PATTERN OF FATAL INJURIES OF FALL FROM HEIGHT AT GREAT CAIRO: A RETROSPECTIVE ANALYTICAL STUDY (2009 – 2013)

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ABSTRACT

Deaths due to fall from height are increasing yearly. Victims of fall from height tend to sustain a unique pattern of injuries that depends on many factors. Therefore, the present work aimed to determine and analyze the pattern of fatal injuries of fall from height among deaths on which medicolegal autopsies were conducted at Cairo Department of Forensic Medicine (Zenhum morgue), Ministry of Justice, Egypt, during the period from 1st January 2009 to 31th December 2013. Data was obtained from available medicolegal reports and was statistically analyzed. There were 270 fall from height deaths representing 3.25% of the total deaths received during the study period. Most of them were males in the age group (19-40) years and from urban areas (55.9%, 59.5% and 55.2% respectively). Most of the victims (23%) were workers followed by students and housewives (19.8% for each). There was a high prevalence (75.6%) of blunt trauma and multiple injuries were the most common injured anatomical region (67.4%), followed by the head (27.0%). Home was the most common scene of fall (50.7%) followed by workplace (34.1%). Accidental manner was the most common (37.8%) and the majority (87.4%) of cases sustained high falls (height >20 feet). The majority (77%) of cases showed negative toxicological analysis and among cases with positive toxicological analysis alcohol was the most common (32.3%). Falling at home was significantly common in females and in age groups (≤18), (19-40) and (>60) years; meanwhile falling at work place was significantly common in males and in age group (41-60) years.

Keywords: fatal injuries, fall from height, Cairo, analytical study

INTRODUCTION

Fall from height is an event where a person falls to a ground from an upper level. It is considered as a persistent hazard met in all communities and occupational settings. Worldwide, it is a major public health concern and stills a significant cause of morbidity and mortality. It is a common accident both at home and work place **(Masud & Morris, 2001 and Mirza et al., 2013).**

Fall from height may be a low fall (in adults: below 20 feet and below one meter in children), and a high fall (in adults: ≥ 20 feet and above one meter in children). It may be intrinsic; where some events or conditions affect postural control, and extrinsic; where an environmental factor is the main contributing reason for the fall **(Wang et al., 2001; Park et al., 2004 and Murthy et al., 2012).**

During fall, the potential energy of height is converted to kinetic energy under the influence of gravity. At the moment of impact, a falling body undergoes deceleration and the amount

of kinetic energy transferred to the ground reacts with an equal amount against the body itself. The body reabsorbs the energy lost in the form of injuries **(Mason, 2000 and Murthy et al., 2012).**

Injuries of fall from height involve the head and the vertebral column leading to brain and spinal cord injuries along with upper and lower extremities causing bones fractures **(Prathapan & Umadethan, 2015).**

Goren et al. (2003) found that the most frequently affected body parts due to fall from height were the head (91%), followed by the thorax (54%), abdomen (37%), extremities (36%), and neck (17%).

Deaths due to fall from height are increasing yearly as many work activities involve working at height. Workers in maintenance, construction and many other jobs could be at risk of falling from height **(Murthy, 1999).**

Victims of fall from height tend to sustain a unique pattern of injuries that depends on many factors such as inertia of the body, movement of the body, rigidity of stationary objects and the nature of ground against which the body falls **(Murthy et al., 2012).**

In Egypt, only few studies were conducted to describe the pattern of fall from height injuries, therefore, the present work aimed to determine and analyze the pattern of fatal injuries due to fall from height among deaths on which medicolegal autopsies were conducted at Cairo Department of Forensic Medicine (Zenhum morgue), Ministry of Justice, Egypt, during the period from 1st January 2009 to 31th December 2013.

MATERIAL AND METHODS

I- Materials:

This is a retrospective analytical study that was carried out on all cases of fatal fall from height on which medicolegal autopsies were conducted at Cairo Department of Forensic Medicine (Zenhum morgue), Ministry of Justice, Egypt, during the period from 1st January 2009 to 31th December 2013.

Data of this study were collected from autopsy reports that list fall from height injuries as a cause of death. The study was approved by the local ethical committee of Faculty of Medicine, Benha University, Egypt.

