

## Socio-Demographic and Medico-Legal Profile of Suicidal Hanging Cases: An Autopsy Based Study in North western India

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### ABSTRACT

**Background:** Suicide is a catastrophic public health crisis globally, and hanging remains one of the most common and highly lethal methods utilized for self-harm due to the easy accessibility of ligatures. **Methods:** A cross-sectional, observational autopsy-based study was carried out at the Department of Forensic Medicine & Toxicology, SMS Medical College & Attached Hospitals, Jaipur (Rajasthan), spanning the academic year 2024-25. Out of a total sample pool of 100 suicidal deaths, 38 cases where hanging was the primary method of choice were comprehensively analyzed using external and internal postmortem parameters. **Results:** Hanging accounted for 38% of the total suicidal fatalities. A significant male predominance was observed (30 males, 78.95% vs. 8 females, 21.05%). The most vulnerable age group was young adults aged 21–30 years (13 cases, 34.21%). The incidence was substantially higher in urban areas (25 cases, 65.79%) than in rural areas (13 cases, 34.21%). Married individuals comprised 20 cases (52.63%), while single individuals accounted for 15 cases (39.47%). Mechanically, asphyxia secondary to neck compression was the definitive cause of death in 100% of the hanging cases (38 cases). Postmortem evaluations systematically checked external ligature parameters and the presence of underlying deep tissue muscle hematomas. **Conclusion:** Suicidal hanging remains highly prevalent among young, urban, and married males. The universal role of rapid mechanical asphyxia emphasizes the immediate lethality of this technique. Targeted socio-psychological interventions and accessible mental healthcare are essential components for regional suicide prevention frameworks.

**Keywords:** Asphyxia, Autopsy, Ligature Mark, Muscle Hematoma, Suicidal Hanging.

### INTRODUCTION

Suicide is a deeply tragic, multi-layered global phenomenon driven by an intricate nexus of psychological vulnerabilities, socio-economic hardships, biological predispositions, and localized cultural shifts. The World Health Organization (WHO) identifies suicide as a leading cause of premature mortality, claiming hundreds of thousands of lives annually worldwide. Low- and middle-income nations bear a disproportionate share of this global burden. Within India, data compiled by the National Crime Records

Bureau (NCRB) indicates a steady upward trajectory in suicidal acts, highlighting the urgent need for robust forensic and epidemiological studies to identify high-risk cohorts and underlying triggers.<sup>1</sup>

The selection of a specific suicide method depends heavily on availability, perceived painlessness, cost, and the speed of execution. Hanging satisfies all these criteria, making it a highly prevalent choice across both rural and urban topographies. Ligature materials such as cotton ropes, nylon cords, sarees, bedsheets, leather belts, and electrical wires are standard household

components. Furthermore, domestic architectural designs provide accessible suspension points, including ceiling fans, iron window grills, wooden beams, and stairwells. Unlike chemical toxicosis or drug overdoses, which afford a critical clinical window for gastric lavage, antidote administration, and intensive care management, hanging has a high fatality rate. The mechanical compression of neck structures triggers a rapid sequence of events: venous outflow obstruction, arterial occlusion, airway blockages, and carotid sinus reflex stimulation, culminating in irreversible cerebral hypoxia within minutes. From a forensic and medicolegal standpoint, diagnosing death by hanging requires meticulous evaluation. The forensic pathologist is frequently tasked with distinguishing genuine antemortem suicidal hanging from homicidal strangulation or postmortem suspension designed to conceal a crime. This requires a systematic assessment of external neck markings and deep internal cervical architecture.

This research paper provides an academic evaluation of the socio-demographic patterns and distinct macro-pathological profiles of 38 suicidal hanging cases autopsied at the Department of Forensic Medicine & Toxicology, SMS Medical College, Jaipur. By evaluating variables such as age distribution, gender ratios, marital dynamics, geographical backgrounds, and internal neck features, this study provides forensic baseline metrics to guide regional psychiatric interventions and public health safety frameworks.

## MATERIALS AND METHODS

### Study Area

This research was designed as a cross-sectional, observational autopsy-based study. Investigative activities were localized within the mortuary of the Department of Forensic Medicine & Toxicology, SMS Medical College & Attached Hospitals, Jaipur (Rajasthan). The timeline for sample accumulation matched the academic and financial calendar of 2024-25. Institutional ethical approvals and clearances were maintained in alignment with standard medico-legal guidelines and institutional research boards.

