WEB OF SCIENTIST: INTERNATIONAL SCIENTIFIC RESEARCH JOURNAL
ISSN: 2776-0979, Volume 5, Issue 01, January, 2024

# FORENSIC MEDICAL ASPECTS OF CASES OF FALLING FROM A HEIGHT AND FROM THE HEIGHT OF OWN GROWTH

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**Annotation:**
Based on the results of the analysis of 519 victims of falls from a height, of which 132 cases (25.4%) fell from a height of up to 3 meters and 387 cases (74.6%) fell from their own height, differential diagnostic criteria were established damage criteria. Falls from a height of one's own height in most cases are observed in people over 45 years of age, while falls from a height of up to 3 meters are observed in people under 45 years of age. When falling from a height of one's own height, among victims with a fatal outcome, death occurred in most cases on days 6-10 (25.0%), when falling from a height of up to 3 meters in the first 3 days (33.3%). In fatal falls from a height of up to 3 meters, combined injuries, closed craniocerebral injuries, open craniocerebral injuries, brain contusions, hemorrhages in the ventricles and under the membranes of the brain, internal injuries, such as blunt trauma to the abdomen, thoracic cells, ruptures and bruises of internal organs. When falling from one's own height, head injuries occur, but not in combination with injuries to internal organs.

**Keywords:** fall from height, falls from own height, forensic medical criteria

## Introduction

There is very little data in the forensic medical literature on the study of injuries caused by falling from one's own height. In this connection, the examination involves the decision to differentiate different types of falls (from a height, one's own height) based on differences in damage. This includes, first of all, the development of differential diagnostic criteria for falling from a height and one's own height [6, 9].
According to statistics, falling from a height ranks second in fatal injuries after car injuries (up to 40% of all fatal injuries). The difficulty of diagnosing these injuries is that a fall from a height is characterized by a variety of fall options, and, consequently, numerous and polymorphic injuries [2, 7, 8].
The discovery of corpses with signs of Traumatic Brain Injury (TBI) and external injuries may be due to a fall from any height, straight or stepped, free or not free.

Forensic medical examination of these corpses is considered the most difficult due to the need to establish the causes of damage. In these cases, falls on a plane from one's own height are possible. The morphology of TBI [4] and its biomechanics have not been fully studied [3, 10]. A unified classification of falls has not been developed showing the type, nature and height of the fall [5], which from the standpoint of mechanogenesis, without a clear differentiation of injury, complicates its forensic assessment [1, 1a].

**Target of the study:**

Based on the results, to substantiate the differential diagnostic criteria for injuries that occur when falling from a height and the height of one's own height.

**Materials and methods of research**

The study is based on a comparative analysis of 61 forensic medical examinations of the Main Bureau of Forensic Medical Examination of the Ministry of Health of the Republic of Uzbekistan and 458 case histories from the Republican Specialized Scientific and Practical Medical Center Traumatology and Orthopedics and the Republican Center for Neurosurgery of the Ministry of Health of the Republic of Uzbekistan in the period from 2016 to 2018. Among the 519 victims there were men (305) and women (214) aged from 18 to 90 years.

Depending on the goal, 519 victims were divided into 2 groups: falls from a height of up to 3 meters - 132 cases (25.4%) and falls from their own height - 387 cases (74.6%). Among 458 living individuals, medical histories were studied to determine the duration of hospitalization, the presence of surgical intervention, and the extent of damage. Damage was assessed using the generally accepted description method during a forensic medical examination. The study took into account the fact of alcohol intoxication.

**Research Results and Discussion**

Most often (43.9%), surviving victims were injured by a fall on a single-level surface covered with snow or ice, and a fall on a single-level surface as a result of a slip, misstep, or trip was the cause of injury in 17.5% of victims. (Table 1).