II- Methods:

The studied cases were assessed regarding the following parameters:

(A) Incidence: incidence rates of deaths due to fatal fall from height in relation to the total deaths received during the studied period.

(B) Demographic data: victim's age, gender, location, residence, and occupation.

(C) Autopsy and medico-legal data: scene of the crime, type of injury, part of body injured, medical intervention**,** type of fall from height (whether low or high falls), manner of death, mechanism of death and toxicological analysis, if present.

(D) The relation between both of victim's age & gender and (type of trauma, site of injury, scene of fall, manner of death and height of fall) was studied.

(E) The relation between the height of fall and (type of trauma and site of injury) was studied.

III- Statistical analysis:

The collected data were tabulated and statistically analyzed using SPSS version 16 microstate software package

(SPSS Inc, Chicago, ILL Company). The significance of difference was tested using: Z test, chi square test (X^2-value) and fisher exact test (FET). A P value <0.05 was considered statistically significant (S) while >0.05 statistically insignificant and a P value <0.01 was considered highly significant (HS) **(Brink, 2010).**

RESULTS

The present study included 270 cases of fatal injuries due to fall from height on which medicolegal autopsies were conducted at Cairo Department of Forensic Medicine (Zenhum morgue), during the period from 1st January 2009 to 31th December 2013.

(A) Incidence:

The present work reported a total of 270 deaths due to fatal fall from height injuries representing 3.25% of the total number (8317) of medicolegal deaths that had been received during the studied period. The high rate of fall from height deaths was in the year 2009 (4.5%), as showed in table (1).

Table (1): Number and percentage of deaths due to fatal fall from height in relation to the total deaths/year that had been received during the studied period:

Year	Total No. of	No. of cases of fall from	%
2009	1100	50	4.5
2010	1250	46	3.6
2011	1992	78	3.9
2012	2116	52	2.4
2013	1859	44	2.3
Total	**8317**	**270**	**3.25**

(B) Demographic characteristics of the studied cases:

- Age and gender:

The present work showed that cases included in this study aged from nine days to eighty two years, the majority (59.5%) of them were in the age group (19-40) years, followed by the age group (41-60) years (19.0%), the age group (≤18) years (16.7%), and the age group (>60) years (4.8%). The majority (55.9%) of cases were males with a mean age for males 33.6 years and for females 25.77 years. as showed in Fig. (1).

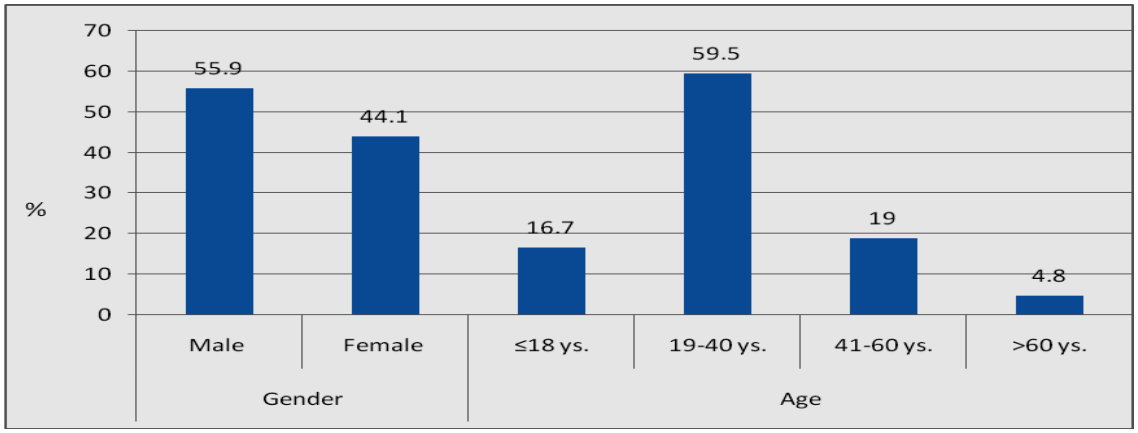


Figure (1): Bar chart showing the distribution of studied cases (n=270) according to gender and age during the period of the study.

