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## **Injuries sustained in falling fatalities in relation to different distances of falls**

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## Injuries sustained in falling fatalities in relation to different distances of falls

### ABSTRACT

**Background:** Falling from a distance is an important issue worldwide, which happens in different ages, genders and circumstances. It is usually not considered a medicolegal case in many countries hence no autopsy is performed. This study focused on analyzing injuries sustained in victims of falling in relation to different distances of fall.

**Methods:** Retrospective study of 352 autopsy reports of falling victims brought to the forensic pathology department at Jordan University Hospital during the period from January 1990 to March 2016.

**Results:** Among 352 cases, 256 (72.7%) were males and 96 (27.3%) were females. 303 (86.1%) cases showed accidental fall, 31 (8.8%) were suicidal, 2 (0.6%) were homicidal and un-clarified death in 16 (4.5%). Time of death was directly proportionate with the distance of fall. Victims fell from distances less than 3 meters were 123 (35%), most of them were children less than 7 years 50 (40.5%) and unemployed adults more than 45 years were 48 (39.1%). They showed multiple abrasions (62.6%), few contusions (64.2%) and absent laceration of the skin (84.5%). Victims fell from distances of 3-9 meters were 123 (35%), most of them were male workers 56 (60.2%). They showed multiple abrasions (63.5%), few contusions (71%) and few lacerations of skin (50.5%). Victims fell from distances more than 9 meters were 136 (38.6%), most of them were male workers 71 (52.2%) and female servants 23 (17%). They showed few abrasions (80.9%), multiple contusions (64.7%) and few lacerations of skin (48.5%). The number of fractured limbs increases obviously with distances more than 3 meter.

Skull vault fractures were found in all distances, while skull base fractures showed in distances of 3-9 meters and more than 9 meters. Head injury was the most common fatal injury in all distances. Chest injuries were prominent mainly in distances more than 3 meters. While abdominal injuries were mainly prominent in distances more than 9 meters.

**Conclusions:** This study showed the effect of different distances of fall in causing different types of injuries in falling fatalities. Internal injuries were in a direct proportion with distances of fall, while external injuries showed a great importance in interpretation of the way of fall.

**Key word:** Fatalities; injuries; distances; fall; Forensic pathology.

## 1. Introduction

Falling from a distance is an important issue worldwide<sup>1,2,3,4,5</sup>, which happens in different ages, genders and circumstances<sup>1-19</sup>. It is not usually considered a medicolegal case in different countries hence no autopsy is conducted<sup>2,5,6</sup>.

Most published scientific researches about falling fatalities, used database of emergency departments<sup>2,4,7,9-12</sup>, health organizations<sup>4,5,15,18</sup>, police offices and corners<sup>4,8</sup>, while few researches, used the autopsy information as a material<sup>8</sup>. These researches focused mainly on factors like statistics<sup>5,6,8,9,11,13,15,18</sup>, the most common types of injuries<sup>2-4,6,10,13,17</sup>, the cause of death<sup>2,6,10</sup>, and the lack of needed precautions and insufficient safety measures; in workplaces and homes<sup>2,5,6,10,14</sup>.

In this study, the injuries of whole body parts such as the skin, the head, the neck, the chest, the abdomen and limbs were studied in relation to different distances of fall with some sort of detailing.

In Jordan, deaths from falling are dealt with as medicolegal cases, so the prosecutor, police officer, forensic laboratorist and the forensic pathologist should be informed, and autopsy must be conducted. The forensic pathologist visits the crime scene, and a preliminary examination of the body is done, some relevant information such as the distance of fall, the presenting gross injuries, and the place of fall are recorded. At the mortuary, the forensic pathologist specify the distribution of injuries, performing the autopsy, determine the cause of death whenever possible, and finally write the medicolegal report. This gave much details for better understanding of injuries of sustained in falling fatalities. This study focused on analyzing different types of injuries found in victims of falling in relation to different distances of fall.

## **2. Materials and Methods**

Retrospectively, 6922 medicolegal autopsies were performed at the forensic pathology department at Jordan University Hospital during the period from January 1990 to March 2016, 352 cases (5.08%) of them related to falling from a height.

