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Original Research Article

Medicolegal Aspects and Autopsy Study Of Cases Of Fall From Height

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Abstract:

Introduction: Falls from height, particularly in workplaces like construction, contribute significantly to work-related fatalities due to factors such as negligence, poor safety measures, and environmental conditions. Suicide-related falls, linked to psychiatric disorders, often involve greater heights and cause more severe injuries. Autopsies and forensic investigations help differentiate between accidental, suicidal, and homicidal falls, providing vital insights for legal, clinical, and public health responses.

Aim and Objectives: The study aims to analyze fatal falls, focusing on identifying injury patterns, understanding the relationship between fall circumstances and outcomes, and distinguishing between accidental, suicidal, and homicidal falls.

Method: A retrospective cross-sectional study was conducted using autopsy reports, police records, and prosecution notes for 30 individuals who died from falls between 2016 and 2018. Data collected included age, gender, injury location, cause of death, and type of fall (accidental, suicidal, or homicidal). The data were analyzed to identify injury patterns and their connection to different types of falls.

Results: The study of 30 participants shows that 53.3% are aged 20-40, with males (76.7%) outnumbering females (23.3%). Falls occurred mostly at home (80%), with head impacts (66.7%) being the most common. Polytrauma (73.3%) was the leading cause of death. Injuries primarily affected the head, extremities, and chest, while internal injuries were most severe in the brain (78.6%) and meninges (83.5%). Thoracic injuries were significant in 69% of cases.

Conclusion: The study has concluded that falls from height, particularly at home, frequently result in head injuries and polytrauma, with males being predominantly affected across all age groups.

Keywords: Fatal Falls, Injury Patterns, Polytrauma, Accidental Falls, Suicide Prevention.

Introduction

Unplanned falls from height are mainly witnessed in the workplace, especially in construction. Experiments show that such falls constitute a notable percentage of work-related deaths, with the contributing causes being negligence by workers, insufficient safety controls, and ill-managed workplaces [1-3]. For example, Hartono et al. points out that falls from height cause 45% of fatalities in construction, highlighting the contribution of unsafe behaviours and environmental conditions [1]. Furthermore, cost constraints and stress to deliver rapidly can also provoke dangerous habits from workers, yet another cause for accidents [2,3]. The height to which one has fallen is a significant predictor of the severity of the injury; the greater the height, the worse the injury [4,5].

Suicidal falls are frequently associated with psychiatric illnesses in the form of depression and addiction. Pavlovski et al. observe that those with mental disorders are more likely to indulge in suicidal activities, such as jumping from heights [6]. Research has indicated that suicidal falls happen from higher places than accidental falls, and these result in more serious injuries and higher death rates. This separation is critical to mental health clinicians and emergency medical personnel in identifying vulnerable persons and taking preventive measures [7].

First and foremost, the determination of the cause of death in fatalities due to falls from height is important both for legal and clinical reasons. Autopsy investigations like those carried out by Ramadan et al. stress that recognition of the pattern of injuries during the fall may show information on the circumstances surrounding death [8]. Forensic examination aids in distinguishing between accidental, suicidal, and homicidal falls, which is crucial for proper legal procedures and public health interventions. Jackson et al. also

demonstrates that falls from a height tend to have typical injuries that can assist forensic pathologists in identifying the type of fall. This distinction is especially critical in urban areas where occupational accidents, as well as suicidal jumps, are common [9].

Secondly, the pattern of injuries caused by falling from a height can enlighten medical experts on the severity and nature of injuries usually suffered. Vadysinghe et al. point out that the height of the fall, body weight, and surface nature greatly determine the nature of injuries [10]. Recognition of these patterns not only facilitates the initial medical treatment but also informs long-term care planning for survivors. Nugent et al. report that roof falls can result in serious long-term injuries, such as traumatic brain injuries (TBIs) and spinal cord injuries, which require extensive medical treatment. Such information is important for both emergency responders and rehabilitative services [11].

Third, medicolegal investigations can have far-reaching implications for workplace safety and public health policy. By recognising underlying causes and conditions for falls from height, as exemplified by Firdaus and Erwandi on construction work accidents, policymakers can implement specific interventions in efforts to curtail the occurrence of such falls [2]. In addition, knowledge of the epidemiology of such accidents, as explained by Kandeel and Azab, can inform the enforcement of safety regulations and training programs for the prevention of falls in high-risk settings [12].

