

Original Research Article

EPIDEMIOLOGICAL AND MEDICO-LEGAL PROFILE OF FATAL FALLS FROM HEIGHT: A PROSPECTIVE AUTOPSY STUDY

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ABSTRACT

Background: Falls from height are an important cause of unnatural mortality worldwide and represent a significant public health and medico-legal concern. Demographic characteristics, occupational exposure, socioeconomic factors, and environmental circumstances play important roles in determining the occurrence of fatal falls. Understanding these factors is essential for identifying vulnerable populations and developing effective preventive strategies.

Materials and Methods: A prospective autopsy-based descriptive study was conducted in the Department of Forensic Medicine of a tertiary care teaching hospital in South India over a period of three years from June 2012 to May 2015. Thirty-five medico-legal autopsy cases of deaths due to falls from height were included. Information regarding demographic profile, occupation, educational status, marital status, socioeconomic class, site of fall, time of occurrence, height of fall, and manner of death was collected from autopsy records, police reports, and investigative documents. Data were analyzed using descriptive statistics.

Results: Among the 35 victims, males accounted for 74.29% of cases, with a male-to-female ratio of 2.9:1. The highest proportion of victims belonged to the 20–29 years age group (34.28%). Construction workers constituted the largest occupational category (31.43%), while the upper-lower socioeconomic class represented the most affected group (28.56%). Residential buildings were the most common site of fall (54.29%), followed by construction sites (31.42%). Most incidents occurred during daytime hours (77.14%). Falls from heights of 30–39 feet accounted for the largest proportion of fatalities (25.71%). Accidental falls predominated, accounting for 85.71% of deaths, whereas suicidal falls constituted 14.29%.

Conclusion: Fatal falls from height primarily affect young adult males and are strongly associated with occupational and environmental risk factors. The predominance of accidental falls occurring from residential buildings and construction sites underscores the need for improved workplace safety practices, enhanced building safety measures, and targeted preventive interventions for high-risk populations.

Keywords: Fall from height; Epidemiology; Medico-legal profile; Occupational risk; Accidental fall; Autopsy study; Socioeconomic factors.

INTRODUCTION

Falls from height constitute a major cause of accidental injury and mortality worldwide and

remain an important public health and medico-legal concern.^[1] With rapid urbanization, expansion of high-rise residential complexes, and increasing construction activities, the incidence of fall-related

fatalities has shown a rising trend, particularly in developing countries.^[1] Falls may occur in a variety of settings, including residential buildings, workplaces, construction sites, agricultural environments, and recreational areas, resulting in significant loss of life and socioeconomic burden.^[2] The epidemiology of fatal falls from height is influenced by multiple demographic, occupational, environmental, and behavioral factors.^[2] Literatures have consistently demonstrated a predominance of young and middle-aged adults among victims, with males being disproportionately affected due to greater occupational exposure to hazardous work environments and risk-taking behaviors.^[2,3] Construction workers, electricians, painters, and other individuals engaged in activities involving elevated work surfaces are particularly vulnerable.^[3] In many developing nations, inadequate implementation of workplace safety regulations, absence of protective equipment, and insufficient training contribute substantially to fall-related mortality.^[4] Apart from occupational exposure, socio-demographic characteristics such as age, educational status, marital status, and socioeconomic background may influence both the occurrence and outcome of falls from height.^[5] Individuals belonging to lower socioeconomic strata often engage in manual labor occupations associated with increased exposure to height-related hazards. Similarly, educational attainment may indirectly affect awareness regarding workplace safety practices and risk prevention measures.^[5] Understanding these factors is important for identifying vulnerable populations and developing targeted preventive interventions.^[6] From a medico-legal perspective, deaths due to falls from height present unique investigative challenges. Establishing the manner of death—whether accidental, suicidal, or homicidal—requires careful evaluation of the circumstances surrounding the incident, scene findings, witness accounts, and autopsy observations.^[7] While accidental falls account for the majority of cases, suicidal jumps from buildings and other elevated structures constitute a significant proportion of urban fatalities in several regions.^[8] Accurate characterization of the circumstances of fall is therefore essential for both forensic investigation and legal adjudication.^[8] Previously, it has been examined the demographic and circumstantial profile of fatal falls and have reported considerable regional variations in age distribution, occupational risk factors, location of occurrence, and manner of death.^[9,10] Such variations are influenced by differences in urban infrastructure, socioeconomic conditions, occupational practices, and cultural factors.^[9] Despite increasing urban development and construction activity in India, comprehensive autopsy-based studies focusing on the epidemiological and medico-legal aspects of fatal falls from height remain relatively limited.^[10]

In this context, the present study was aimed to evaluate the epidemiological characteristics and medico-legal profile of fatal falls from height among cases subjected to medico-legal autopsy at a tertiary care center in South India.