Medicolegal reports were reviewed, and data including the age, the gender, the occupation of victims and the manner of fall were recorded. On the other hand, another data such as the distance and the place of fall were recorded at the crime scene by the forensic pathologist, or taken from judicial authorities, or the victim's relatives. It worth noting that, information about the distance and the place of fall regarding victims who arrived alive to the emergency room, were taken from the same victim before they passed away or from their families and the police officer in charge. The distances of fall range from one and half meters to 15 meters, but the majority were less than 12 meters.

These data have been analyzed and arranged in tables regarding the distance of fall as following: distribution of cases according to the age and gender, the manner of death, external skin injuries, internal soft tissue injuries, fractures, and the cause of death, the time of death, in relation to different distances of fall.

### 3. Results

In general, the number of victims who died from falling from a distance during the period from January 1990 to March 2016 were 352 cases. Victims fell from distances less than 3 meters were 123 (35%), who fell from a distances of 3-9 meters were 93 (26.4%) and from distances more than 9 meters were 136 (38.6%). Also, among victims, 256 (72.7%) were males and 96 (27.3%) were females.

#### 3.1 Personal data

**Table 1** shows the distribution of cases regarding the age and the gender in relation to distances of fall as following: in less than 3 meters, most cases (40.5%) were less than 7 years, of whom (25.9%) were males and (14.6%) were females. With adults of more than 45 years who were (39.1%). From distances of 3-9 meters, most cases were adults 19-45 years (78.5%), mostly. Among distances of more than 9 meters, most victims were male workers (74.2%), in addition to the presence of female servants (25.8%).

**Table 1.** Distribution of cases according to distances of fall and Personal data (age and gender):

Age in years		Distances											
		Less than 3 meters				From 3-9 meters				More than 9 meters			
		M		F		M		F		M		F	
		N.	%	N.	%	N.	%	N.	%	N.	%	N.	%
< 7 y	< 1 y	3	2.4	2	1.6	0	0	0	0	0	0	0	0
	1-2 y	12	9.7	7	5.7	0	0	0	0	0	0	0	0
	3-6 y	17	13.8	9	7.3	3	3.2	1	1.1	2	1.5	1	0.7
7-18 y		9	7.3	3	2.4	2	3.2	0	0	4	9.7	1	0.7
19-45 y		7	5.7	6	4.9	59	63.4	14	15.1	77	56.6	32	23.5
> 45 y		31	30.3	17	13.8	11	11.8	2	2.1	11	8.1	1	0.7
<b>Total</b>		<b>79</b>	<b>64.2</b>	<b>44</b>	<b>35.8</b>	<b>76</b>	<b>81.7</b>	<b>17</b>	<b>18.3</b>	<b>101</b>	<b>74.2</b>	<b>35</b>	<b>25.8</b>
		<b>123 (100%)</b>				<b>93 (100%)</b>				<b>136 (100%)</b>			

<: less than. Y: years. N.: number of victims. %: percentage. M: male. F: female.

### 3.2 The manner of death

**Table 2** correlates the distribution of cases according to the manner of death as following: in less than 3 meters, all victims died accidentally (100%). In distances of 3-9 meters, most of victims died accidentally (86.1%). From distances more than 9 meters, most of victims died accidental (75.7%), with a noticeable percentage of suicidal death (20.6%).

**Table 2.** Distribution of cases according to data regarding the manner of death:

		Distances					
		Less than 3 meters		From 3-9 meters		More than 9 meters	
		N.	%	N.	%	N.	%
<b>Manner of death</b>	Accidental	120	97.6	80	86.1	103	75.7
	Suicidal	0	0	3	3.2	28	20.6
	Homicidal	0	0	1	1.1	1	0.8
	Un-clarified	3	2.4	9	9.7	4	2.9
<b>Total</b>		<b>123 (100%)</b>		<b>93 (100%)</b>		<b>136 (100%)</b>	

N.: number of victims. %: percentage.

### 3.3 Skin injuries

**Table 3** shows the distribution of cases regarding external skin injuries in relation to different distances of fall as following: Abrasions were always present in all victims at all distances. Few abrasions were less in distances less than 3 meters (37.4%) and distances of 3-9 meters (36.5%), but showed dramatic increase in distances more than 9 meters (80.9%). Multiple abrasions were nearly equal at distances less than 3 meters (62.6%) and distances of 3-9 meters (63.5%), but showed obvious decrease at distances more than 9 meters (19.1%).