One of the main ways autopsy evidence aids in discrimination is by identifying injury patterns related to various types of falls. For example, Kang et al. discovered that skull fractures were more strongly linked to low-level falls and thoracic and extremity fractures with high-level falls. This is important because the location and type of injury may point towards the height from which a subject fell, which can further suggest whether an accidental or deliberate fall occurred. In addition, Casali et al. found that falls off heights of 12 meters or higher were correlated with higher injuries to internal organs like the liver and diaphragm, and this again indicates that the severity of the injury corresponds to fall height [7,12].

Furthermore, biomechanics at the time of the fall can provide some indication of intent. For example, studies have found that suicidal falls are likely to have more severe and multiple injuries compared to accidental falls due to the purposeful action and height of the fall. Autopsy findings of a pattern of damage consistent with high-energy impact could be suggestive of a fall from height, which is usually associated with suicidal rather than accidental behaviour [6]. In addition to injury patterns, the circumstances of the fall, as shown through autopsy and forensic examination, may also differentiate among fall types. For instance, the presence of alcohol or drugs in the system may suggest a heightened risk for unanticipated falls since Pavlovski et al. noted that alcohol increases the likelihood of falls. Alternatively, the absence of such drugs and psychiatric examination may suggest suicidal behaviour [6,13].

Furthermore, the conditions under which the fall occurred can also be accounted for by autopsy reports. For example, evidence compatible with struggle or defensive wounds would suggest a homicidal fall, while the absence of such evidence would suggest an accidental or suicidal classification [13].

Method

Research Design: This is a retrospective cross-sectional study was conducted from 2016 to 2018 among 30 patients. In order to conduct this study, it was collected data regarding the patient's age, gender, past medical record, residence, the height of the fall, pattern of injuries, and cause of death. This study was received from files of fatal fall-from-height cases, which were the result of toxicological screening and histopathological analysis. We gathered information about the fall site, medical history, and death circumstances from prosecution notes and police records. In each case, age, gender, residence, medical history, and fall circumstances were recorded. The clothes were closely inspected for body fluid, stains, rips, and other impurities. The postmortem alterations were noticed after a comprehensive exterior inspection. All external injuries that were identified were recorded. Various patterns of damage were observed throughout all body regions. Blood and urine samples, liver tissue, kidney tissue, and gastrointestinal contents were screened for toxicology, and the results were reported. Tissue samples for histological analysis were obtained from fatal height falls that did not result in any obvious injuries, and the findings were reported.

Inclusion and Exclusion Criteria

Inclusion:

- This study included those participants who had fatal fall cases.

Exclusion:

- This study excluded those patients who had an evident cause of death other than a fall from a height, and it comprised putrefied cases.

Statistical Analysis: The statistical software SPSS 27 was used for all analyses. Qualitative data were shown as percentages and figures included in

parenthesis. The Chi-square goodness of fit test was used to confirm the hypothesis of equal distribution between categories, whereas Fisher's Exact test was employed to analyze connections between variables. A significance threshold of $p < 0.05$ was used to interpret the test results.

Ethical Consideration: This study was approved by the ethical committee of the hospital.

Result

Table 1 shows the age and gender distribution of the 30 participants in the study. The majority of patients (53.3%) are aged 20-40, with males (75.0%) outnumbering females (25.0%). The age range of 40 to 60 years comprises 20.0% of the total patient population, with males constituting 83.3% and females 16.7%. It is interesting to note that all patients over 60 are men (100.0%), accounting for 16.7% of the total. The youngest age group, 1 to 20 years, constitutes merely 10.0% of the sample, with a greater percentage of girls (66.7%) than men (33.3%). Males (76.7%) dominate all age groups, whereas females (23.3%) are significantly fewer, particularly in senior age categories.

