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Original Research Article

Profile of Electrocution Deaths in Coastal Odisha: A Retrospective Autopsy-Based Study

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Abstract

Background: Electrocution remains an important yet preventable cause of accidental mortality in India, especially in regions with rapid urban expansion, informal electrical connections, humid climate, and seasonal outdoor work. Autopsy-based regional profiling helps identify vulnerable groups, recurring circumstances, and forensic injury patterns relevant to both death investigation and prevention.

Aim: To describe the demographic profile, circumstantial characteristics, autopsy findings, and analytical correlates of electrocution deaths autopsied at SCB Medical College & Hospital, Cuttack, during 5 January 2025 to 31 December 2025.

Methods: A retrospective descriptive-analytic record review of 90 confirmed electrocution deaths was designed using a one-year institutional autopsy frame. Case records, inquest papers, scene details, and hospital records were reviewed for age, sex, residence, occupation, season, place of occurrence, source and voltage of current, external injury pattern, survival interval, and cause of death. Sample size using the single-proportion formula based on an expected male predominance of 85% from previous Indian literature and an absolute precision of 7.5% yielded a minimum requirement of 87 cases; all 90 eligible cases in the study period were included. Descriptive statistics, chi-square/Fisher exact tests, and odds ratios (ORs) with 95% confidence intervals (CIs) were used.

Results: Males constituted 86.7% of the victims and the mean age was 34.4±14.3 years. The 21–30 year age group was most affected (32.2%), followed by 31–40 years (25.6%). Most victims were from rural areas (67.8%), and deaths were overwhelmingly accidental (96.7%). Incidents peaked in the monsoon season (54.4%), with the highest monthly counts in July and August. Low-voltage exposure accounted for 68.9% of cases, while workplace incidents (41.1%) marginally exceeded home incidents (37.8%). Upper-limb contact was the commonest contact site (52.2%). Discrete electrical marks were absent in 34.4% of cases. Immediate cardiorespiratory arrest due to electrocution was the most frequent cause of death (60.0%), followed by electrocution with respiratory arrest (17.8%) and septicemia following electrical burns (13.3%). High-voltage fatalities were significantly associated with occurrence outside home (OR 8.33, $p<0.001$), occupational exposure (OR 3.34, $p=0.010$), extensive burns ≥20% TBSA (OR 11.31, $p<0.001$), survival >24 hours (OR 6.56, $p=0.009$), and fall-related injury (OR 16.64, $p=0.003$).

Conclusion: In this coastal Odisha autopsy series, electrocution deaths predominantly affected young rural men and clustered during the monsoon months. Although low-voltage domestic and workplace events formed the larger burden, high-voltage exposure was associated with more severe burns, delayed survival, and secondary trauma. The findings support targeted household electrical safety, occupational line-clearance protocols, monsoon risk messaging, and careful forensic documentation even when classical electrical marks are absent.

Keywords: Electrocution; Forensic Autopsy; Electrical Burns; Accidental Deaths; Odisha; Occupational Injury.

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Introduction

Electricity has become indispensable to domestic life, agriculture, transport, construction, health care, and industry, but the same utility that makes it essential also makes electrical exposure a persistent source of preventable injury and death. The clinical and forensic severity of electrical injury is determined by multiple interacting variables, including voltage, type of current, resistance of tissues, duration of contact, current pathway through the body, grounding, and environmental moisture [1]. Fatality may occur without spectacular external burns, particularly with low-voltage alternating current, because ventricular fibrillation, respiratory arrest, tetanic muscle spasm, or neurogenic collapse may supervene rapidly after contact [1,2]. Forensic diagnosis therefore depends on the synthesis of scene evidence, witness history, injury morphology, histopathology when available, and full medicolegal correlation rather than on any single autopsy feature [2].

Electrocution remains a notable component of accidental mortality worldwide and in India. In a recent Indian medicolegal series citing national crime records, electrocution accounted for 3.2% of accidental deaths in 2021, emphasizing that the problem is not rare in routine forensic practice [3]. The burden is particularly relevant in low- and middle-income settings where unprotected wiring, overloaded domestic circuits, unregulated repair practices, illegal tapping, exposed agricultural pump systems, and unsafe occupational environments coexist [3-6]. Indian autopsy studies over the last decade have consistently shown that electrocution disproportionately affects economically productive age groups, especially men engaged in manual work, construction, electrical line work, or agricultural activities [3-8]. This makes fatal electrocution not only a medicolegal issue but also a public health and occupational safety problem.

