation. The use of routinely maintained hospital records also reflects real-world emergency and inpatient service utilisation.

The limitations are inherent to the retrospective single-centre design. Selection bias may have occurred because only workers reporting to ESIC Model Hospital, Jaipur, were captured. Information bias and misclassification may have occurred due to incomplete routine registry documentation. Minor injuries treated outside the hospital may have been missed. Injury severity scores such as the Injury Severity Score were not available. Denominator data such as total insured workers, factory-specific workforce and worker-hours were not available, preventing calculation of true incidence rates. The master chart did not include a fully disaggregated mechanism-of-injury variable; therefore, mechanism-wise interpretation was limited.

Recommendations: Based on the findings, preventive strategies should focus on engineering controls such as machine guarding and maintenance of safety devices; administrative controls such as regular safety audits, shift-wise supervision and pre-monsoon toolbox talks; and personal protective measures such as task-specific gloves and anti-slip footwear. Younger workers should receive periodic refresher training and close supervision during high-risk tasks. At the system level, multi-centre ESIC injury surveillance with denominator data, mechanism-wise classification and severity scoring should be developed. Intervention studies evaluating monsoon-season PPE campaigns, machine guarding audits and safety-culture interventions are recommended.

Conclusion

Traumatic occupational injuries among ESIC beneficiaries reporting to ESIC Model Hospital, Jaipur, predominantly affected young male workers, with upper limbs as the most frequent anatomical site. Registry presentations increased over time and showed a monsoon-season peak, particularly in July and August. Although the single-centre retrospective design limits generalisability, the findings provide regionally important evidence for targeted workplace injury prevention. Tailored engineering, administrative and behavioural interventions, especially before the monsoon season and among younger workers, are warranted to reduce the burden of occupational trauma.

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