Table 1: Baseline characters of patients

Age Group	Male (N, %)	Female (N, %)	Total (N, %)
1 - <20	1 (33.3%)	2 (66.7%)	3 (10.0%)
20 - <40	12 (75.0%)	4 (25.0%)	16 (53.3%)
40 - <60	5 (83.3%)	1 (16.7%)	6 (20.0%)
>60	5 (100.0%)	0 (0.0%)	5 (16.7%)
Total	23 (76.7%)	7 (23.3%)	30 (100%)

Table 2 discusses the conditions associated with falls and the ensuing autopsy results. The majority of falls occurred at home (80%), followed by workplaces (13.3%), while accidents on the road and in hospitals were infrequent (3.3% each). With a statistically significant correlation ($X2 = 15.5$, $p < .001$), the head was the place of first impact most often (66.7%), followed by the feet (16.7%) and side (16.7%). The majority of deaths were accidental (66.7%), while violent deaths were uncommon (3.3%). Suicidal and deliberate jumps each represented 10%, while ambiguous cases also constituted 10%. The primary cause of death (73.3%) was polytrauma, with a significant correlation ($X^2 = 45.67$, $p < .001$). These findings imply that casual falls at home cause head injuries and polytrauma most often.

Table 2: Fall scene and autopsy outcomes in examined cases

Feature	Category	N	%	Chi Square χ^2	P Value
Place of Fall	Home	24	80	65.12	<.001*
	At Workplace	4	13.3		
	Hospital	1	3.3		
	Road	1	3.3		
	Not Mentioned	0	0		
Site of First Impact	Head	20	66.7	15.5	<.001*
	Feet	5	16.7		
	Side	5	16.7		
Manner of Death	Accidental	20	66.7	41.23	<.001*
	Homicidal	1	3.3		
	Suicidal	3	10		
	Intended Jump	3	10		
	Obscure	3	10		
Cause of Death	Polytrauma	22	73.3	45.67	<.001*
	Head Only	5	16.7		
	Chest Only	2	6.7		
	Abdomen Only	1	3.3		

Table 3 shows the association between fall-related fatalities' mode, cause, and principal impact site. The head was the major impact site (70%), followed by the side (20%) and feet (10%) in accidental falls (66.7%). Suicidal instances (13.3%) had brain (50%), foot (25%), and side (25%) impacts. Homicidal and cryptic falls were infrequent (3.3% and 6.7%, respectively) and head-impacting. Intended jumps (10%) usually hit feet-first (66.7%) or heads-first (33.3%). The most common cause of mortality (73.3%) was polytrauma, with a significant correlation (X^2 = 10.72, p = 0.040). Polytrauma cases have 63.6% head impact, 18.2% side, and 18.2% foot impact. 20% had head-only injuries, mostly from head-first impact (83.3%). Few (3.3% each) chest and abdomen injuries affected only the head and feet, respectively. Head trauma is the most prevalent outcome in accidental and suicide falls, while planned jumps generally involve feet-first impact.

Table 3: The correlation between the cause, mode, and principal impact place of death

			Site of primary impact				Fisher's Exact test	
			Head	**Feet**	**Side**	**Total**	**χ^2**	**P-value**
Manner of Death	Accidenta	N	14	2	4	20	8.62	0.087
		%	70	10	20	100		
	Suicida	N	2	1	1	4		
		%	50	25	25	100		
	Homicidal	N	1	0	0	1		
		%	100	0	0	100		
	Intended Jump	N	1	2	0	3		
		%	33.3	66.7	0	100		
	Obscure	N	2	0	0	2		
		%	100	0	0	100		
	Total	N	20	5	5	30		
		%	66.7	16.7	16.7	100		
Cause of death	Polytrauma	N	14	4	4	22	10.72	0.040*
		%	63.6	18.2	18.2	73.3		
	head only	N	5	0	1	6		
		%	83.3	0	16.7	20		
	chest only	N	1	0	0	1		
		%	3.3	0	0	3.3		
	abdomen only	N	0	1	0	1		
		%	0	3.3	0	3.3		
	Total	N	20	5	5	3.3		
		%	100	100	100	100		

The prevalence of injuries in different body locations during external inspection is shown in Figure 1. Fall impacts on the head and face were the most common (90.5%), consistent with severe head trauma cases. Furthermore, lower extremity injuries (88.1%) indicated frequent ground impact, especially in feet-first falls. Upper extremity injuries (81%) are either secondary or fall-related. Chest injuries (71.4%) were similarly severe, perhaps from fall impact. Back injuries (35.7%) and abdominal and pelvic injuries (31%) were rare but significant, especially in side or back landings. Neck injuries (2.4%), the least common, imply this region is rarely hit in fall-related deaths. These findings show that fall-related deaths mostly involve the head, extremities, and chest, with injury patterns changing by impact.