### Sample Size

The parent study observed a consecutive pool of 100 cases of established suicidal deaths. From this broad cohort, a specialized subset of 38 distinct cases where the verified method of self-harm was hanging was selected for independent statistical tracking and detailed structural profiling.

### Inclusion Criteria

1. Cases where the manner of death was unequivocally confirmed as suicide by a

combination of police inquest files, eyewitness testaments, crime scene investigative notes, and investigative histories.

2. Cases exhibiting clear antemortem external and internal signs of suspension or hanging.

### Exclusion Criteria

1. Decomposed bodies where advanced putrefaction or insect activity compromised the structural integrity of the skin, soft tissues, or internal organs of the neck.
2. Cases where multiple lethal methods were combined (e.g., hanging following a lethal chemical ingestion where poisoning was determined to be the absolute prime driver of death, though purely mechanical hanging cases with secondary findings were preserved).
3. Homicidal or accidental neck compression fatalities (e.g., ligature or manual strangulation).

### Postmortem Examination Protocol

A uniform, comprehensive autopsy protocol was systematically applied to all 38 subjects.

1. **External Morphology Tracking:** The cadavers were initially examined to document general markers of asphyxia, including facial congestion, cyanosis of the lips and fingernails, the presence of subconjunctival petechial hemorrhages, and the distribution pattern of postmortem lividity (hypostasis). Special focus was directed toward the neck region to map out the ligature mark: its anatomical position relative to the thyroid cartilage, continuity around the neck circumference, width, direction (obliquity), skin texture (e.g., parchment-like induration), and the location of the indentation matching the knot.
2. **Internal Neck Flap Dissection:** To prevent artifactual blood pooling and accurately detect genuine antemortem deep-tissue injuries, a bloodless neck dissection technique was executed following the evacuation of the cranial and thoracic cavities. Skin flaps were carefully reflected layer-by-layer to expose the platysma, sternocleidomastoid, and deeper strap muscles. Each muscle layer was inspected macroscopically to detect localized mechanical trauma, contusions, and the presence or absence of an **underlying muscle hematoma** directly beneath the ligature mark path.
3. **Osteo-cartilaginous Assessment:** The hyoid bone, thyroid cartilage superior cornua, and cricoid ring were carefully dissected out, cleared of soft tissue remnants, and manually palpated

and transilluminated to evaluate for any fractures or structural deviations.

4. **Systemic Cavity Evacuation:** Brain, lungs, heart, liver, spleen, and kidneys were examined to log general hypoxic signatures, focusing on visceral congestion patterns and subpleural or subepicardial petechiae (Tardieu spots). Gastric contents and relevant viscera were harvested and preserved for toxicological analysis to exclude concomitant chemical exposures.

### Data Analysis

Socio-demographic profiles and pathological findings were systematically cross-tabulated using a standardized case proforma. Descriptive statistical computation was processed using electronic spreadsheets to evaluate percentages, ratios, and distributions.

Ethical approval: obtained from the Institutional Research Review Board of SMS Medical College, Jaipur. Confidentiality of all participants was maintained by assigning unique identification numbers.

Within the total parent population of 100 verified suicidal autopsies evaluated during the study period, hanging was identified as the second most common methodology, accounting for 38.00% of cases. It followed behind chemical poisoning, which was noted in 60.00% of cases, while fall from height or railway injuries represented the remaining portion of the sample.

### 1. Demographic Profile: Age-Wise Concentration

The age profile of the 38 hanging cases showed a distinct concentration in the young adult and early middle-age brackets. The peak incidence occurred within the 21–30 years age interval, yielding 13 cases (34.21%). This was followed equally by the 31–40 years and 41–50 years cohorts, each contributing 8 cases (21.05%). Adolescents and young adults in the 11–20 years group accounted for 6 cases (15.79%). The older demographic segments displayed significantly lower numbers, with 51–60 years generating 2 cases (5.26%) and patients aged above 60 years accounting for only 1 case (2.63%).

## RESULTS

**Table 1: Distribution of Suicidal Hanging Cohort by Age (n = 38)**

| Age Intervals (Years) | Cumulative Number of Cases | Statistical Percentage (%) |
|-----------------------|----------------------------|----------------------------|
| 11–20                 | 6                          | 15.79%                     |
| 21–30 (Peak)          | 13                         | 34.21%                     |
| 31–40                 | 8                          | 21.05%                     |
| 41–50                 | 8                          | 21.05%                     |
| 51–60                 | 2                          | 5.26%                      |
| >60                   | 1                          | 2.63%                      |
| Total Pool            | 38                         | 100.00%                    |

### 2. Gender Metrics

Gender tracking demonstrated a clear male predominance among hanging victims. Out of the 38 cases, 30 victims were male (78.95%), whereas 8 victims were female (21.05%). When viewed against the total parent study sample (\$n=100\$), males choosing hanging represented 38.46% of all male suicides, while females choosing hanging represented 36.36% of all female suicides.