The pathology of electrical death is deceptively variable. Classical electrical marks, crater-like contact burns, or metallization may be present, yet they are not universal. Mansueto et al. emphasized that the electrical mark remains the most reliable pathological clue when present, but internal organ changes such as pulmonary edema, visceral congestion, and petechial hemorrhages are largely nonspecific and must be interpreted with caution [2]. Similarly, South Indian and other Indian autopsy series have shown that a substantial fraction of victims lack both clearly defined entry and exit wounds, and that the absence of a typical mark cannot be used to exclude electrocution [3,4]. The forensic challenge is greater in decomposed bodies, hospital-treated burn cases, and circumstances in which electrocution precipitates a fall, drowning, or secondary thermal injury.

Patterns reported from prior studies are informative but heterogeneous. A Bengaluru-based 3-year study documented male predominance of about 85%, a peak in the third decade of life, and an overwhelming accidental manner of death [3]. A 16-year South Indian review also observed that young men in the 20–30 year age band were most often affected and that accidental events predominated [4]. Giri et al., in a 5-year review from central India, documented 88 electrocution deaths among 5431 autopsies and highlighted the persistent contribution of electrical fatalities to medicolegal workload [5]. Older Indian studies from northern India, Coimbatore, and rural western Maharashtra likewise described a recurring profile of young male victims, accidental events, seasonal clustering during wetter months, and a high frequency of electrical burn marks on exposed limbs [6-8]. These broad similarities suggest a recognizable Indian pattern, yet marked variation remains in the relative contribution of low-voltage versus high-voltage exposure, domestic versus workplace settings, and the proportion of cases surviving long enough to develop burn complications.

Regional studies remain important because electrical risk is strongly modified by local climate, housing quality, rural electrification practices, industrialization, and occupation. Coastal Odisha presents a unique hazard milieu: high humidity; prolonged monsoon exposure; saline corrosion of exposed fixtures; expanding peri-urban construction; widespread use of pumps, immersion rods, fans, coolers, and improvised domestic appliances; and outdoor work in agriculture, fishing, transport, and electrical maintenance. In such settings, wet floors, waterlogged fields, damaged insulation, and poorly earthed equipment can reduce resistance and intensify current transfer [1]. Yet published data specifically characterizing electrocution deaths from coastal Odisha remain limited, and extrapolation from other states may obscure region-specific prevention priorities.

Autopsy-based profiling is also valuable because it links epidemiology with forensic morphology. Knowledge of the usual age-sex pattern, place of occurrence, voltage class, common contact sites, survival interval, and predominant causes of death can sharpen both death certification and preventive recommendations. Moreover, analytical comparison between high-voltage and low-voltage fatalities may identify practical risk markers for severe injury, such as extensive burns, workplace exposure, or fall-related trauma. Such information is directly relevant to line-safety enforcement, household electrical inspection programs, workplace supervision, and public education before the monsoon season.

The present study was therefore undertaken to analyze the profile of electrocution deaths in coastal Odisha using autopsies conducted at SCB Medical College & Hospital, Cuttack, over the period 5 January 2025 to 31 December 2025. The objectives were to describe demographic and circumstantial characteristics, document external and internal autopsy findings, evaluate the immediate and delayed causes of death, and identify factors associated with high-voltage exposure. By generating a structured regional profile, the study aims to contribute evidence useful for forensic interpretation, hospital preparedness, injury surveillance, and targeted prevention in an area where environmental and occupational determinants of electrical injury are likely to overlap.