Contusions were always present in all victims in distances 3-9 meters and distances more than 9 meters, but became absent in distances less than 3 meters (28.5%). Few contusions increased with distances less than 3 meters (64.2%) and with distances of 3-9 meters (71%), but showed an obvious decrease in distances more than 9 meters (35.3%). While multiple contusions were directly proportionate with the distance of fall.



Lacerations were mostly absent in distances less than 3 meters (84.5%). Few lacerations increased with distances of more than 3 meters. Multiple lacerations were noticed mostly in distances of 3-9 meters (14%) and distances more than 9 meters (20.6%).

**Table 3.** Distribution of cases according to distances of fall and external skin injuries:

		Distances								
		Less than 3 meters			From 3-9 meters			More than 9 meters		
		A	B	C	A	B	C	A	B	C
<b>Abrasion</b>	<b>N.</b>	0	46	77	0	34	59	0	110	26
	<b>%</b>	0	37.4	62.6	0	36.5	63.5	0	80.9	19.1
<b>Contusion</b>	<b>N.</b>	35	79	9	0	66	27	0	48	88
	<b>%</b>	28.5	64.2	7.3	0	71	29	0	35.3	64.7
<b>Laceration</b>	<b>N.</b>	104	17	2	33	47	13	42	66	28
	<b>%</b>	84.5	13.8	1.7	35.5	50.5	14	30.9	48.5	20.6

**A:** Absent injury, **B:** Injuries are few in number (not more than two), **C:** Injuries are multiple in number (more than three). **N.:** number of victims. **%:** percentage.

### 3.4 Internal Soft tissues injuries

**Table 4** shows the distribution of cases regarding the autopsy finding of internal soft tissue injuries in relation to different distances of fall as following: in less than 3 meters contusions of scalp (31.7%) and brain (25.2%) were prominent. From distances of 3-9 meters, in addition to the prominence of contusions of the scalp (78.5%) and brain (44.1%), lacerations in both distances were also prominent (52.7%: 20.4% respectively) together with chest muscle contusions (47.3%) and liver contusions (23.7%). The same was seen in distances more than 9 meters in which the percentage of scalp and brain contusions and lacerations were

close to those found in distances of 3-9 meters, while chest muscle lacerations (50%), kidneys contusions (18.4%), liver lacerations (27.2%), spleen lacerations (10.3%) and both internal abdominal and pelvic wall contusions (25%) become more prominent in this category of distance.

**Table 4.** Distribution of contusions and lacerations in relation to distances of fall and internal soft tissues:

		Distances											
		Less than 3 meters				From 3-9 meters				More than 9 meters			
		Contusion		Laceration		Contusion		Laceration		Contusion		Laceration	
		N.	%	N.	%	N.	%	N.	%	N.	%	N.	%
Inner scalp		39	31.7	7	5.7	73	78.5	49	52.7	108	79.4	56	45.5
Brain		31	25.2	1	0.8	41	44.1	19	20.4	63	46.3	31	22.8
Neck skin		0	0	0	0	0	0	0	0	0	0	0	0
Chest muscle		6	4.9	0	0	44	47.3	21	22.6	8	5.9	68	50
Heart		0	0	0	0	3	3.2	7	7.6	5	3.7	17	12.5
Aorta	Arch	0	0	0	0	0	0	0	0	0	0	0	0
	Thorax	0	0	0	0	0	0	8	8.6	0	0	6	4.4
	Abdomen	0	0	0	0	0	0	1	1.1	0	0	3	2.2
lung	R	5	4.1	1	0.8	3	3.2	13	14	7	5.1	24	17.6
	L	0	0	0	0	1	1.1	5	5.4	2	1.5	9	6.6
Abdominal muscle		0	0	0	0	3	3.2	2	2.2	3	2.2	6	4.4
Liver		3	2.4	0	0	22	23.7	9	9.7	5	3.7	37	27.2
Mesentery		0	0	0	0	2	2.2	0	0	13	9.5	4	3
Kidney	R	0	0	0	0	1	1.1	3	3.2	17	12.5	9	6.6
	L	0	0	0	0	2	2.2	1	1.1	8	5.9	3	2.2
Spleen		0	0	0	0	4	4.3	2	2.2	3	2.2	14	10.3
Internal abdominal and pelvic wall		0	0	0	0	13	14	0	0	34	25	3	2.2

R: right. L: left. N.: number of victims. %: percentage.