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ISSN: 2776-0979, Volume 5, Issue 01, January, 2024

Table 1. **Distribution of living victims by fall circumstances (n=458)**

| ICD-10 | Circumstances of the fall | Total | |
|---|---|---|---|
| | | abs. | % |
| W00 | Falling on a level surface covered with snow or ice | 201 | 43.9 |
| W01 | Falling on a level surface due to a slip, misstep, or tripping | 80 | 17.5 |
| W03 | Other falls on the same level surface due to a collision with another person | 54 | 11.8 |
| W09 | Fall from equipment on the sports field | eleven | 2.4 |
| W 10 | Falls on stairs and steps or from stairs and steps | 8 | 1.7 |
| W 11 | Falling on or from a ladder | 22 | 4.8 |
| W 12 | Falling on or from scaffolding | 28 | 6.1 |
| W 13 | Falling from (from or through) a building or structure | 54 | 11.8 |
| W 14 | Falling from a tree | 17 | 3.7 |

Falls on a level surface resulting from a collision with another person were 11.8%. Falls from a building or structure were also observed in 11.8% of survivors. Falls from ladders and scaffolding were recorded in 4.8% and 6.1% of cases. Sports injury, e.g. falls from sports equipment were reported at 2.4%.

Among those with a fatal outcome, the most frequently recorded fall was from a height of one's own height as a result of a collision with another person - 36.1%, on a surface of the same level as a result of a slip, false step or tripping - 34.4%.

Less common were falls from a height of up to 3 meters from a building or structure – 8.2%. Falls on stairs and steps or from stairs and steps were 3.3% (Table 2).

Table 2. **Distribution of corpses of victims according to the circumstances of the fall (n = 61)**

| ICD-10 | Circumstances of the fall | Total | |
|---|---|---|---|
| | | abs. | % |
| W00 | Falling on a level surface covered with snow or ice | 9 | 14.8 |
| W01 | Falling on a level surface due to a slip, misstep, or tripping | 21 | 34.4 |
| W03 | Other falls on the same level surface due to a collision with another person | 22 | 36.1 |
| W09 | Fall from equipment on the sports field | 0 | 0 |
| W 10 | Falling on stairs or from stairs and steps | 2 | 3.3 |
| W 11 | Falling on or from a ladder | 0 | 0 |
| W 12 | Falling on or from scaffolding | 2 | 3.3 |
| W 13 | Falling from (from or through) a building or structure | 5 | 8.2 |
| W 14 | Falling from a tree | 0 | 0 |

The age gradation when falling from a height and one's own height had its own fundamental features (Fig. 1).