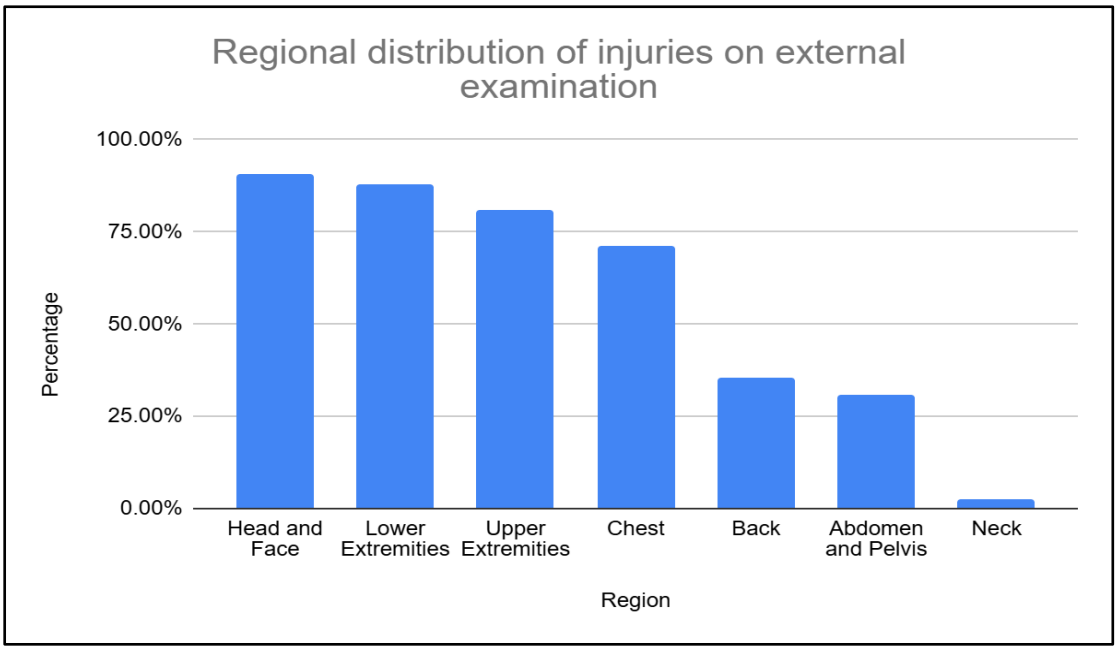

Figure 1: Regional distribution of injuries on external examination

Figure 2 shows the internal examination of head and neck injury distribution. The brain has the most lesions at 78.60%, followed by the meninges at 83.50%, showing a major influence on brain protection. At 40.50% and 66.70%, the base and vault of the skull have significant injury percentages, signifying major trauma. Cervical vertebrae injuries are rare, with only 2.40% of cases demonstrating damage, compared to the brain and skull.