MATERIALS AND METHODS

Study Design and Setting: A prospective descriptive autopsy-based study was conducted in the Department of Forensic Medicine of a tertiary care teaching hospital in Bengaluru, South India. The study analyzed medico-legal autopsy cases of deaths resulting from falls from height over a period of three years extending from June 2012 to May 2015. Institutional Ethics Committee approval had been obtained prior to commencement of the study, and all procedures were carried out in accordance with prevailing medico-legal and ethical guidelines.

Study Population: The study included all deceased individuals who were brought for medico-legal autopsy with a documented history of fall from height during the study period. For the purpose of the study, fall from height was defined as any fall from a higher level to a lower level, including falls from buildings, rooftops, staircases, ladders, trees, compounds, and other elevated structures. Cases involving falls from moving vehicles such as trains, buses, or other modes of transport were excluded because of the different injury mechanisms and medico-legal circumstances associated with such events. A total of 35 cases fulfilled the inclusion criteria and were included in the final analysis.

Data Collection and Medico-Legal Evaluation: Data were retrieved from medico-legal autopsy records, police inquest reports, requisition forms, hospital records, and other relevant investigative documents available at the time of autopsy. Whenever available, supplementary information was obtained from eyewitness accounts, statements from relatives, and scene investigation records. Particular emphasis was placed on collecting information related to the demographic profile of the deceased, educational status, marital status, occupation, socioeconomic background, place of occurrence, timing of the incident, estimated height of fall, and manner of death.

Information regarding the approximate height of fall was obtained from police records, eyewitness testimony, site inspection reports, and scene photographs. In selected cases, direct observations from scene visits conducted as part of the medico-legal investigation were also considered to corroborate the reported circumstances of the incident. The manner of death was determined after comprehensive evaluation of available investigative findings, circumstantial evidence, police records, and autopsy observations.

Study Variables: The primary variables analyzed included age, sex, occupation, educational status, marital status, socioeconomic status, site from which

the fall occurred, time of occurrence, estimated height of fall, and manner of death. Occupations were categorized according to the principal work activity reported for the deceased. Socioeconomic status was classified into standard socioeconomic categories based on information available in police and family records. Sites of fall were grouped into residential buildings, construction sites, trees, compounds, and other locations to facilitate epidemiological assessment.

Statistical Analysis: The collected data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) software version 20.0 (IBM Corp., Armonk, NY, USA). Descriptive statistical methods were employed for analysis. Categorical variables were summarized as frequencies and percentages and presented using tables and graphical representations.

The findings were interpreted to identify demographic trends, occupational risk groups, environmental factors, and medico-legal characteristics associated with fatal falls from height.

RESULTS

During the three year study period, 900 medico-legal autopsies were performed, of which 35 deaths were attributed to falls from height, accounting for 3.89% of all autopsies. Males constituted the majority of victims (74.29%), resulting in a male-to-female ratio of 2.9:1. The highest number of victims belonged to the 20–29 years age group (34.28%), followed by the 30–39 years and 40–49 years age groups (17.14% each) [Table 1].

Table 1: Age- and Sex-wise Distribution of Victims of Fatal Falls from Height (n = 35).

Age Group (Years)	Male (n=26)	Female (n=9)	Total (n=35)
	Number (%)		
0–9	0 (0.00)	1 (11.11)	1 (2.86)
10–19	1 (3.85)	2 (22.22)	3 (8.57)
20–29	9 (34.62)	3 (33.33)	12 (34.28)
30–39	5 (19.23)	1 (11.11)	6 (17.14)
40–49	6 (23.08)	0 (0.00)	6 (17.14)
50–59	3 (11.54)	0 (0.00)	3 (8.57)
>60	2 (7.69)	2 (22.22)	4 (11.43)

Construction workers constituted the largest occupational category (31.43%), followed by individuals belonging to miscellaneous occupations (22.87%). Painters, students, housewives, and retired individuals each accounted for 8.57% of cases. Most victims had attained middle school education (25.71%), followed by high school and graduation levels (22.85% each). Illiterate

individuals constituted 11.44% of cases. Married individuals constituted nearly two-thirds of all victims (62.86%), whereas unmarried individuals accounted for 37.14%. The largest proportion of victims belonged to the upper-lower socioeconomic class (28.56%), followed by the upper-middle (22.86%) and lower socioeconomic classes (20.00%) [Table 2].