- **Location and residence**:

The present work showed that the highest incidence (45.9%) of fall from height occurred in Cairo, followed by Giza (31.9%), then Qalubia (22.2%). Fall from height deaths were more common in urban areas (55.2%) than rural areas (44.8%), as showed in Fig. (2).

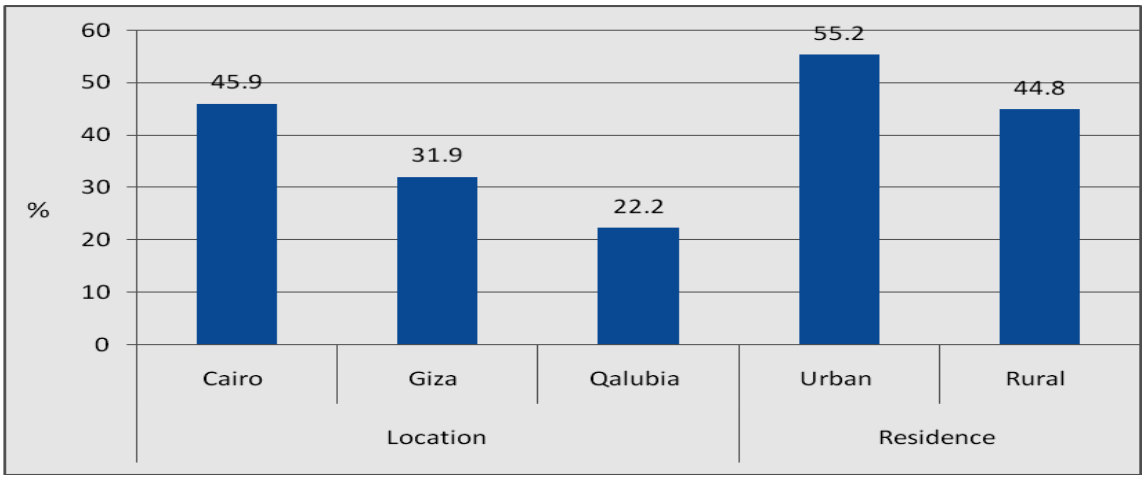


Figure (2): Bar chart showing the distribution of studied cases (n=270) according to location and residence during the period of the study.

- **Occupation:**

The present work confirmed that the majority (23%) of fall from height deaths occurred among workers followed by students (19.8%) and housewives (19.8%), as showed in Fig. (3).

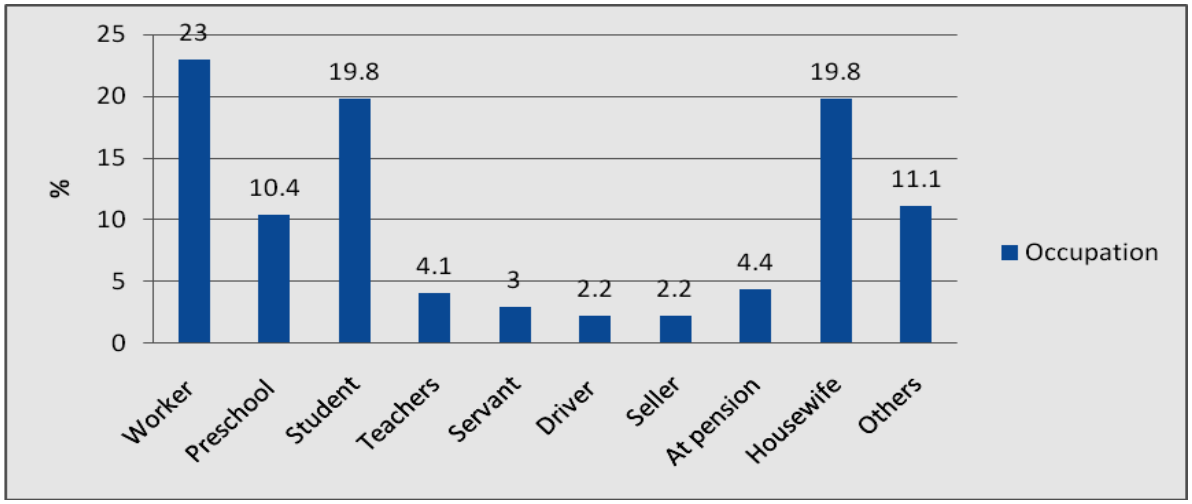


Figure (3): Bar chart showing the distribution of studied cases (n=270) according to occupation.