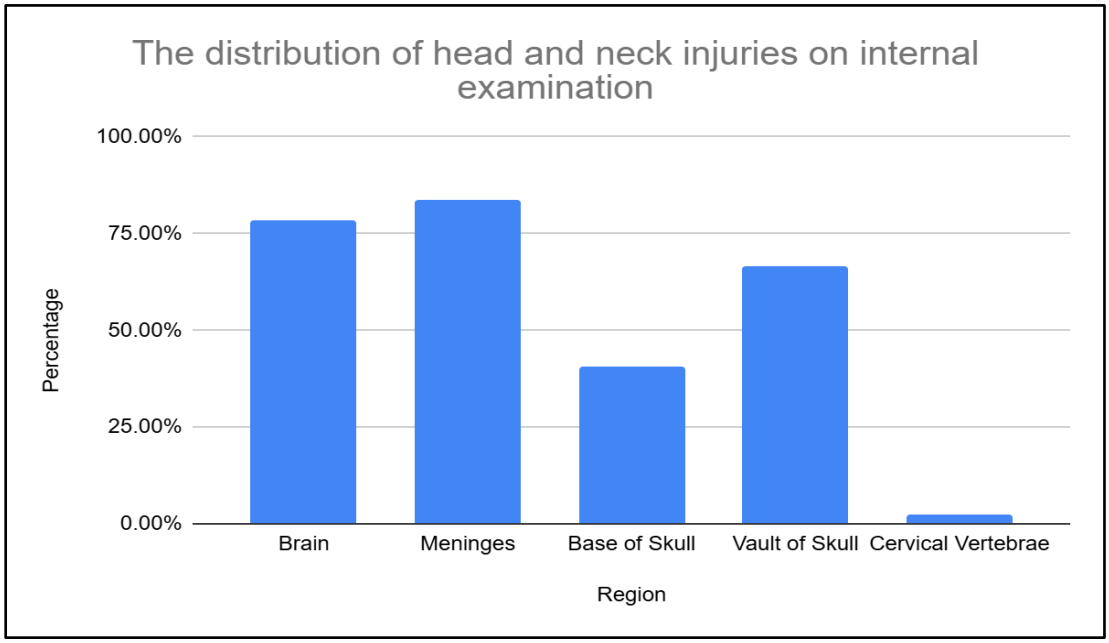

Figure 2: The distribution of head and neck injuries on internal examination

Figure 3 shows that autopsy results show external, thoracic, and abdominal injuries. Extremity injuries account for 26.20% of total injuries, indicating a high rate of external trauma. Thoracic cage and lungs are impacted in 69.00% of cases, showing significant chest injury. The heart and thoracic vertebrae have 4.80% and 2.40 percent injuries, respectively. In abdomen and pelvis injuries, the liver accounts for 19.00%, the kidneys for 7.10%, the spleen for 4.80%, and the bladder for 2.40%. The lumbar vertebrae and uterus have a 2.40% injury incidence, demonstrating lower damage rates than other abdominal organs.

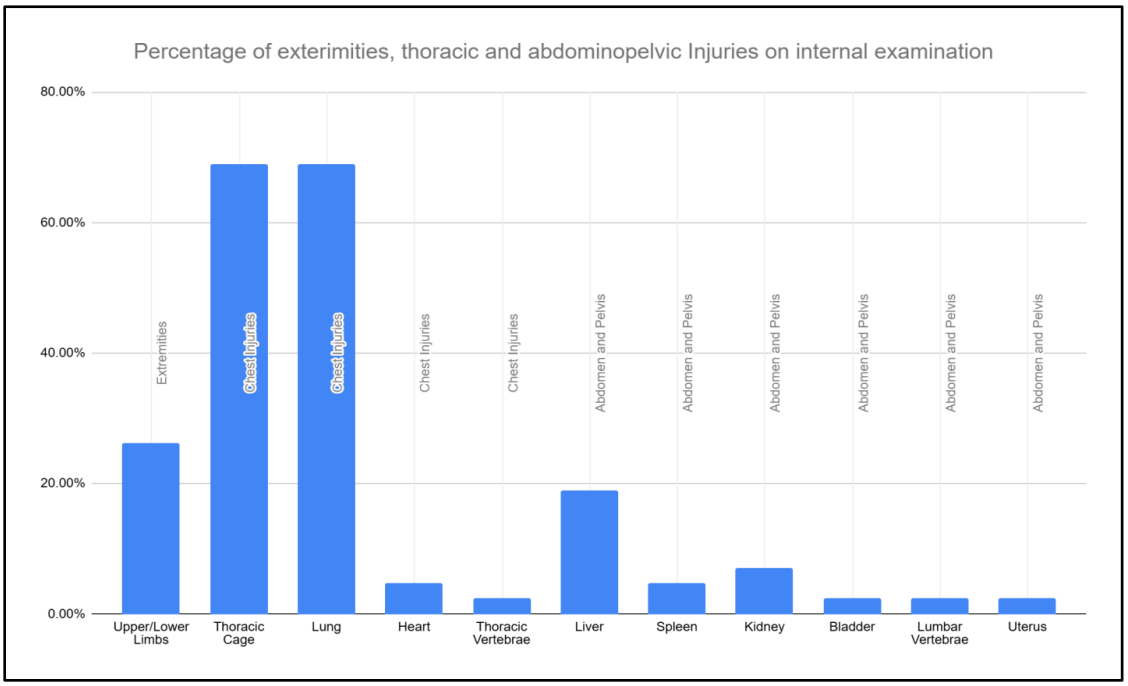

Figure 3: The percentage of external, thoracic, and abdominal injuries found at autopsy.

