

"A Retrospective Analysis of Fatal Asphyxial Deaths Based on Medico-Legal Autopsies at a Medical College in the Garhwal Region, Uttarakhand"

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Abstract

Background: Mechanical and traumatic asphyxial deaths constitute an important category of unnatural deaths encountered in forensic practice. Their epidemiological profile varies according to geographical, environmental, and socio-demographic factors. The present study was undertaken to analyse the demographic characteristics, pattern, and medico-legal profile of fatal asphyxial deaths in the Garhwal region of Uttarakhand.

Materials and Methods: This retrospective record-based observational study included all medico-legal autopsy cases of fatal mechanical and traumatic asphyxia conducted in the Department of Forensic Medicine & Toxicology, Veer Chandra Singh Garhwali Government Institute of Medical Sciences & Research, Srinagar, Pauri Garhwal, Uttarakhand, from 1 January 2022 to 31 December 2025. Data were collected from post-mortem records using a predesigned proforma and analysed using Microsoft Excel and SPSS version 21. Descriptive statistics were used to summarize the findings, and the Chi-square/Fisher's exact test was applied to determine associations between categorical variables. A p-value of <0.05 was considered statistically significant.

Results: During the study period, 439 medico-legal autopsies were performed, of which 79 (17.9%) were due to fatal asphyxia. The highest proportion of cases was recorded in 2022 (26.6%). Victims were predominantly males (81.0%), with a male-to-female ratio of approximately 4.3:1. The majority belonged to the 31–40-year age group (36.7%). Drowning was the most common type of asphyxial death (67.1%), followed by hanging (29.1%) and traumatic asphyxia (3.8%). Accidental deaths constituted 60.8% of cases, while suicidal deaths accounted for 39.2%. Most incidents occurred in rural areas (64.6%), and rivers were the commonest place of occurrence (67.1%).

Conclusion: Fatal asphyxial deaths in the Garhwal region predominantly affected adult males and were mainly accidental, with drowning emerging as the leading cause. The predominance of river-related incidents and rural occurrence highlights the need for region-specific drowning prevention strategies, public awareness programmes, and improved safety measures around natural water bodies. Further multicentric studies with larger sample sizes are recommended to better understand the epidemiology of asphyxial deaths.

Keywords: Drowning, Medico-legal Autopsy, Unnatural death, Mechanical asphyxia

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1. Introduction

Mechanical asphyxia is a major category of unnatural deaths encountered in forensic practice and results from interference with normal respiration due to external compression or obstruction of the airway. These deaths occur under a variety of circumstances, ranging from accidental events to suicidal and homicidal acts, making their medico-legal evaluation particularly challenging. A thorough understanding of the epidemiological profile, demographic distribution, and mechanisms of mechanical asphyxia is essential for accurate cause-of-death determination, crime scene reconstruction, and the

administration of justice. Mechanical asphyxia includes several distinct entities such as hanging, strangulation, drowning, and suffocation. Suffocation comprises conditions in which respiration is impeded by mechanisms other than hanging, strangulation, or drowning, including smothering (occlusion of the external respiratory openings), choking (obstruction of the internal air passages), exposure to oxygen-deficient or irrespirable atmospheres, and traumatic asphyxia resulting from restriction of respiratory movements. Deaths due to violent asphyxia constitute a substantial proportion of medico-legal autopsies involving unnatural

fatalities, including suicides, homicides, and accidental deaths. Among the various forms of violent asphyxia, hanging is one of the most common methods of suicide. It is defined as compression of the neck by a ligature with the constricting force produced by the weight of the suspended body.¹ In the majority of cases, hanging is suicidal in manner, although accidental hanging may occur in cases of sexual misadventure, while homicidal hanging is rare and may be encountered in lynching or judicial execution.

Strangulation is another important type of mechanical asphyxia in which the neck is compressed by a force other than the individual's body weight. The constricting force may be applied using a ligature, the hands (manual strangulation or throttling), or other objects such as the elbow, knee (mugging), or bamboo poles (bansdola).² Differentiating strangulation from hanging is of considerable forensic importance because of its close association with homicidal violence.

Drowning is defined as a form of asphyxial death caused by submersion or immersion in a liquid, resulting in the prevention of normal gaseous exchange within the lungs. It remains a major global public health problem and may occur in either freshwater or seawater environments depending on the medium involved.³

Traumatic asphyxia, also referred to as crush asphyxia, occurs when respiratory movements are restricted because of severe compression or penetrating injury to the thoraco-abdominal region. This form of asphyxia is most commonly accidental and is characterized by prominent cervicofacial cyanosis, subconjunctival haemorrhages, and extensive petechial haemorrhages over the face, neck, and upper chest due to sudden elevation of venous pressure following thoracic compression.⁴

Despite the medico-legal significance of asphyxial deaths, comprehensive autopsy-based studies from Uttarakhand remain limited. Analysis of demographic characteristics, manner of death, causes, and autopsy findings can provide valuable epidemiological data, assist forensic investigations, and support the development of preventive public health strategies. Therefore, the present retrospective autopsy-based study was undertaken to evaluate the pattern and characteristics of fatal asphyxial deaths in the Garhwal region of Uttarakhand.