Others (painter, decorator, trainer, waiter, plumber, manager, nurse, etc……..).

(C) Autopsy and medico-legal results:

• Scene of fall:

The present study confirmed that home was the most common (50.7%) scene for fall accidents, followed by work place (34.1%) then other places (15.2%), as showed in Fig. (4).

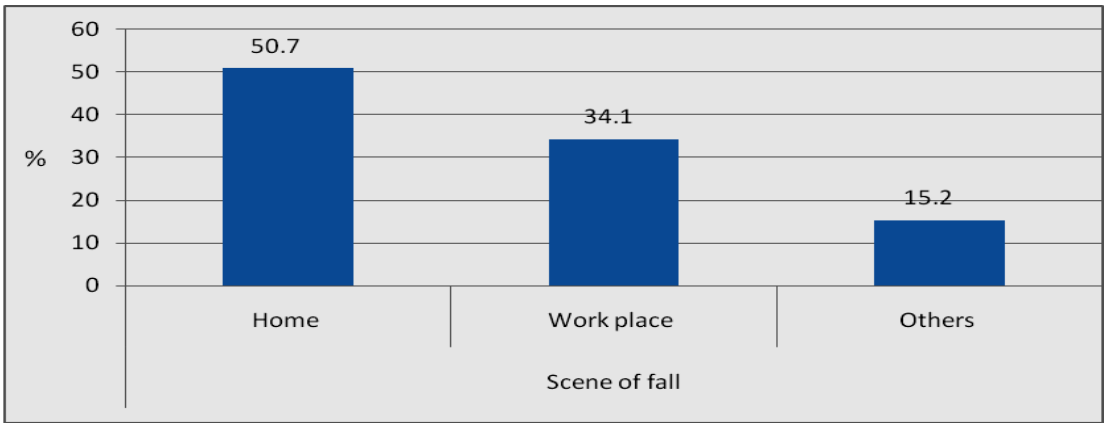


Figure (4): Bar chart showing distribution of studied cases (n=270) according to the scene of fall during the period of study.

Others (school, hospital, road, office, factory, sport club, etc…….).

• Site of injury:

The present study showed that multiple injuries represented the most common (67.4%) injured anatomical region, followed by the head (27.0%), abdomen (2.2%), chest (1.9%), and spine (1.5%), as showed in table (2).

Table (2): Distribution of the studied cases (n=270) according to site of injury during the period of study.

Site	No.	%
Head	73	27.0
Abdomen	6	2.2
Chest	5	1.9
Spine	4	1.5
Multiple	182	67.4

Multiple: (head, neck, chest, abdomen, spine, pelvis and extremities).

• Type of trauma, medical intervention and height of fall:

The present study confirmed that blunt trauma represented the vast majority (75.6%) among the studied cases, as a type of trauma. There was no medical intervention in 69.3% of studied cases. The majority (87.4%) of studied cases sustained high falls (height >20 feet), as showed in Fig. (5).