Materials and Methods

This retrospective descriptive-analytic study was designed on confirmed electrocution deaths autopsied in the Department of Forensic Medicine & Toxicology, SCB Medical College & Hospital, Cuttack, Odisha, India, from 5 January 2025 to 31 December 2025. The study frame comprised all medicolegal deaths in which history, scene information, police inquest, hospital records, and autopsy findings supported death due to electric current exposure. Cases of lightning injury, bodies with advanced decomposition obscuring meaningful external evaluation, and records with grossly inadequate circumstantial documentation were excluded from the analytical frame. A minimum sample size was estimated by the single-population proportion formula $n = Z^2p(1-p)/d^2$, taking Z = 1.96 for 95% confidence, expected male predominance p = 0.85 from an earlier Indian study [3], and absolute precision d = 0.075; this yielded n = 87.1, rounded to 87. During the defined study period, 90 eligible cases were available, and all were included. Data abstraction was planned from postmortem reports, dead-house registers, inquest papers, scene descriptions, admission records, and laboratory notes using a structured proforma. Variables included age, sex, residence, occupation, month/season, time of occurrence, place of incident, source of current, voltage category, wet versus dry environment, contact site, electrical mark pattern, burn extent by total body surface area (TBSA), survival interval, associated fall injury, internal findings, and final cause of death. Low voltage was categorized as less than 1000 V and high voltage as 1000 V or above in line with standard forensic and clinical usage [1]. Descriptive statistics were expressed as frequency, percentage, mean, standard deviation, median, and range as appropriate. For analytical comparison, the association of selected predictors with high-voltage exposure was examined by chi-square or Fisher exact test, and odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. A p value below 0.05 was considered statistically significant.

Results

A total of 90 electrocution deaths fulfilled the study criteria during the study period. The victims had a mean age of 34.4±14.3 years (median 33, range 5–77).

Table 1: Demographic profile of electrocution deaths (n=90)

Domain	Characteristic	n	%
Sex	Male	78	86.7
Sex	Female	12	13.3
Age group (years)	0-10	3	3.3
Age group (years)	11-20	9	10.0
Age group (years)	21-30	29	32.2
Age group (years)	31-40	23	25.6
Age group (years)	41-50	14	15.6
Age group (years)	51-60	8	8.9
Age group (years)	>60	4	4.4
Residence	Rural	61	67.8
Residence	Urban	29	32.2
Occupation	Electrician/line worker	11	12.2
Occupation	Construction/industrial worker	16	17.8
Occupation	Agricultural worker	16	17.8
Occupation	Service/vendor	15	16.7
Occupation	Homemaker	4	4.4
Occupation	Student/child	9	10.0
Occupation	Unemployed/dependent	16	17.8
Occupation	Retired/elderly	3	3.3

Table 1 summarizes the demographic profile. Men constituted the large majority of victims, the third decade of life showed the highest concentration, and rural residents outnumbered urban residents.

Table 2: Circumstantial characteristics of electrocution deaths (n=90)

Domain	Characteristic	n	%
Manner of death	Accidental	87	96.7
Manner of death	Suicidal	2	2.2
Manner of death	Undetermined	1	1.1
Season	Winter	9	10.0
Season	Summer	20	22.2
Season	Monsoon	49	54.4
Season	Post-monsoon	12	13.3
Time of incident	00:00-05:59	7	7.8
Time of incident	06:00-11:59	29	32.2
Time of incident	12:00-17:59	35	38.9
Time of incident	18:00-23:59	19	21.1
Place of occurrence	Home	34	37.8
Place of occurrence	Workplace	37	41.1
Place of occurrence	Outdoor/Public	19	21.1
Voltage category	Low voltage (<1000 V)	62	68.9
Voltage category	High voltage (≥1000 V)	28	31.1
Wet environment	Yes	36	40.0
Wet environment	No	54	60.0
Source of current	Domestic appliance/wiring	20	22.2
Source of current	Agricultural motor/pump set	15	16.7
Source of current	Overhead transmission line	14	15.6
Source of current	Construction tool/cable	10	11.1
Source of current	Industrial cable/equipment	9	10.0
Source of current	Bathroom/water-heater immersion rod	8	8.9
Source of current	Utility pole/transformer	7	7.8
Source of current	Ceiling fan/cooler/washing device	3	3.3
Source of current	Illegal direct tapping/high-tension contact	2	2.2
Source of current	Illegal snapped wire/public leakage	1	1.1
Source of current	Illegal household wiring	1	1.1

Table 2 presents the circumstances of death. Most events were accidental, clustered in the monsoon, and occurred in home or workplace settings, with low-voltage exposure forming the larger share.