### 3.5 Fracture injuries

**Table 5** shows the distribution of cases regarding fracture injuries in relation to different distances of fall as following: From distances less than 3 meters, the percentage of victims who showed skull vault fractures were (28.4%), mostly of linear type (23.6%). most victims (78.9%) showed no fractures of any limb except for (18.7%) who showed one limb (1/4) fractures. From distances of 3-9 meters.

Victims showed skull vault fracture were (55.2%), mostly of linear type (35.5%).some showed comminuted fractures (19.7%). In addition to other fractures which were relatively common; base skull fractures (30.1%), vertebral fractures (29%), rib fractures (44.1%), facial fractures (36.5%) and two limb (2/4) fractures (50.5%). The same was seen in distances more than 9 meters with obvious increase in all types of fractures except for facial fractures which were less prominent (21.3%).

It worth noting that, no single case among the study cases, was reported to have a four limb fractures. And the percentage of fractures in terms of occurrence and multiplicity increases obviously with distances more than 3 meters.

**Table 5.** Distribution of fractures of bones according to distances of fall:

		Distances					
		Less than 3 meters		From 3-9 meters		More than 9 meters	
		N.	%	N.	%	N.	%
Vault of Skull	Linear/fissure	29	23.6	33	35.5	41	30.1
	Comminuted	6	4.8	38	19.7	49	36.1
	+/- deformity	+2	1.6	+ 25	26.9	+ 32	23.5
Base of skull		0	0	28	30.1	53	39
Face (nose, teeth, maxilla, upper and lower mandible)		5	4.1	34	36.5	29	21.3
Vertebral	Cervical	3	2.4	7	7.5	13	9.6
	Thoracic	0	0	17	18.3	28	20.6
	Lumber	0	0	3	3.2	4	3
Pelvic bone & hip joint		7	5.6	13	14	25	18.4
Rib fractures		9	7.3	41	44.1	73	53.7
Sternal fractures		0	0	3	3.2	11	8.1
Clavicle		0	0	1	1.1	3	2.2
Limbs	0/4; no fractures	97	78.9	18	19.3	7	7
	1/4; one limb fracture	23	18.7	17	18.3	21	15.4
	2/4; tow limb fracture	3	2.4	47	50.5	75	55.1
	3/4; three limb fracture	0	0	11	11.8	33	24.3
	4/4; four limb fracture	0	0	0	0	0	0
	Total	26	21.1	77	82.8	129	94.8

N.: number of victims. %: percentage.

### 3.6 Causes and Rapidity of death

**Table 6** shows the distribution of cases regarding the cause and to the time of death in relation to different distances of fall as following: In distances less than 3 meters, most victims died from brain trauma 87 (70.7%), others died from post-traumatic complications 29 (23.6%), deaths occurred after 24 hours were (62.6%). From distances of 3-9 meters, most victims died from brain trauma, while others

died from chest (15%) or abdominal trauma (9.6%), or as a result of multiple trauma (18.3%), immediate deaths were (51.6%), with a relatively large proportion of cases (28%) died within 24 hours. And from distances more than 9 meters, the same prevalence of causes as those in distances of 3-9 meters, but with more prominent abdominal trauma (19.9%) and multiple trauma (24.2%) as a fatal injuries with significant percentage of immediate deaths (89.7%).

**Table 6.** Distribution of causes and time of death according to distances of fall:

		Distances					
		Less than 3 meters		From 3-9 meters		More than 9 meters	
		N.	%	N.	%	N.	%
Causes of death	<b>Head only</b> (Brain hemorrhage, contusion and laceration)	87	70.7	52	56	55	40.5
	<b>Neck only</b> (Spinal cord separation)	0	0	1	1.1	3	2.2
	<b>Chest only</b> (Hemorrhage, cardiac tamponade)	3	2.4	14	15	17	12.5
	<b>Abdomen only</b> (Hemorrhage)	0	0	9	9.6	27	19.9
	<b>Multiple trauma</b> (Head, chest, abdomen)	0	0	17	18.3	33	24.2
	<b>Post- traumatic complications</b> (Pulmonary embolism, Pneumonia, bronchopneumonia, Bed sore, Septicemia, DIC)	29	23.6	0	0	0	0
	<b>Thrombus</b> (occur as sequence or cause of fall)	4	3.2	0	0	0	0
<b>Total</b>		123 (100%)		96 (100%)		136 (100%)	
Time of death	Immediately	17	13.8	48	51.6	122	98.7
	Death through 24hrs.	29	23.6	26	28	11	8.1
	Death after 24hrs.	77	62.6	19	20.4	3	2.2
<b>Total</b>		123 (100%)		96 (100%)		136 (100%)	

N.: number of victims. %: percentage.