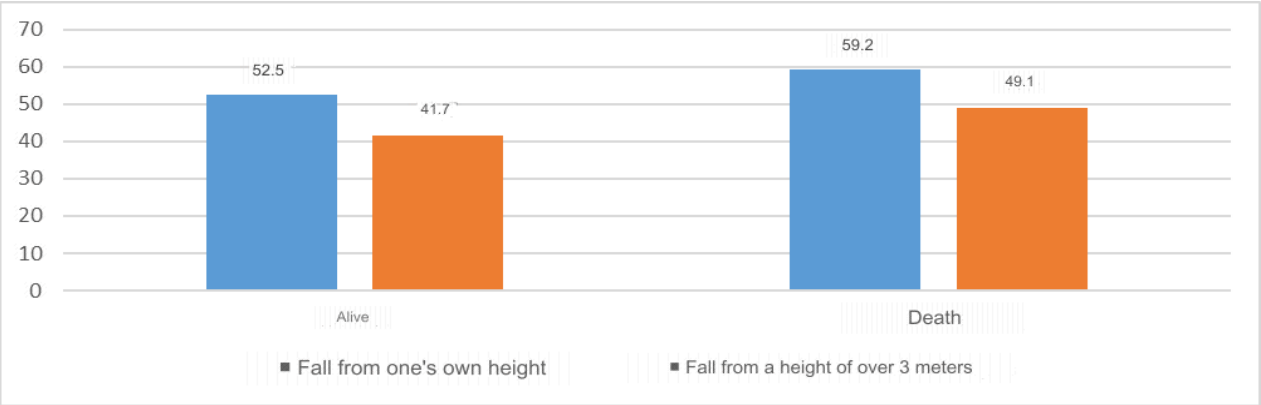


**Fig. 1. Indicators of average age in the studied groups of victims (years)**

As can be seen from the diagram, when falling from a height of one's own height, the average age was higher than among people who fell from a height of up to 3 meters (55.9±1.8 years versus 45.4±±3.3 years) by almost 10 years. When falling from one's own height, the average age of living persons is 52.5±1.0 years, while among the dead it was higher and amounted to 59.2±2.1 years ($p<0.05$), with a fall of up to 3 meters, the average age of the dead (49.1±3.4 years) was significantly lower in relation to the living persons (41.7±1.5 years; $p<0.05$).

When falling from a height or height of one's own height, the male gender (305 persons; $P<0.05$) was significantly more likely to prevail in relation to the female gender (214 persons), their ratio was 1.4:1.

In 6.0% of cases, ethyl alcohol was found in the blood of victims, and it was 10.5 times more likely to be observed among victims with a fatal outcome (29.5% versus 2.8%; $p<0.001$), which was significant. When falling from a height of one's own height, the presence of alcohol was found in 6.5%, while in a fall of up to 3 meters in 9.8%, which is 1.5 times more (Fig. 2).

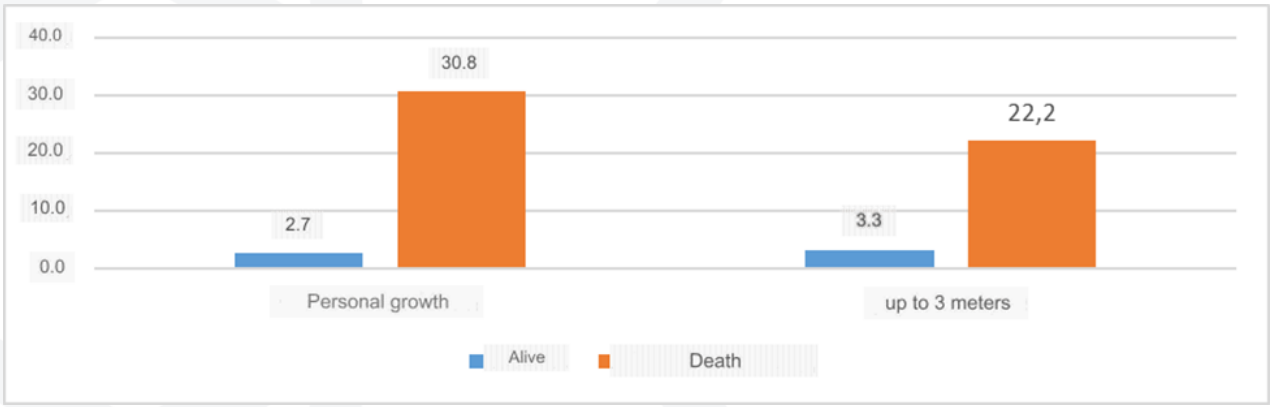


**Fig. 2. Percentage of alcohol intoxication when falling from one's own height and up to 3 meters (%)**

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ISSN: 2776-0979, Volume 5, Issue 01, January, 2024

When falling from a height of one's own height, among victims with a fatal outcome, death occurred in most cases on days 6-10 (25.0%), when falling from a height of up to 3 meters in the first 3 days (33.3%) (Fig.3).