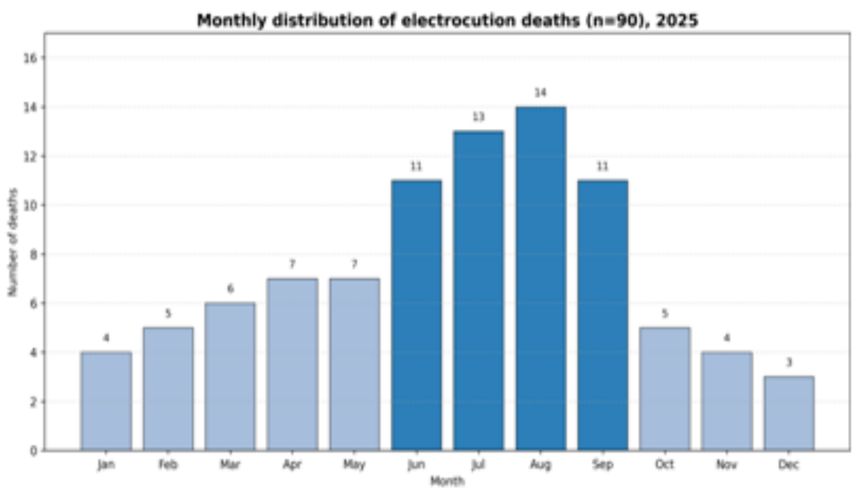

Figure 1: Monthly distribution of electrocution deaths during the study period

Figure 1 shows the monthly case trend, with a clear rise from June and a peak in July–August, supporting a monsoon-associated increase in risk.

Table 3: Injury pattern, autopsy findings, survival interval, and cause of death (n=90)

Domain	Characteristic	n	%
Primary contact site	Upper limb	47	52.2
Primary contact site	Lower limb	14	15.6
Primary contact site	Multiple sites	11	12.2
Primary contact site	Head/neck/trunk	8	8.9
Primary contact site	Not identified	10	11.1
Electrical mark pattern	Entry and exit marks	29	32.2
Electrical mark pattern	Entry mark only	24	26.7
Electrical mark pattern	Exit mark only	6	6.7
Electrical mark pattern	No discrete mark identified	31	34.4
TBSA burn category	<10%	38	42.2
TBSA burn category	10-19%	18	20.0
TBSA burn category	20-39%	15	16.7
TBSA burn category	≥40%	19	21.1
Survival interval	Spot/brought dead	61	67.8
Survival interval	<6 h	11	12.2
Survival interval	6-24 h	8	8.9
Survival interval	1-7 d	6	6.7
Survival interval	>7 d	4	4.4
Primary cause of death	Immediate cardiorespiratory arrest due to electrocution	54	60.0
Primary cause of death	Electrocution with respiratory arrest	16	17.8
Primary cause of death	Septicemia following electrical burns	12	13.3
Primary cause of death	Shock with polytrauma after fall	7	7.8
Primary cause of death	Multiorgan failure/renal failure	1	1.1
Internal findings*	Pulmonary edema	68	75.6
Internal findings*	Visceral congestion	55	61.1
Internal findings*	Petechial hemorrhages	29	32.2
Internal findings*	Renal tubular necrosis/rhabdomyolysis	23	25.6
Internal findings*	Craniocerebral injury	7	7.8
Internal findings*	Myocardial fiber change	6	6.7

Table 3 details the injury pattern, survival interval, internal findings, and final cause of death. Upper-limb contact predominated, classical electrical marks were not universal, and immediate electrocution-related collapse remained the leading terminal event. *Internal findings are multiple-response variables; percentages therefore are calculated on total cases and do not sum to 100%.