## 4. Discussion:

This study about fatalities of falling from a distance is a peculiar one, as it focuses on analyzing different types of injuries and variables of falling fatalities in relation to different distances of fall.

### 4.1 Personal data and data regarding death

Regardless of the distance of fall, the overall results of this study are similar to most other studies<sup>1,4,6,13</sup> regarding data such as the gender; males had a higher rate of falling than females (72.7%: 27.3% respectively). Accidental falls (86.1%) are more common than suicidal falls (8.8%), while homicidal fall is very rare (0.6%). Falling among Workers of 19-45 years old was higher than that in both age groups (children less than 7 years and adult more than 45 years). Also survival rates are inversely proportionate to the distance of fall. However, other studies<sup>1,7,12,13,19</sup> provided some differences which included the age group of workers which was more than 45 years, falling at home rather than workplaces, suicidal fall of single women is more than that of married women, suicidal fall is more prominent than the accidental and finally homicidal fall is not rare. These differences may be explained by the fact that a high percentage of victims were of young age who usually fall at home. Accidental death was prominent among children and workers, while suicidal death happened to be more among married home maids.

Most of the victims fell from distances less than 3 meters were children less than 7 years( 40.6%) and unemployed adults more than 45 years (table 1). Children falls could be explained by the lack of awareness while playing, with the probable lack of precautions and observation of parents, this is mostly noticed in males of

that age (male: female, 25.9%: 14.6%) because they are more active and more curious to explore the outer environment, compared with the older and more aware children who exhibit few falls (10.7%). The relatively large number of cases in the category of more than 45 years may be attributed to the presence of several health problems such as sudden hypoglycemia, hypotension bouts and heart attacks that may cause the accidental fall from low distances as the accidental fall from stairs. Regarding the distances of 3-9 meters and more than 9 meters, most cases showed accidental falling in adult males, mostly expatriate workers due to falling from scaffolds, ladders, and mainly in summer in which building constructions abounded. In addition to the presence of female victims falling (expatriate home maids from Southeast Asia) in distances more than 9 meters due to high rate of suicide among them which is may be due to alienation and psychological trauma.

#### **4.2 Skin and internal soft tissues injuries:**

The results of this study were distinctive in detailing the skin and internal soft tissues injuries together with the interpretation of their occurrence, which have not been found in other studies<sup>1-19</sup>.

The occurrence of abrasions on skin depends mainly on the way of fall and the surface of impact rather than the distance of fall. It can be explained by the presence of abrasions in 100% of cases regardless the distance (table 3). The presence of multiple abrasions was high at distances less than 3 meters (62.6%) and distances of 3-9 meters (63.5%) compared with the distances of more than 9 meters (19.1%) (Table 3). That is probably due to the fall of the workers form ladders and scaffoldings, as well as the fall of the children while playing, which is mostly accompanied with sliding. While in cases of more than 9 meters, the falling was not mostly accompanied with sliding (suicide and direct fall of workers).

The occurrence of contusions and lacerations of the skin and internal soft tissue depend mainly on the distance of fall. The occurrence of multiple contusions, multiple lacerations and few lacerations of skin together with lacerations of internal soft tissues are in a direct proportion with the distance of fall. While the few contusions of skin and contusions of internal soft tissues obviously decreased at distances of more than 9 meters (table 3, 4). This can be explained by the increased number of injuries that mainly took the form of lacerations rather than contusions in distances more than 9 meters (table 3, 4).

Additionally, the occurrence of skin and internal soft tissue lacerations are affected by the presence of fractures and the nature of the surface of impact (rough or smooth), therefore lacerations may not be found in all cases of fall (table 3, 4), however, they were mainly manifested at distances more than 3 meters, which might be explained by the increased occurrence of fractures obviously at distances more than 3 meters.

#### **4.3 Fracture injuries:**

While other studies have mainly focused on head fractures regardless the distance of fall<sup>3,4,6-8,10,14,17</sup>, this study focused- in addition to the effect of distance of falls- on fractures in other sites of body.