Table 2: Occupational, Educational, Marital and Socioeconomic Profile of Victims of Fatal Falls from Height (n = 35).

Parameters	Number	%
Occupation		
Construction worker	11	31.43
Painter	3	8.57
Electrician	2	5.71
Student	3	8.57
Housewife	3	8.57
Farmer	2	5.71
Retired person	3	8.57
Others	8	22.87
Educational Status		
Illiterate	4	11.44
Primary school	4	11.44
Middle school	9	25.71
High school	8	22.85
Pre-university	2	5.71
Graduate	8	22.85
Marital Status		
Married	22	62.86
Unmarried	13	37.14
Socioeconomic Class		
Upper	6	17.14
Upper middle	8	22.86
Lower middle	4	11.44
Upper lower	10	28.56
Lower	7	20.00

Buildings constituted the predominant location of fatal falls. Residential buildings accounted for 54.29% of cases, while construction sites accounted for 31.42%. Most fatal falls occurred during daytime hours (77.14%), whereas only 22.86% occurred at night. The majority of fatal falls occurred from heights between 30 and 39 feet (25.71%). Falls from heights between 10–29 feet collectively accounted for nearly half of all cases (45.72%). The majority of

fatal falls occurred from heights between 30 and 39 feet (25.71%). Falls from heights between 10–29 feet collectively accounted for nearly half of all cases (45.72%). Accidental falls constituted the predominant manner of death. Suicidal falls accounted for a smaller proportion of cases, while homicidal deaths were not encountered in the study population [Table 3].

Table 3: Circumstantial and Medico-Legal Characteristics of Fatal Falls from Height (n = 35).

Parameters	Number	%
Site of Fall		
Residential building	19	54.29
Construction site	11	31.42
Tree	3	8.57
Table	1	2.86
Compound wall	1	2.86
Time of Fall		
Day	27	77.14
Night	8	22.86
Height of Fall (Feet)		
<10	2	5.71
10–19	8	22.86
20–29	8	22.86
30–39	9	25.71
40–49	4	11.44
50–59	2	5.71
>60	2	5.71
Manner of Death		
Accidental	30	85.71
Suicidal	5	14.29
Homicidal	0	0.00

DISCUSSION

Fatal falls from height remain an important cause of unnatural mortality and constitute a significant medico-legal challenge, particularly in rapidly urbanizing regions where occupational and residential exposure to elevated structures is increasing. The present study evaluated the epidemiological and medico-legal characteristics of 35 fatal fall victims and demonstrated distinct demographic, occupational, socioeconomic, and circumstantial trends that provide insight into populations at increased risk.

A marked male predominance was observed in the present study, with males accounting for 74.29% of victims and a male-to-female ratio of 2.9:1. Similar findings have been reported by Biswas et al., Ramadan et al., and Saroj, who documented male involvement ranging from 70% to 85% of fatal fall cases.^[11-13] The predominance of males is likely attributable to greater occupational exposure to hazardous environments, particularly construction work and other outdoor activities involving elevated locations.^[11] Additionally, males are generally more involved in physically demanding occupations and may exhibit greater risk-taking behavior, increasing their vulnerability to falls from height.^[12]

The highest proportion of victims belonged to the 20–29 years age group (34.28%), and individuals aged 20–49 years collectively accounted for more than two-thirds (68.56%) of all cases. This finding is

consistent with previous forensic studies by Guntheti et al., and Vaghela et al., that have identified young and middle-aged adults as the most frequently affected population.^[14,15] Guntheti et al. reported a similar concentration of cases in the third and fourth decades of life, while Vaghela et al., observed peak incidence among economically productive age groups.^[14,15] The predominance of younger adults may reflect their greater participation in occupational activities involving physical labor, construction work, and outdoor employment.^[14] From a public health perspective, fatalities in this age group result in substantial socioeconomic losses because they affect individuals during their most productive years.^[15]