Aims

To analyse the epidemiological, demographic, and medico-legal profile of fatal asphyxial deaths based on medico-legal autopsies conducted at a tertiary care medical college in the Garhwal region, Uttarakhand.

Objectives

- 1.To determine the demographic characteristics (age, sex, residence, and occupation) of victims of fatal asphyxial deaths.
- 2.To analyse the pattern of fatal asphyxial deaths with respect to the type of asphyxia and manner of death.
- 3.To evaluate the medico-legal and autopsy findings associated with different types of fatal asphyxial deaths.

- 4.To identify the temporal and epidemiological trends of fatal asphyxial deaths in the Garhwal region of Uttarakhand.

2. Materials and Methods

- **Study design:** A retrospective record-based observational study.
- **Study population:** The study population comprised all medico-legal autopsy cases of fatal asphyxial deaths conducted in the Department of Forensic Medicine & Toxicology, Veer Chandra Singh Garhwali Government Institute of Medical Sciences & Research (VCSGGIMS & R), Srinagar, Pauri Garhwal, Uttarakhand, during the study period.
- **Sampling Technique:** Consecutive sampling
- **Period of study:** 1st January 2022 to 31st December 2025

Inclusion criteria:

- i.All medico-legal autopsy cases in which the cause of death was attributed to mechanical or traumatic asphyxia, including hanging, strangulation, drowning, smothering, choking, traumatic (crush) asphyxia, and other forms of mechanical interference with respiration.
- ii.Cases with complete post-mortem reports and relevant medico-legal records.

Exclusion Criteria

- i.Cases in which the cause of death was due to non-mechanical asphyxia, including toxic and pathological causes of asphyxia.
- ii.Cases with incomplete post-mortem or medico-legal records.
- iii.Advanced decomposed bodies in which the cause of death could not be determined conclusively.

- **Method of Collection of Data:** Data were extracted using a predesigned data collection proforma. Variables collected included age, sex, residence, occupation, type of asphyxia, manner of death, place of occurrence, seasonal distribution, external and internal autopsy findings, associated injuries, and toxicological findings wherever available.
- **Statistical Analysis:** The collected data were entered into Microsoft Excel and analysed using the Statistical Package for the Social Sciences (SPSS) version (Version 1.0.0.1406, IBM® SPSS® Statistics 21). Descriptive statistics were used to summarize the data. Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as mean $\pm$ standard deviation or median with interquartile range, as appropriate. A p-value of <0.05 was considered statistically significant.

3. Results

A total of 439 medicolegal autopsies were conducted during the study period from 1st January 2022 to 31st December 2025. Of these, 79 cases were identified as deaths due to asphyxia, accounting for 17.9% of all medicolegal autopsies performed during the study period.

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The highest number of cases was recorded in 2022 (26.6%), while 2023 and 2024 each contributed 24.1% (Table-1)

The majority of victims belonged to the 31–40 years age group (36.7%), followed by the 21–30 years age group (20.3%). (Table-2)

Males predominated (81.0%), giving a male: female ratio of approximately 4.3:1. (Table-3)

Drowning was the most common type of asphyxial death (67.1%), followed by hanging (29.1%) and traumatic asphyxia (3.8%). (Table-4)

Among the 79 asphyxial deaths, accidental deaths constituted the majority (60.8%), whereas suicidal deaths accounted for 39.2% of the cases (Table-5)

Out of the total 79 cases the maximum incidence 64.6% was reported from rural area and incidence of 25.4% from Urban. (Table-6)

Out of total 79 cases, Rivers were the most frequent place of occurrence (67.1%), followed by homes (24.1%). (Table-7)

The distribution of different types of asphyxial deaths according to sex. The association between sex and type of asphyxial death was assessed using the Chi-square test/Fisher's exact test. (Table-8)

Hanging was exclusively suicidal (23 cases), whereas drowning was predominantly accidental (45/53 cases). All cases of traumatic asphyxia were accidental. A statistically highly significant association was observed between the type of asphyxial death and the manner of death ($p < 0.001$). (Table-9)

Drowning was the most common type of asphyxial death in both rural (33 cases) and urban (20 cases) areas, followed by hanging and traumatic asphyxia. No statistically significant association was observed between the type of asphyxial death and the area of incidence ($p = 0.827$) (Table 10)

Table 1: Year-wise distribution

YEAR	No. of cases	Percentage (%)
2022	21	26.6
2023	19	24.1
2024	19	24.1
2025	20	25.3
Total	79	100.0

Table 2: Distribution of cases based on age

Age group (years)	No. of cases	Percentage (%)
0-10	0	0.0
11-20	9	11.4
21-30	16	20.3
31-40	29	36.7
41-50	15	19
51-60	6	7.6
>60	4	5.1
Total	79	100