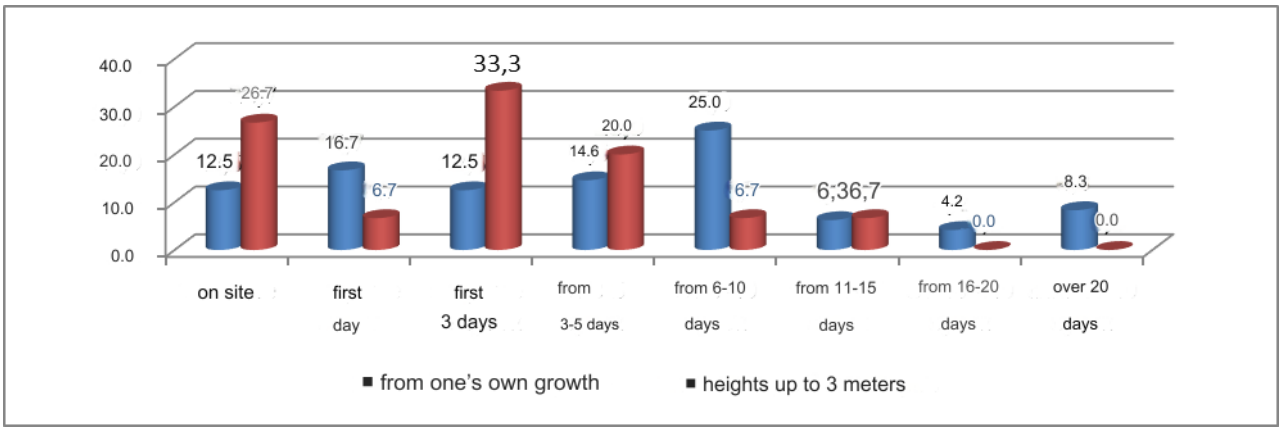


**Fig. 3. Distribution of fatalities depending on the timing of death**

The length of hospital stays among living victims of a fall from a height and their own height also had their own patterns, which are presented in Figure 4.

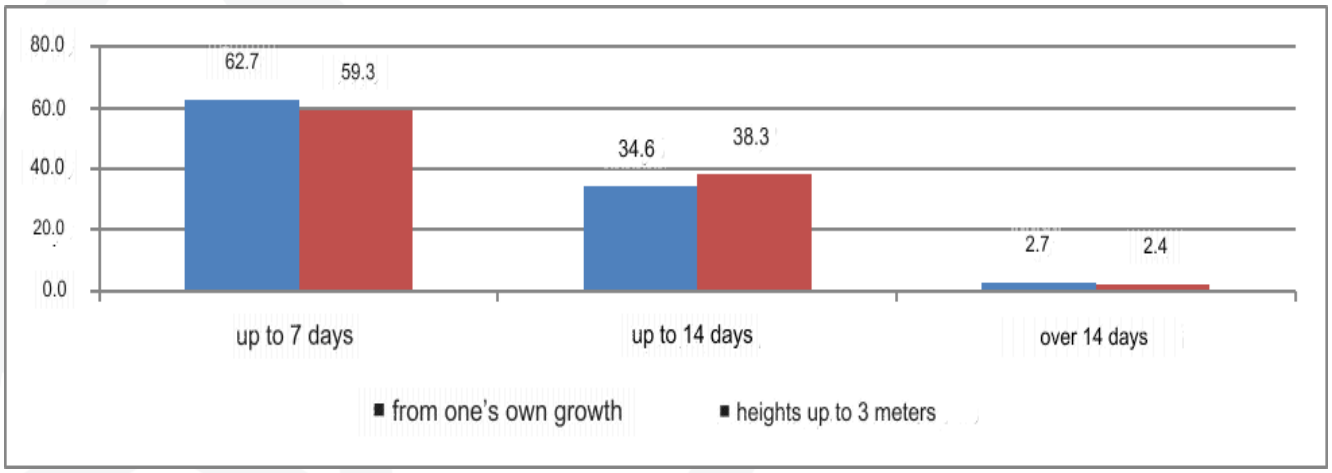


**Fig. 4. Distribution of surviving victims depending on the duration of treatment (%)**

As can be seen from the diagram, 62.7% of surviving victims of a fall from their own height spent up to 7 bed days in the hospital, up to 14 days - 34.6% and 2.7% over 14 days, while in case of a fall from a height up to 3 meters, 59.3% received hospital treatment for up to 7 bed days, up to 14 days – 38.3%, and over 14 days – 2.4%, respectively.