Occupational analysis revealed that construction workers constituted the largest group of victims (31.43%). Comparable observations have been reported in several studies by Zaini et al., where construction-related falls represented a major proportion of fatal incidents.^[16-18] The construction industry inherently involves exposure to elevated work surfaces, scaffolding, rooftops, and unfinished structures.^[16] Inadequate use of personal protective equipment, absence of safety harnesses, poor supervision, and non-compliance with occupational safety regulations are recognized contributors to fall-related mortality.^[17] The finding underscores the need for stricter enforcement of workplace safety standards and regular training programs aimed at reducing preventable occupational deaths.^[18]

Educational and socioeconomic characteristics also demonstrated important trends. Middle-school educated individuals constituted the largest educational group (25.71%), while the upper-lower socioeconomic class accounted for the highest proportion of victims (28.56%). Similar patterns have been observed in developing countries in studies by Mekkodathil et al., Sharma et al., and Jagannatha et al., where individuals from lower socioeconomic backgrounds are more frequently employed in manual labor occupations associated with greater occupational hazards.^[19-21] Limited educational attainment may further influence awareness regarding workplace safety measures and risk perception.^[19] These findings suggest that socioeconomic disadvantage remains an important determinant of vulnerability to fatal falls from height.^[21]

The majority of victims in the present study were married (62.86%). Comparable observations have been reported by Prathapan et al., and Patil et al.^[22,23] This finding likely reflects the predominance of adults within the economically productive age group rather than a direct association between marital status and risk of falls.^[22] Nevertheless, fatalities among married individuals may have substantial social and financial consequences for dependent family members.^[23]

With respect to the circumstances of falls, residential buildings constituted the most common site of occurrence (54.29%), followed by construction sites (31.42%). Similar observations have been reported by Jagannatha et al., who found buildings to be the predominant location for fatal falls.^[21] The increasing prevalence of multistoried residential structures in urban environments may explain the large proportion of residential falls.^[24] Construction sites represented the second most common location, further emphasizing the occupational dimension of fall-related mortality.^[24] Together, residential buildings and construction sites accounted for over 85% of all incidents, highlighting the importance of environmental modifications and safety interventions in these settings.^[24]

Most falls occurred during daytime hours (77.14%), a finding comparable to previous studies that reported higher frequencies of daytime incidents. This observation is likely related to increased occupational activity, construction work, household tasks, and outdoor movement during daylight hours.^[25] The greater exposure to potentially hazardous environments during the day naturally increases the likelihood of fall events.^[25]

Analysis of fall height demonstrated that the largest proportion of fatalities occurred following falls from 30–39 feet (25.71%), while falls between 10 and 39 feet collectively accounted for over 70% of cases. Similar findings have been documented in studies from urban settings by Somasundaram et al., and Saritha et al., where moderate-height buildings and construction structures predominate.^[26,27] This

observation suggests that fatal outcomes are not limited to extreme heights and that falls from relatively moderate elevations can result in mortality.^[26] The risk of fatality is influenced not only by the height of fall but also by factors such as impact surface, body orientation, age, and pre-existing health conditions.^[27]

The medico-legal analysis revealed that accidental falls accounted for the vast majority of deaths (85.71%), whereas suicidal falls constituted only 14.29% of cases. No homicidal falls were identified. Similar predominance of accidental deaths has been reported by Jagannatha et al., and Uthayakumar et al., studies.^[21,28] The high proportion of accidental falls reflects the substantial contribution of occupational and environmental hazards in the studied population.^[28] The relatively lower proportion of suicidal falls may be attributable to regional sociocultural factors, variations in urban infrastructure, and differences in healthcare and mental health service utilization.^[28] The absence of homicidal falls is consistent with the rarity of such events reported in forensic literature.^[28]

Limitations: The present study was limited by its relatively small sample size and single-center prospective design, which may affect the generalizability of the findings. Information regarding occupational safety practices, use of protective equipment, alcohol consumption, and detailed psychosocial factors was not consistently available in all records. Additionally, the study relied on medico-legal and investigative documents, which may be subject to incomplete reporting in some cases.

CONCLUSION

Fatal falls from height predominantly affected young adult males in the economically productive age group, with construction workers representing the most vulnerable occupational category. Most victims belonged to lower socioeconomic strata, and the majority of incidents occurred during daytime hours from residential buildings and construction sites. Accidental falls accounted for the overwhelming proportion of deaths, highlighting the significant contribution of occupational and environmental hazards. The findings emphasize the need for improved workplace safety measures, strict enforcement of building and construction regulations, public awareness regarding fall prevention, and targeted interventions for high-risk populations to reduce fall-related mortality and its associated socioeconomic burden.

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