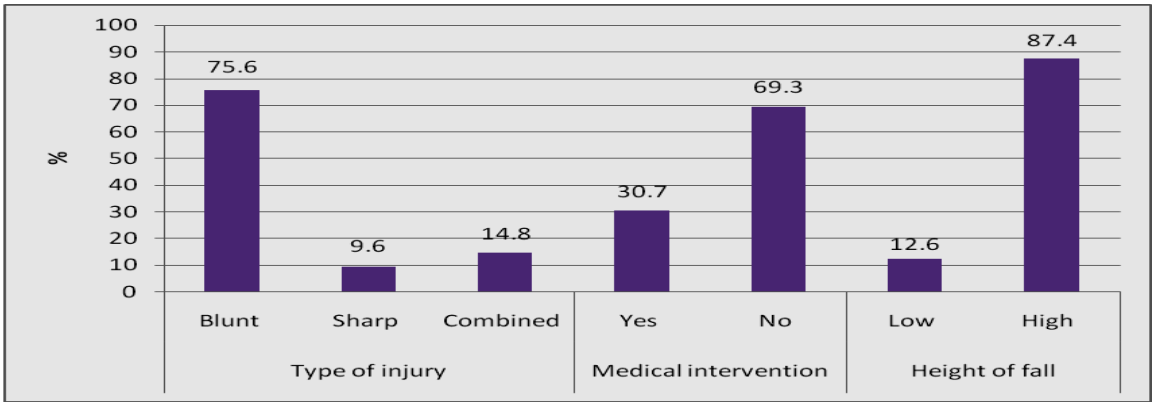
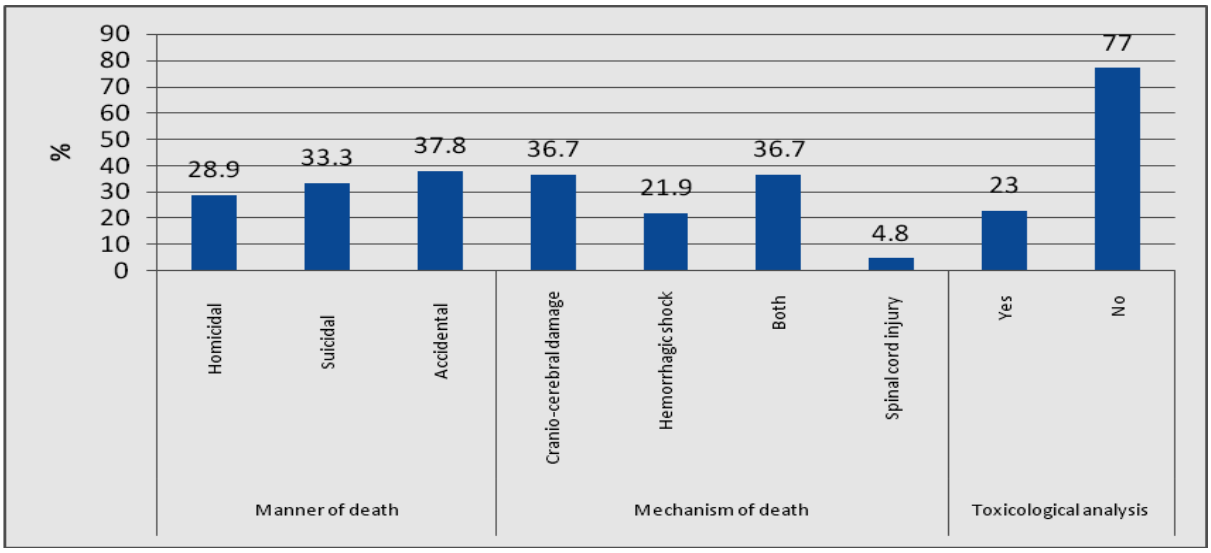


Figure (5): Bar chart showing the distribution of studied cases (n=270) according to type of injury, medical intervention and height of fall during the period of study.
(Combined: blunt and sharp traumas)

• **Manner, mechanism of death and toxicological analysis:**

The present study found that accidental manner was the most common (37.8%) among the studied group. Regarding the mechanism of death; cranio-cerebral damage either alone or combined with hemorrhagic shock were the most common (36.7% for each). In the majority (77%) of cases, toxicological analysis was negative, as showed in Fig. (6).



Both: (cranio-cerebral damage and hemorrhagic shock)

Figure (6): Bar chart showing the distribution of studied cases (n=270) according to manner & mechanism of death and toxicological analysis during the period of study.

The present study showed that among cases of fall from height with a positive toxicological analysis, the most common toxins involved were alcohol (32.3%) followed by sedative hypnotics and opiates (29% and 19.4% respectively), as showed in Fig. (7).