When falling from a height of one's own height and from a height of up to 3 meters, the nature of the injuries changed: the number of isolated injuries decreased with an increase in multiple and combined injuries (Fig. 5).

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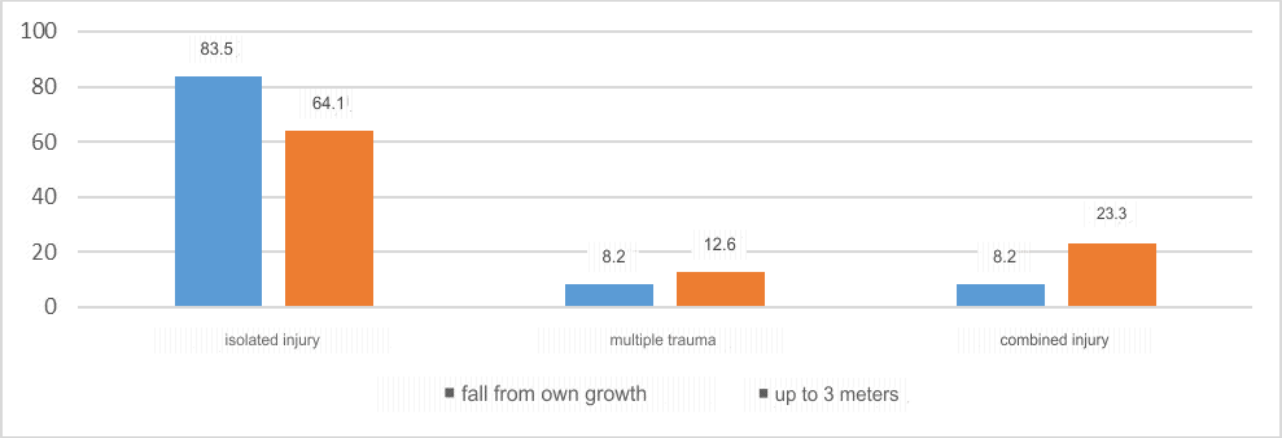


**Fig. 5. Dependence of the frequency and nature of injury on the height of the fall**

If among those who fell from their own height, 83.5% of victims had isolated injuries, then from a height of up to 3 m - already 64.1%, with a proportional increase in multiple and combined injuries.

Among survivors who fell from their own height, 90.7% had isolated injury, 9.3% had multiple injury, while among those with a fatal outcome, this percentage increased to 65.9%, while isolated injury decreased to 34. 1%.

The majority (66.0%) of victims landed on a hard surface (asphalt, concrete or wood). 31.1% fell on a semi-hard surface (compacted earth, snow) and 2.9% fell on a soft surface (loose soil, snow, water). Landing on a soft surface resulted in a decrease in the severity of injury and the condition of falling from a height.

An analysis of head injuries among living individuals depending on fall height is presented in Table 3.

**Table 3. Percentage of head injuries among living persons depending on fall height**

| Damage | Fall from own height ( n =335) | | Fall up to 3 meters ( n =123) | |
|---|---|---|---|---|
| | Abs. | % | Abs. | % |
| Brain contusion | 16 | 4.8 | 16 | 13.0* |
| Fractures of the skull bones | 12 | 3.6 | 15 | 12.2** |
| Brain concussion | 42 | 12.5 | 6 | 4.9** |
| Head wound(s) | 10 | 3.0 | 7 | 5.7 |
| Bruising(s) of the head | 26 | 7.8 | 15 | 12.2 |
| Head abrasion(s) | 5 | 1.5 | 0 | 0.0 |
| Epidural hematomas | 6 | 1.8 | 7 | 5.7* |
| subdural hematomas | 8 | 2.4 | 7 | 5.7* |
| TBI | 5 | 1.5 | 9 | 7.3** |
| CTBI | 37 | 11.0 | 12 | 9.8 |