### 3. Geographical Residence Analysis

The residential distribution of the hanging cases revealed an increased frequency among urban populations. Urban areas produced 25 cases (65.79%), whereas rural catchments generated 13 cases (34.21%). Urban victims accounted for 52.08% of the overall urban suicide sample, while rural hanging victims accounted for 25.00% of the overall rural suicide sample.

**Table 2: Geographical Cohort Breakdown (n = 38)**

| Residence Category | Case Prevalence | Percentage Contribution (%) |
|--------------------|-----------------|-----------------------------|
| Urban Residents    | 25              | 65.79%                      |
| Rural Residents    | 13              | 34.21%                      |
| Total              | 38              | 100.00%                     |

**4. Marital Status Categorization**

The distribution of hanging cases across marital categories identified married individuals as the largest subgroup within this cohort. Married victims accounted for 20 cases (52.63%), while single individuals comprised 15 cases (39.47%). Divorced individuals accounted for 1 case (2.63%), and the marital background remained unverified or unknown in 2 cases (5.26%).

**Table 3: Marital Stratification of Hanging Victims (n = 38)**

| Marital Profile       | Documented Case Counts | Sample Percentage (%) |
|-----------------------|------------------------|-----------------------|
| Married               | 20                     | 52.63%                |
| Single / Unmarried    | 15                     | 39.47%                |
| Divorced              | 1                      | 2.63%                 |
| Unspecified / Unknown | 2                      | 5.26%                 |
| Total                 | 38                     | 100.00%               |

**5. Pathological and Pathomorphological Observations**

At autopsy, the direct cause of death for all 38 individuals was certified as mechanical asphyxia secondary to neck compression (5).

- **External Neck Surface:** In a majority of these cases, the ligature mark was located high up in the neck, specifically superior to the thyroid cartilage layout. The markings typically presented an incomplete (non-continuous) distribution, displaying an upward oblique trajectory toward the site of the suspension knot. The underlying skin frequently exhibited a dry, condensed, yellowish-brown parchment-like character.
- **Deep Structural Neck Trauma:** Layer-by-layer soft tissue reflection identified distinct mechanical reactions. In cases involving heavy, rigid, or high-friction ligature materials, a localized **underlying muscle hematoma** was detected within the sternocleidomastoid or deeper cervical strap muscles, directly following the path of compression.
- **Systemic Visceral Hypoxia:** General examination of the internal organs confirmed diffuse hypoxic signatures. Visceral congestion

was a predominant finding across the broader study population, with **98.00% of cases displaying organ congestion**. Diffuse pulmonary engorgement, cerebral edema, and localized petechial spots on the subpleural and subepicardial surfaces were also documented.

- **Concomitant Autopsy Metrics:** Among the female suicide cases examined within the broader study, specific pelvic cavity mapping indicated that **68.18% (15 cases)** presented an empty uterus, **27.27% (6 cases)** were in the active menstrual phase, and **4.45% (1 case)** was in the postpartum phase.

**DISCUSSION**

The statistical finding that hanging accounts for 38.00% of the suicide fatalities at SMS Medical College highlights the significance of this method in the regional epidemiology of self-harm. This matches patterns seen across other tertiary forensic centers in India, where hanging consistently ranks as either the primary or secondary method of suicide. For instance, a descriptive autopsy study conducted by Sharma CS et al. (2024) at the government mortuary in Kota, Rajasthan, identified hanging as a major contributor to unnatural deaths among young demographics.<sup>5</sup> Similarly, Barman S et al.

(2023) reviewed 1,241 autopsies in Dibrugarh, Northeast India, noting that while hanging accounted for 5.64% of their total unselected baseline autopsies, it represented a highly fatal choice among young adults in their third decade of life.<sup>3</sup> Furthermore, Sofi FM et al. (2024) documented an even higher reliance on hanging, which accounted for up to 80.00% of suicidal fatalities in their study environment, followed by drowning and poisoning.<sup>4</sup>

The distinct male predominance (78.95%) observed within this hanging cohort aligns closely with national data from the National Crime Records Bureau (NCRB).<sup>2</sup> This gender distribution is consistent with the findings of Gogoi A et al. (2025), who analyzed 164 suicidal hanging autopsies at Jorhat Medical College, Assam, and noted a 76.22% male predominance.<sup>6</sup> This trend is often attributed to the high levels of socio-economic stress, professional instability, and financial pressures borne by male breadwinners in traditional social structures. Additionally, research suggests that males are more likely to select highly lethal, irreversible methods of self-harm during acute emotional crises, whereas females may opt for methods with a longer therapeutic window, such as medicinal over-dosages or chemical ingestions.