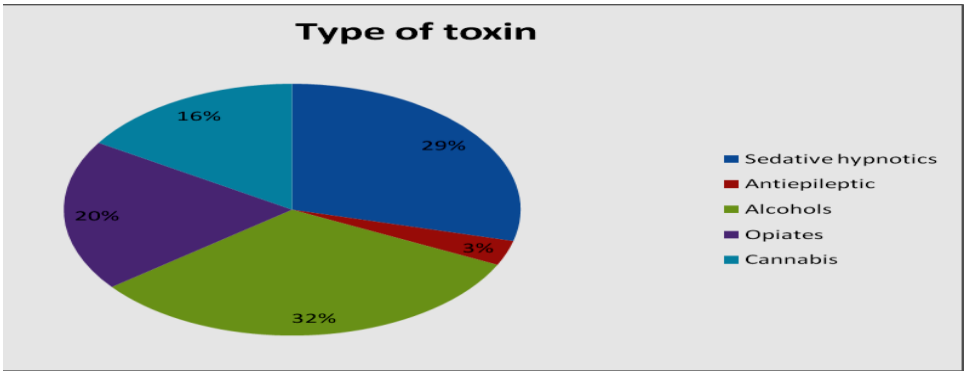


Figure (7): Pie chart showing the different types of toxins found in cases of fall from height with positive toxicological analysis during the period of study.

• **Relation between victim's age and (manner of death, type of trauma, height of fall and site of injury):**

The present study confirmed that accidental falling was common in age groups (≤18) and (41-60) years; meanwhile suicidal manner was common in age groups (19-40) and (>60) years. Blunt trauma was common among the different age groups. High falls were common among different age groups, this was highly significant (p value = 0.001). Among all age groups the multiple injuries were the most common, followed by head injuries, as showed in table (3).

Table (3): Relation between age of victim and (scene of fall, manner of death, type of trauma, height of fall and site of injury) among studied cases (n. = 270)

Age / groups		≤18		19-40		41-60		>60		Total		FET test	P value
		No.	%	No.	%	No.	%	No.	%	No.	%		
Scene of fall	**Home**	37	82.2	71	44.4	20	39.2	8	61.5	136	50.6	**42.03**	**0.001**
	Work	2	4.4	67	41.9	23	45.1	0	0	92	34.2		
	Others	6	13.3	22	13.8	8	15.7	5	38.5	41	15.2		
Manner of death	**Homicidal**	14	31.1	43	26.9	15	29.4	5	38.5	77	28.6	**9.14**	**0.166**
	Suicidal	8	17.8	59	36.9	17	33.3	6	46.2	90	33.5		
	Accidental	23	51.1	58	36.2	19	37.3	2	15.4	102	37.9		
Type of trauma	**Blunt**	38	84.4	117	73.1	38	74.5	10	76.9	203	75.5	**2.54**	**0.864**
	Sharp	3	6.7	17	10.6	5	9.8	1	7.7	26	6.7		
	Combined	4	8.9	26	16.2	8	15.7	2	15.4	40	14.9		
Height of fall	**Low**	13	28.9	14	8.8	2	3.9	5	38.5	34	12.7	**20.94**	**0.001**
	High	32	71.1	145	91.2	49	96.1	8	61.5	234	87.3		
Site of injury	**Head**	16	35.6	35	21.9	17	33.3	5	38.5	73	27.1	**13.32**	**0.346**
	Abdomen	2	4.4	2	1.2	2	3.9	0	0	6	2.2		
	Chest	1	2.2	4	2.5	0	0	0	0	5	1.9		
	Spine	0	0	2	1.2	2	3.9	0	0	4	1.5		
	Multiple	26	57.8	117	73.1	30	58.8	8	61.5	182	67.3		

Multiple= (head, neck, chest, abdomen, spine, pelvis and extremities), **combined=** (blunt and sharp trauma), **others =** (school, hospital, road, office, factory, sport club, etc…...), **both =** (cranio-cerebral damage and hemorrhagic shock). **FET:** fisher exact test**, P value:** <0.05 was considered statistically significant (S) while >0.05 statistically insignificant and a P value <0.01 was considered highly significant

• Relation between height of fall and (type of trauma and site of injury):

The present study illustrated that multiple injuries were significantly common (74%) in high fall, meanwhile head injuries were common (67.6%) in low falls. Blunt trauma was the most common type of trauma in both high and low falls (76.5% and 75.3% respectively) and this was statistically significant (p value = 0.001), as showed in table (4).