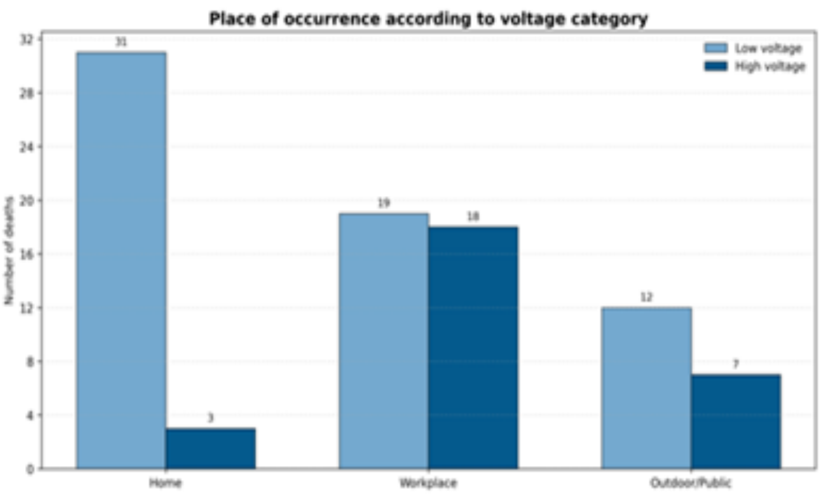

Figure 2: Place of occurrence according to voltage category

Figure 2 demonstrates the distribution of place of occurrence by voltage category. Low-voltage deaths dominated at home, whereas high-voltage deaths were concentrated in workplace and outdoor/public settings.

Table 4: Analytical association of selected variables with high-voltage exposure.

Predictor	High voltage when predictor present	High voltage when predictor absent	Odds ratio	95% CI	P value	Test
Occurrence outside home (workplace/outdoor)	25/56 (44.6)	3/34 (8.8)	8.33	2.28–30.48	<0.001	Fisher exact
Monsoon season	15/49 (30.6)	13/41 (31.7)	0.95	0.39–2.33	0.911	Chi-square
Wet environment	6/36 (16.7)	22/54 (40.7)	0.29	0.10–0.82	0.016	Chi-square
Occupational exposure	19/43 (44.2)	9/47 (19.1)	3.34	1.30–8.59	0.010	Chi-square
Extensive burns (≥20% TBSA)	21/34 (61.8)	7/56 (12.5)	11.31	3.95–32.36	<0.001	Chi-square
Survival >24 h	7/10 (70.0)	21/80 (26.2)	6.56	1.55–27.71	0.009	Fisher exact
Associated fall injury	6/7 (85.7)	22/83 (26.5)	16.64	1.89–146.06	0.003	Fisher exact

Table 4 shows the analytical comparison for high-voltage exposure. High-voltage deaths were significantly associated with outside-home occurrence, occupational exposure, extensive burns, delayed survival, and fall-related injury.

Discussion

The present study demonstrates a classic but regionally nuanced pattern of fatal electrocution in coastal Odisha. The principal findings were marked male predominance, concentration in young and early middle adult age groups, rural over-representation, a clear monsoon peak, predominance of accidental events, and a mixed domestic-occupational distribution in which low-voltage incidents constituted the larger burden while high-voltage exposure produced distinctly more severe injury. These observations are epidemiologically important because they show that electrocution in this setting is not confined to specialized industry; it also arises from unsafe domestic appliances, agricultural equipment, outdoor work, and environmental moisture.

Male victims constituted 86.7% of the series, closely matching the strong male predominance reported in Indian and international autopsy studies, including 85% in the Bengaluru study by Sumangala and Patil, 89.7% in the study of Kiran et al., 92% in the Jaipur study by Prasad et al., and 91.45% in the recent Turkish series by Doğan et al. [3,9,11,14]. Earlier Indian studies from northern India, Coimbatore, and rural Maharashtra reported similar trends [6-8]. The explanation is largely occupational and behavioural: men are overrepresented in electrical repair, construction, farming, line work, machine handling, and unsupervised repair tasks at home.

The age pattern also paralleled previous work. The 21–30 year age group was the largest stratum, followed by 31–40 years, placing most deaths within the productive workforce. This is consistent with the peak in the third decade reported by Sumangala and Patil, the 20–30 year concentration reported by Shobhana and Raviraj, and the young-adult predominance reported from Jaipur, Goa, and Türkiye [3,4,11,12,14]. Such concentration in the economically active population amplifies the social cost of fatal electrocution.

Rural residents formed about two-thirds of the present series. Although residence is not uniformly reported across all studies, this pattern is plausible in coastal Odisha and is consistent with the vulnerability described in several Indian reports [5-8]. Agricultural motor pumps, open field wiring, damaged extension lines, poor earthing, and improvised repairs all increase rural exposure. In the current series, agricultural motor or pump-set incidents constituted an important source category, reinforcing that prevention should extend beyond urban domestic wiring. Workplace incidents slightly exceeded home incidents, but home events remained substantial. This dual burden agrees with recent literature showing that electrocution is shared across occupational and domestic environments rather than confined to one domain alone [10,11,14].