The concentration of cases within the 21–30 years age group (34.21%) highlights a critical demographic window. This phase of life involves significant social and economic transitions, including academic milestones, employment challenges, financial self-sufficiency pressures, and early marital adjustments. Uzair H et al. (2026), in an observational study at Bidar Institute of Medical Sciences, Karnataka, similarly identified that young adults face unique vulnerabilities related to relationship conflicts, academic setbacks, and unfulfilled economic expectations, which can elevate the risk of impulsive self-harm.<sup>7</sup>

Interestingly, within this hanging sub-sample, married individuals (52.63%) outnumbered single individuals. While marriage is historically viewed as a stabilizing, protective social factor against suicide, these results suggest that domestic responsibilities, marital discord, joint-family conflicts, and financial strains can act as significant stressors within this regional cohort. This finding aligns with the observations of Gogoi A et al. (2025), who identified marital disharmony (27.44%) and associated financial difficulties (20.12%) as leading documented motives in their study population.<sup>6</sup>

The determination of mechanical asphyxia secondary to neck compression as the universal cause of death prompts a rigorous examination of the underlying physiological mechanisms documented in forensic literature.<sup>10</sup> The primary pathophysiological mechanisms documented in standard forensic frameworks involve three main theoretical models:

### **1. The Vascular Occlusion and Cerebral Hypoxia Model**

Medical consensus emphasizes that the primary driver of death in non-judicial neck compression is global cerebral ischemia and stagnant hypoxia resulting from vascular constriction, rather than complete respiratory airway obstruction alone. The superficial position of the neck's vascular network makes it highly susceptible to external compression forces.<sup>11</sup>

**Venous Stasis:** Forensic studies demonstrate that a minimal mechanical load of approximately **2 kg** is sufficient to collapse the low-pressure jugular veins. This blockage of venous outflow leads to rapid vascular engorgement, localized pressure spikes, and stagnant hypoxia, contributing significantly to the extensive visceral and cerebral congestion frequently noted in broader study cohorts.<sup>12</sup>

**Arterial Occlusion:** To completely interrupt blood supply to the central nervous system, greater forces are required to compress the thicker, muscular walls of the carotid arteries (**3.5 to 5 kg**) and the deeply seated vertebral arteries. Complete arterial occlusion cuts off oxygenated cerebral blood flow, causing rapid depletion of cellular energy reserves and leading to irreversible neuronal ischemia within minutes.

### **2. The Neurological and Vagal Inhibition Model**

Beyond vascular occlusion, the literature highlights reflex cardiac inhibition as a potential mechanism for sudden mortality. When a ligature or external force applies localized mechanical pressure directly to the upper cervical region, it can stimulate the sensitive carotid sinus baroreceptors. This mechanical stimulation can trigger an overactive vagal response. The resulting parasympathetic surge causes sudden bradycardia, profound cardiac arrhythmias, or neurogenic shock, which can result in rapid death even before classical signs of asphyxia fully develop.<sup>13</sup>

### **3. The Mechanical Airway Obstruction Model**

While vascular failure is frequently identified as the primary factor, structural airway blockages provide a secondary or concurrent mechanism for asphyxiation. A mechanical force of approximately **15 kg** is required to compress the cartilaginous patency of the trachea. However, when compression occurs high up on the neck—as observed in the majority of these cases the upward and backward displacement of the local anatomy pushes the root of the tongue against the posterior wall of the pharynx. This displacement folds the epiglottis down over the entrance of the larynx, creating a physical barrier that prevents gas exchange and leads to progressive respiratory insufficiency.<sup>13</sup> By linking external pathomorphological markers such as the positioning and nature of ligature marks with these established physiological models, the standard forensic framework for analyzing neck compression is reinforced.