Table (4): Relation between the height of fall and (type of trauma and site of injury) among studied cases (n. = 270):

Parameters \ Height of fall		Low		High		Total		Z test	P value
		No.	%	No.	%	No.	%		
Site of injury	**Head**	23	67.6	49	20.9	73	26.8	3.28	**0.001**
	Abdomen	2	5.9	4	1.7	6	2.2	0.866	**0.193**
	Chest	1	2.9	4	1.7	5	1.9	1.68	**0.047**
	Spine	0	0	4	1.7	4	1.5	-	**-**
	Multiple	8	23.5	174	74	182	67.7	30.01	**0.001**
Type of injury	**Blunt**	26	76.5	177	75.3	203	75.5	15.86	**0.001**
	Sharp	7	20.6	19	8.1	26	9.7	2.65	**0.003**
	Combined	1	2.9	39	16.6	40	14.9	19.24	**0.001**

Multiple= (head, neck, chest, abdomen, spine, pelvis and extremities), **combined =** (blunt and sharp trauma**). P value:** <0.05 was considered statistically significant (S) while >0.05 statistically insignificant and a P value <0.01 was considered highly significant

• Relation between gender of victim and (type of trauma, site of injury, manner of death and height of fall):

The present study found that in both genders blunt trauma was the most common type of trauma (80% in males and 69.7% in females), this was highly significant (p value = 0.003). Multiple injuries were the most common site of injury (64.2% in males, 71.4% in females). Accidental manner was significantly prevalent among males (44.4%) on the other hand suicidal manner was common among females (40.3%) and high fall was the most common type of fall among both genders (86.7% in males, 88.2% in females), as showed in table (5).

Table (5): Relation between gender of victim and (type of trauma, site of injury, scene of fall, manner of death and height of fall) among studied cases (n. = 270):

Parameters \ Gender		Male		Female		Total		Z test	P value
		No.	%	No.	%	No.	%		
Type of trauma	**Blunt**	121	80.1	83	69.7	204	75.6	**2.71**	**0.003**
	Sharp	10	6.6	16	13.4	26	9.6	**1.21**	**0.11**
	Combined	20	13.2	20	16.8	40	14.8	**0.0**	**0.5**
Site of injury	**Head**	45	29.8	28	23.5	73	27.0	**2.05**	**0.02**
	Abdomen	3	2.0	3	2.5	6	2.2	**0.0**	**0.5**
	Chest	2	1.3	3	2.5	5	1.9	**0.456**	**0.324**
	Spine	4	2.6	0	0.0	4	1.5	**-**	**-**
	Multiple	97	64.2	85	71.4	182	67.4	**0.89**	**0.19**
Scene of fall	**Home**	50	33.1	87	73.1	137	50.7	**3.28**	**0.001**
	Work place	75	49.7	17	14.3	92	34.1	**7.97**	**0.001**
	Others	26	17.2	15	12.6	41	15.2	**1.78**	**0.037**
Manner of death	**Homicidal**	42	27.8	36	30.3	78	28.9	**0.681**	**0.25**
	Suicidal	42	27.8	48	40.3	90	33.3	**0.634**	**0.26**
	Accidental	67	44.4	35	29.4	102	37.8	**3.34**	**0.001**
Height of fall	**Low**	21	13.3	14	11.8	35	12.6	**1.05**	**0.15**
	High	130	86.7	105	88.2	235	87.4	**1.64**	**0.05**

Combined= (blunt and sharp trauma), **Multiple=** (head, neck, chest, abdomen, spine, pelvis and extremities) and **others=** (school, hospital, road, office, factory, sport club, etc…...). **P value:** <0.05 was considered statistically significant (S) while >0.05 statistically insignificant and a P value <0.01 was considered highly significant.