Discussion

Among the most significant forensic markers is the extent and manner of injuries sustained during the fall. Kang et al. have shown through their research that suicidal falls are more serious in injury than falls by accident, and higher fall heights are more likely to be associated with suicidal intent. This is supported by Pavlovski et al.'s findings, where they documented that suicidal falls are more generalised and complex in patterns of injury involving multiple body regions [6,7]. Spontaneous falls have localised, and less severe wounds based on the cause of the fall and the fall height [7,14].

A key indicator is whether contextual evidence is present on the scene of the fall. Gentile et al. highlight that forensic pathologists must pay attention to the circumstances of death, such as any potential evidence of combat, witnesses, or signs of intent, for instance, suicide notes [14]. The absence of such contextual clues would suggest a fall due to an accident, while their presence would suggest suicidal or homicidal intent. Additionally, the investigation of the scene may show other significant evidence, such as the body position and setting, and may provide information regarding the nature of the fall [15].

Additionally, toxicology report analysis may also serve as a forensic indicator. The detection of alcohol or drugs in the body may signify a higher likelihood of accidental falls, as indicated by Pavlovski et al. [6]. Conversely, a lack of intoxicants combined with evidence of mental illness could be suggestive of suicidal intention. Lack of defensive wounds or struggle in cases of suspected homicide is also indicative, as argued by Mittal et al., who asserted that homicides might masquerade as suicides or accidents sometimes [16].

Lastly, autopsy findings related to the mechanism of injury might provide valuable information. For example, some types of injury, such as those resulting from blunt force trauma or strangulation, may point towards homicide if they are not compatible with the mode of a fall [12]. Byard and Maxwell-Stewart emphasise that the character of injuries should be analysed thoroughly to rule out the possibility of disguised homicide and accidental or suicidal death [17].

One of the most important ways in which injury distribution can be used to estimate body position is by the recognition of some injury patterns specific to specific fall situations. Head, neck, and upper torso injuries, for instance, might indicate that the individual was upright or standing at the time of the fall. Kort et al. point out that the fall height, impact surface, and landing position determine the pattern and severity of the injuries and can be employed to reconstruct the dynamics of the fall Kort et al. [18]. Fractures, contusions, and abrasions can provide forensic experts with a clue to the orientation of the body upon impact.

Also, the position and nature of injuries can indicate the angle of the fall. For instance, if most of the injuries are on one side of the body, it could mean that the person fell at an angle or spun during the fall. Dineva et al. note that the mechanism of their causation can group damage, and there are typical patterns in relation to falls as opposed to

other forms of trauma. This is very important in determining the nature of how the body met the ground and the forces that caused the fall [16].

Also, the study of the severity of the injury can provide information about the position of the body upon impact. As Kandeel and Azab noted, the distribution of the injuries sustained may vary quite significantly based on the height of the fall as well as the point of landing, which can be indicative of the victim's posture during the fall. For instance, a great height fall that resulted in severe polytrauma could suggest the victim was standing. In contrast, those injuries more consistent with a lower fall height could suggest the individual was more horizontally oriented [12].

Forensic experts can also use advanced imaging techniques, such as three-dimensional photogrammetry, to document and analyse patterns of injury. The technology allows for a more accurate examination of injury distribution and can be employed to reconstruct the dynamics of the fall. By comparing the documented injuries with known patterns from previous cases, forensic experts can make educated estimates about the orientation and position of the body at the time of the fall [19].

Conclusion

The study has concluded that falls from height, particularly at home, frequently result in head injuries and polytrauma, with males being predominantly affected across all age groups. The severity of injuries, especially to the head, extremities, and chest, is a critical factor in determining outcomes, with polytrauma being the leading cause of death. Internal injuries, particularly to the brain and skull, are most prevalent, underscoring the significant impact of fall-related accidents on health and the need for targeted prevention measures.

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