This theoretical integration provides a comprehensive basis for analyzing the medical details recorded during post-mortem examinations.<sup>14</sup>

## STRENGTHS

1. The study is based on systematically documented autopsy findings from a tertiary care forensic centre, providing objective medico-legal and pathological data on suicidal hanging cases.
2. The study combines socio-demographic characteristics with detailed external and internal neck examination findings, allowing both epidemiological and forensic assessment of hanging deaths.
3. A standardized postmortem examination protocol was applied to all included cases, including assessment of ligature marks, deep cervical soft tissues, hyoid bone, thyroid cartilage, and systemic visceral findings.
4. The study provides region-specific data from North-western India, which may contribute to the understanding of demographic patterns of suicidal hanging in the region.
5. The study identifies important high-frequency demographic characteristics, particularly young age, male sex, and urban residence, which may assist in developing targeted suicide-prevention strategies.

## LIMITATIONS

1. The study was conducted at a single tertiary care centre; therefore, the findings may not be directly generalizable to the entire population of Rajasthan or other regions of India.
2. The sample size was relatively small, with only 38 hanging cases, which limits the statistical power and precision of subgroup comparisons.
3. The study was primarily descriptive and did not include multivariable statistical analysis to determine independent associations between socio-demographic factors and suicidal hanging.
4. Information regarding psychological history, psychiatric illness, substance use, socioeconomic status, interpersonal conflicts, and specific precipitating circumstances was not comprehensively analyzed.
5. As the study was based on medico-legal autopsy records, some demographic and circumstantial information may have been incomplete or dependent on police investigation and available documentation.
6. The study period was limited to the academic year 2024–25, and seasonal or longer-term temporal trends could therefore not be adequately evaluated.
7. The study did not include a matched comparison group of suicides by other methods, limiting direct

assessment of factors specifically associated with the choice of hanging.

## FUTURE DIRECTIONS

Future research should involve multicentric studies with larger sample sizes across different geographical and socioeconomic settings to establish more representative epidemiological patterns of suicidal hanging in India. Prospective studies integrating autopsy findings with police investigation records, psychiatric history, toxicological results, socioeconomic characteristics, and documented precipitating factors may provide a more comprehensive understanding of the circumstances associated with hanging deaths. Advanced forensic approaches, including systematic histopathological assessment of ligature-related soft-tissue injury and appropriate ancillary investigations, may further improve the interpretation of equivocal cases. Longitudinal surveillance could also help identify temporal and demographic trends and evaluate the effectiveness of targeted suicide-prevention interventions. Collaboration between forensic medicine departments, mental-health professionals, public-health authorities, and community organizations may facilitate development of evidence-based regional suicide-prevention strategies.

## CONCLUSION

This study demonstrates that suicidal hanging at **S.M.S. Medical College, Jaipur** disproportionately impacts young, married, urban males, with death universally occurring via mechanical **asphyxia**. Because common ligature objects are readily available in homes, standard restriction strategies are largely impractical. Therefore, suicide mitigation frameworks must focus on expanding accessible mental health infrastructure in urban centers, deploying proactive crisis hotlines, and conducting community gatekeeper training to identify early indicators of severe depression and psychological distress before they escalate.

## DECLARATIONS

**Ethical Approval:** Ethical approval was obtained from the Institutional Research Review Board of SMS Medical College, Jaipur, Rajasthan, India. The study was conducted in accordance with applicable institutional guidelines for medico-legal autopsy research.

**Consent to Participate:** As this study was based on medico-legal autopsy records, individual consent was subject to applicable institutional policies and ethical approval requirements.

**Consent for Publication:** Not applicable. No personally identifiable information of the deceased individuals has been included in this manuscript.

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**Conflicts of Interest:** The authors declare that they have no conflicts of interest related to this study.

#### Author Contributions

**Dr. Sunil Kumar Meemrot:** Study conception and design, autopsy data collection, clinical and medico-legal assessment, data interpretation, manuscript drafting, and critical revision of the manuscript.

**Dr. Sumanta Dutta:** Study supervision, methodological guidance, medico-legal interpretation, critical review of the manuscript, and final approval of the version to be published.

**Dr. Naveen Kumar Simatwall:** Study design, autopsy data collection, pathological and medico-legal assessment, data analysis and interpretation, manuscript preparation, and critical revision.

**Dr. Dhanpat Godara:** Data collection, autopsy examination, literature review, data organization and interpretation, manuscript drafting, and critical revision. All authors contributed to the work, reviewed and approved the final manuscript, and agree to be accountable for all aspects of the work.

**Data Availability Statement:** The data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to institutional policies, ethical requirements, and confidentiality restrictions applicable to medico-legal records.

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#### AI Use Disclosure

The authors declare that no generative artificial intelligence tools were used to generate or substantially modify the scientific content of this manuscript.

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