Table 3: Distribution of cases-based on Sex

SEX	No. of cases	Percentage (%)
Male	64	81
Female	15	19
Total	79	100

Table 4: Type of asphyxial death

TYPE	No. of cases	Percentage (%)
Drowning	53	67.1
Hanging	23	29.1
Traumatic asphyxia	3	3.8
Total	79	100

Table 5: Distribution of cases based on Manner of death

Manner	No. of cases	Percentage (%)
Accidental	48	60.8
Suicidal	31	39.2
Total	79	100

Table 6: Distribution of cases based on area of incidence

Area	No. of cases	Percentage (%)
Rural	51	64.6
Urban	28	35.4
Total	79	100

Table 7: Distribution of cases based on Place of occurrence

Place	No. of cases	Percentage (%)
River	53	67.1
Home	19	24.1
Workplace	5	6.3
Canal	2	2.5
Total	79	100

Table 8. Association between type of asphyxial death and sex (n = 79)

Type of asphyxial death	Male n (%)	Female n (%)	Total	p-value
Hanging	18	5	23	
Drowning	44	9	53	
Traumatic asphyxia	02	01	3	
Total	64	15	79	0.721

Table 9. Association between type of asphyxial death and manner of death (n = 79)

Type of asphyxial death	Accidental n (%)	Suicidal n (%)	Total	p-value
Hanging	0	23	23	
Drowning	45	8	53	
Traumatic asphyxia	3	0	3	
Total	48	31	79	<0.001

Table 10. Association between type of asphyxial death and area of incidence (n = 79)

Type of asphyxial death	Rural n (%)	Urban n (%)	Total	p-value
Hanging	16	7	23	
Drowning	33	20	53	
Traumatic asphyxia	02	01	3	
Total	51	28	79	0.827

4. Discussion

- The present retrospective study analysed 79 cases of asphyxial deaths autopsied over a four-year period (2022–2025). Asphyxial deaths continue to represent an important cause of medico-legal mortality, with demographic and epidemiological patterns varying according to geographic region, environmental factors, and socio-cultural characteristics.
- The number of asphyxial deaths remained relatively stable throughout the study period, with the highest proportion recorded in 2022 (26.6%). The distribution across the remaining years was comparable, suggesting no major year-to-year variation in the incidence of asphyxial deaths during the study period. These findings are consistent with the findings of Adjai Suwandono YA et al7.
- The highest proportion of victims belonged to the 31–40-year age group, followed by the 21–30-year age group. Individuals in these economically productive age groups are more frequently exposed to occupational hazards, psychosocial stress, and outdoor activities, which may increase the risk of accidental and suicidal asphyxial deaths. These findings are consistent with the findings of Prasad KJ et al5, Mirza FH et al6
- Males constituted 81.0% of all cases, with a male-to-female ratio of approximately 4.3:1. This male predominance is consistent with previous forensic studies and may be attributed to greater occupational exposure, outdoor activities, risk-taking behaviour, and higher involvement in medico-legal incidents. These findings are consistent with the findings of Byard RW et al8, Wagner SA et al9, Iqbal F et al10.

- Drowning was the predominant type of asphyxial death (67.1%), followed by hanging (29.1%) and traumatic asphyxia (3.8%). The predominance of drowning in the present study may be attributed to the geographical characteristics of the study area, where rivers and other natural water bodies are abundant. These findings are consistent with the findings of Kumar N et al¹¹, Nayak GH et al¹².
- Accidental deaths constituted the majority (60.8%), whereas suicidal deaths accounted for 39.2% of all cases. The predominance of accidental deaths is likely attributable to the high proportion of drowning cases in the study population. These findings are consistent with the findings of Kumar N et al¹¹, Azmak D et al¹³.
- Most incidents occurred in rural areas (64.6%). Rural populations often have greater exposure to rivers, canals, agricultural environments, and limited safety infrastructure, which may contribute to the increased incidence of accidental asphyxial deaths. These findings are consistent with the findings of Varshney AK et al¹⁴, Kumar Pathak M et al¹⁵, Bharatee P et al¹⁷.
- Rivers constituted the most common place of occurrence (67.1%), followed by homes (24.1%). The predominance of river-related incidents corresponds with the high frequency of drowning observed in the present study. These findings are consistent with the findings of Kumar N et al¹¹, Baweja VS et al¹⁶, Bharatee P et al¹⁷, Kokusho K et al¹⁸.

5. Conclusion

The present study demonstrates that asphyxial deaths predominantly affected adult males and were mainly accidental in nature. Drowning was the leading type of asphyxial death, with rural areas and rivers being the most common area and place of occurrence, respectively. These findings highlight the need for targeted drowning-prevention strategies, community-based drowning prevention programmes, public awareness, and improved safety measures around natural water bodies. Further multicentric studies with larger sample sizes are recommended to better understand regional variations in asphyxial deaths.

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Conflicts of interest: There are no conflicts of interest

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