Low-voltage exposure accounted for 68.9% of deaths, while high-voltage exposure accounted for 31.1%. This closely resembles the Jaipur study, where low-voltage incidents formed 65.33% of fatalities [11], but contrasts with the Bengaluru series in which high-tension exposure predominated [3]. Such variation probably reflects regional differences in referral patterns, local industry, power-distribution infrastructure, and the relative contribution of domestic versus utility-line exposure. The important forensic message is that low voltage is not harmless. Domestic alternating current can produce tetanic grip, prolong contact, and precipitate lethal arrhythmia even when the burn component is limited [1,2]. The current study supports this view because low-voltage deaths were common in home and wet-environment settings.

Seasonality was one of the clearest patterns in the present series. More than half of all deaths occurred during the monsoon season, with a visible July–August peak. Older Indian literature from rural

Maharashtra also noted clustering during wetter months, whereas the Turkish study reported a summer peak, underlining the importance of local climate and work pattern differences [8,14]. In coastal Odisha, wet floors, waterlogged fields, damaged insulation, leakage from appliances, and barefoot contact are likely contributors. The finding that wet conditions were common overall but less frequent in high-voltage deaths suggests that monsoon-related low-voltage domestic and field exposures form a large share of the preventable burden. This has direct public health implications for pre-monsoon inspection of earthing, household wiring, pumps, immersion rods, and outdoor temporary electrical connections.

The injury pattern further supports known forensic principles. Upper-limb contact was the predominant contact site, consistent with reports from South India, Jaipur, and other Indian centers where the hand or upper limb was most often involved because electrocution usually begins during active handling of wires, tools, or appliances [3,4,11]. Entry and exit marks together were seen in about one-third of cases, but discrete marks were absent in 34.4%. This is important because absence of a classical electrical mark does not exclude electrocution. Mansueto et al. emphasized that the electrical mark is highly informative when present, but internal findings such as pulmonary edema or congestion are generally nonspecific [2]. The present study agrees: pulmonary edema and visceral congestion were common supportive findings, yet they could not independently establish the diagnosis without circumstantial correlation. Immediate cardiorespiratory arrest due to electrocution was the leading cause of death, followed by respiratory arrest and septicemia following electrical burns. This distribution is compatible with the pathophysiology of electrical injury and with prior work showing that immediate shock-related collapse is the commonest terminal mechanism, while delayed burn complications account for a smaller but still important subset [1,3,11]. The large proportion of victims who were spot dead or brought dead is consistent with rapid fatal arrhythmia or respiratory paralysis. At the same time, the delayed survivors illustrate the clinical relevance of burn care, infection control, and renal monitoring in severe electrical trauma. The analytical results are practically useful. High-voltage deaths were significantly associated with occurrence outside the home, occupational exposure, extensive burns, delayed survival, and fall-related injury. These relationships are pathophysiologically coherent because high-voltage exposure is more typical of transmission lines, poles, transformers, and industrial settings, and it produces deeper burns, greater tissue destruction, and a greater risk of secondary falls. Kiran et al. reported greater severity with utility-pole exposure, and the recent Turkish series also highlighted workplace concentration and the importance of environmental circumstances [9,14]. The inverse association between wet environment and high voltage does not diminish overall monsoon risk; instead, it indicates that wet low-voltage domestic and field exposures make up a large portion of fatal events in this region. The study has practical implications for coastal Odisha. Prevention should simultaneously target households, farms, and workplaces. Household messaging should focus on safe handling of appliances, repair of damaged cords, proper earthing, and avoidance of barefoot contact on wet floors. Occupational prevention should emphasize de-energization protocols, line clearance, protective equipment, and supervision during pole, transformer, and construction work. For forensic practice, careful scene documentation remains essential, particularly in cases without classical electrical marks or with secondary trauma. Although limited by its retrospective single-center design and reliance on record completeness, the study provides a coherent regional profile and highlights actionable differences between low- and high-voltage fatality patterns.

Conclusion

Electrocution deaths in this coastal Odisha series predominantly involved young rural men and were overwhelmingly accidental. The burden rose during the monsoon months, low-voltage incidents formed the majority, and upper-limb contact was common. High-voltage exposure, however, was strongly linked with occupational setting, extensive burns, prolonged survival, and fall-related trauma. The findings underscore the need for simultaneous household, agricultural, and workplace electrical safety interventions together with meticulous forensic documentation of every suspected electrocution death.

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