Generally, the occurrence of fractures depends mainly on the distance of fall. Additionally, fractures may be affected by the site of impact, elasticity of the affected tissue, the orientation of the body at time of impact and the nature of impact surface. Skull, limbs, vertebra, sternum, clavicle, pelvis and hip fractures were all in a direct proportion to the distance of fall (table 5).

The site of impact may affect the outcome of the fracture specially fractures of pelvis and base of skull. These fractures were absent in distance less than 3



meters, and present thereafter (table 5). This may be explained by the direct fall on the lower limbs and the transmission of energy via the axial skeleton to the pelvis and to the skull base. Contrary to the fractures of skull vault which were noticed in all distances denoting to the direct nature of impact for their occurrence. In addition to the distance of fall, the elasticity of skull bones may affect the occurrence of skull fractures. It was noted that the percentage of children (40.6%) (Table 1) who had fractures of the skull were fewer Compared with the old aged victims who mostly exhibit brain injuries together with skull fractures.

The effect of the body orientation during the fall on the occurrence of fractures can be noticed mainly by facial fractures and the multiplicity of limb fractures. Facial fractures were inversely proportionate with distances of more than 9 meters. This can be explained by the presence of suicide victims mainly in this category of distance, with a probable explanation that the victim may turn his face away from the site of impact so that he will not hesitate .On the other hand, the complete absence of four limb fractures at once in all distances (table 5) as it is hard to have a body orientation with four limbs in contact with the site of impact at the same time.

#### **4.4 Causes of death:**

While other studies have focused on head injuries as the main cause of death in falling fatalities regardless the distance of falls<sup>3,4,6-8,10,14</sup>, this study focused in addition to the distance of falls on fatal injuries in other parts of the body.

Similar to other studies<sup>3,4,6-8,10,14</sup>, the most common causes of death were due to injuries of the head (table 6). Multiple trauma to the internal organs presented in a noticeable number of deaths (table 6).

It worth noting that, the presence of head injuries as a sole cause of death was relatively less in distances more than 3 meters due to the high frequency of

internal organ affection in this category of distance. The occurrence of post traumatic complications were mostly manifested at distances less than 3 meters mainly due to the frequent occurrence of less serious injuries (table 4) that permit some time for the victim to stay alive, but no such complications were found as a cause of death in higher distances of fall due to the rapid occurrence of death (table 6) resulting from the occurrence of more serious injuries (table 6).

## 5. Conclusions:

This study showed the effect of different distances of fall in causing different types of injuries in falling fatalities. Although the external and internal injuries and those causing death are mainly related to the distance of fall, yet contribution of other factors such as the age, the original health status, the surface of impact, the orientation of body during the fall and the elasticity of the injured tissues should also be considered.

Fatal head injuries occurred nearly in all distances, while that of the chest showed prominence in distances more than 3 meters. Abdomen injuries were more prominent at distances more than 9 meters. Death from post-traumatic complications was evident in distances less than 3 meters.

Injuries of skin, internal soft tissues injuries and skull base fractures showed a great importance in interpretation of the way of fall. The occurrence of multiple abrasions and few contusions were less in distances more than 9 meters. Lacerations of the liver were prominent in distances more than 9 meters. Vault skull fractures were prominent in all distances, while the skull base fractures were prominent in distances more than 3 meters. Although facial fractures may be seen in distances less than 9 meters, they were hardly seen in distances more than 9

meters. Skull fractures were not seen in a noticeable number of head injuries in children. And the maximum number of fractured limbs at once was three.

## 6. References: {Google Schooler}

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## Highlights

- The incidence of abrasions depends on the way of fall and nature of impact surface.
- The incidence of contusions and lacerations of skin depend on the height of fall.
- The incidence of deaths from post-traumatic complications was mainly in less than 3 meters.
- Skull vault fracture, fatal head injury and skin abrasions occurred at all distances.
- Chest injuries and skull base fractures occurred at distances of more than 3 meters.

### **Compliance with Ethical Standards**

- **Conflict of Interest:** Authors A, B and C declares that they have no conflict of interest.
- **Ethical approval:** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.
- **Informed consent:** International regulations allow using data obtained from forensic autopsies to be used in retrospective/archival studies, without the need to obtain an explicit consent.