Note: * - reliability of data between groups (* - P<0.05; ** - P<0.01)

As can be seen from the presented data, among living persons who fell from their own height, head injuries are observed on average 2.5 times less often in relation to indicators for falls from a height of up to 3 meters. The most severe injuries in the form of head injury and skull fractures were significantly more often observed in falls from a height of up to 3 meters (7.3% versus 1.5% (p <0.01) and 12.2% versus 3.6% (p<0.01)). Concussion was most often observed in individuals who fell from their own height (12.5% versus 4.9%; p<0.05). Head abrasions were noted only when falling from one's own height. Cerebral hemorrhages in the form of epidural and subdural hematomas were most often recorded in falls from a height of up to 3 meters and were significant (p <0.05). CTBIs prevailed in the group of living individuals when falling from their own height, but were not significant.

The analysis of head injuries in persons with fatal outcomes also had a multidirectional nature depending on the height of the fall; the data obtained are presented in Table 4.

**Table 4. Percentage of head injuries among fatalities depending on fall height**

| Damage | Fall from own height ( n =52) | | Fall up to 3 meters ( n =9) | |
|---|---|---|---|---|
| | Abs. | % | Abs. | % |
| Brain contusion | 32 | 61.5 | 4 | 44.4 |
| Fractures of the skull bones | 19 | 36.5 | 3 | 33.3 |
| Brain concussion | 33 | 63.5 | 4 | 44.4 |
| Head wound(s) | 1 | 1.9 | 0 | 0.0 |
| Bruising(s) of the head | 6 | 11.5 | 5 | 55.6** |
| Head abrasion(s) | 1 | 1.9 | 1 | 11.1** |
| Epidural hematomas | 39 | 75.0 | 2 | 22.2** |
| Subdural hematomas | 8 | 15.4 | 1 | 11.1 |
| TBI | 7 | 13.5 | 2 | 22.2 |
| CTBI | 41 | 78.8 | 5 | 55.6 |

Note: * - reliability of data between groups (* - P<0.05; ** - P<0.01)

As can be seen from the presented data, when falling from a height of one's own height and up to 3 meters, in persons with a fatal outcome, the severity of head injuries was significantly more common than in living persons. Depending on the height of the fall, more severe head injuries are observed. Thus, TBI was recorded 1.6 times more often in falls from a height of up to 3 meters, while TBI prevailed in persons falling from their own height.

The presence of subdural and epidural hematomas was significantly more often recorded in cases of falls from a height of up to 3 meters (P<0.05)

We also found that there was a significant prevalence of chest contusions (Table 5) when falling from a height of up to 3 meters (19.5% versus 9.6%; p<0.05) among living persons, and also significantly less often when one's own height falls, fractures of the thoracic and lumbar vertebrae are observed (P<0.05).

**Table 5. Percentage of injuries to the chest, spine, upper and lower extremities among living persons, depending on the height of the fall**

| Damage | Fall from own height ( n =335) | | Fall up to 3 meters ( n =123) | |
|---|---|---|---|---|
| | Abs. | % | Abs. | % |
| Rib fractures | 5 | 1.5 | 2 | 1.6 |
| Chest contusion | 32 | 9.6 | 24 | 19.5* |
| Clavicle fractures | 20 | 6.0 | 12 | 9.8 |
| Fractures of the thoracic vertebrae | 5 | 1.5 | 6 | 4.9* |
| Fracture of lumbar vertebrae | 5 | 1.5 | 5 | 4.1* |
| Damage to the upper extremities (bruises, abrasions, wounds) | 158 | 47.2 | 56 | 45.5 |
| Upper limb fractures | 155 | 46.2 | 58 | 47.2 |
| Injuries to the lower extremities (bruises, abrasions, wounds) | 147 | 43.9 | 48 | 39.0 |
| Fractures of the lower extremities | 163 | 48.7 | 65 | 55.8 |

Note: * - reliability of data between groups (* - P<0.05; ** - P<0.01)

Damage to the upper and lower extremities was observed in 98.2% and 69.8% of living persons when falling from their own height, respectively. In living persons, when falling up to 3 meters, damage to the upper and lower extremities was observed in 97.7% and 72.4%, respectively. Fractures of both upper and lower extremities were most common in falls from a height of up to 3 meters.

Injuries to the upper and lower extremities in the form of bruises, abrasions and wounds were most often observed in persons who fell from their own height, but the data obtained were not reliable.

In persons with a fatal outcome, injuries to the chest in the form of rib fractures were observed more often in relation to indicators for falls from a height of up to 3 meters; the data were not statistically significant (Table 6).

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ISSN: 2776-0979, Volume 5, Issue 01, January, 2024

**Table 6 Percentage of injuries to the chest, upper and lower extremities among fatalities, depending on the height of the fall**

| Damage | Fall from own height (n =52) | | Fall up to 3 meters (n =9) | |
|---|---|---|---|---|
| | Abs. | % | Abs. | % |
| Rib fractures | 8 | 15.4 | 2 | 22.2 |
| Chest contusion | 5 | 9.6 | 1 | 11.1 |
| Clavicle fractures | 1 | 1.9 | 1 | 11.1** |
| Fractures of the thoracic vertebrae | 1 | 1.9 | 1 | 11.1** |
| Fracture of lumbar vertebrae | 1 | 1.9 | 1 | 11.1** |
| Damage to the upper extremities (bruises, abrasions, wounds) | 10 | 19.2 | 2 | 44.4* |
| Upper limb fractures | 3 | 5.8 | 1 | 11.1* |
| Injuries to the lower extremities (bruises, abrasions, wounds) | 3 | 5.8 | 3 | 33.3* |
| Fractures of the lower extremities | 1 | 1.9 | 2 | 44.4* |

Note: * - reliability of data between groups (* - P<0.05; ** - P<0.01)

Clavicle fractures were 5.8 times more likely to be observed in falls from a height of up to 3 meters, as were fractures of the thoracic and lumbar vertebrae (P<0.01).
Injuries and fractures of the upper and lower extremities in people with a fatal outcome were significantly more often observed when falling from a height of up to 3 meters (44.4% and 33.3%, respectively) in relation to indicators when falling in one's own height (25% and 7. 7% respectively).
Damage to internal organs when falling from a height of up to 3 meters was observed in 44.4% of victims, while when falling from their own height, these injuries were not noted.

## CONCLUSIONS

1. Falls from one's own height in most cases are observed in people over 45 years of age, while falls from a height of up to 3 meters are observed in persons under 45 years of age (P < 0.05).
2. When falling from a height of one's own height, the presence of alcohol in the blood was found in 6.5%, while when falling to 3 meters in 9.8%, which is 1.5 times more, moreover, in cases with a fatal outcome, this percentage increased by 10.5 times.
3. In fatal falls from a height of up to 3 meters, combined injuries, head injury, brain contusions, and cerebral hemorrhages are often encountered; internal injuries are manifested by blunt trauma to the abdomen and chest, spine, ruptures and bruises of internal organs.

4. When falling from one's own height, death as a result of a brain contusion occurs in 61.5% of cases.
5. When falling from one's own height, no damage to internal organs was observed.
6. When falling from a height of one's own height, among the victims with a fatal outcome, death occurred in most cases on days 6-10, when falling from a height of up to 3 meters in the first 3 days.

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