DISCUSSION

Mortality due to falls in the Eastern Mediterranean region is reported as 2.9 per 100,000 populations which is the highest among all World Health Organization regions. Taking into consideration the morbidity associated with injuries, falls account for 12.2% of the injury-related disability and hence cause large financial and productivity deficits **(Fayyaz et al., 2015).**

The present study reported 270 cases of fatal fall from height injuries representing 3.25% of the total number of cases (8,317) received at Cairo Department of Forensic Medicine (Zenhum morgue), Ministry of Justice, Egypt, during the period from 1st January 2009 to 31th December 2013. Some previous studies recorded similar rates in relation to the present study; **Mirza et al. (2013)** in Pakistan, reported a total of 11,109 autopsies, conducted during a five years from 1st January 2007 to 31th December 2011, of which 144 cases reported to have died due to fall from height, representing 1.29% of the total deaths. Also **Hyder et al. (2007)** found that in the United States, the annual incidence of falls from height was 2.81 per 100,000 inhabitants.

On the other hand, **Henley et al. (2007)** in Australia recorded a high rate in relation to the present study; as they found that fall from height deaths among workers represented 30% of all recorded deaths in 2003 – 2004. Also **Liu et al. (2009)** found that in North Taipei area in Taiwan, there was a relatively high mortality rate ranges from 22.7% to 37.6% among victims who had fallen from a height.

The present study, found that most (59.5%) of fall from height deaths were in the age group (19-40) years, followed by the age group (41-60) years (19.0%) and the age group (≤18) years (16.7%). The least common age group involved was (>60) years (4.8%). This was in accordance with **Murthy et al. (2012)** in Karnataka, India; who reported that the maximum number of fall from height cases was seen in the age group 21-30 years (34.61%), the least number of fall from height cases occurred in age group of 61-70 years and 81-90 years, accounting to 1.9% in each group. Also, **Grivna et al. (2014)** in United Arab Emirates (UAE), found that the majority (68%) of victims of fall from height were adults of 20–54 years old and 22% were children <19 years.

In contrast **Suleyman et al. (2003)** in Diyarbakir region of Turkey, found that 42.6% of deaths of fall from height were reported in the age group less than 15 years. Meanwhile, **Al et al. (2009)** found that in Turkey, the mortality incidence was high in patients who were older than 60 years.

The high incidence of fall from height among age group (19-40) years may be explained by the fact that the period from the 19 -40 years was the period of peak activity in which people usually play, work, struggle and are subjected to accidents and assaults more than the older age. It also suggests more vulnerability of young age group having occupational setting of work at reasonable height **(Mirza et al., 2013)**.

Regarding the gender of the studied cases, it was found that male victims represented the majority (55.9%) of them. This was in agreement with **Cripps and Carman (2001)** in Australia, who reported a 71% male predominance among cases of fall from height. Later on, **Driscoll et al. (2003)** in Australia confirmed that the risk of fatal injury from falls was 10 times greater in men.

In contrast, **Stevens and Sogolow (2005)** and **Orces (2014)** found that in USA, the higher prevalence of fall-related injuries and deaths among women. Also, **Saari et al. (2007)** found that in Finland, the rate of injurious falls per thousand person-years was 188 among women and 78 among men.

Mirza et al. (2013) explained the high prevalence of male death by the fact that males mostly busy in outdoor work and those working at height and thereby likely to die from falls. Females are mostly involved in house work or indoor works, suffer nonfatal fall injuries. Few women may take unnecessary physical risks compared to men.

In the present study, fall from height deaths were more common (55.2%) in urban areas than rural areas (44.8%), and there was a high prevalence (75.6%) of blunt trauma among cases of falling from height.

This was in accordance with **Risser et al. (1996)** in Austria; **Turk and Toskos (2004)** in Germany; **Kohli and Banerjee (2006)** in India; **David et al. (2007)** in France and **Gulati et al. (2012)** in India, who confirmed that fall from height was a common urban phenomenon and blunt trauma was the most common type of trauma among cases of fall from height.

Fall from height was common in urban areas as peoples from backward and undeveloped areas rush to cities for earning the money for their families. They are always ready to work at cheaper rates without considering the

availability of safety/preventive measures **(Grivna et al., 2014).**

As regarding the occupation of the victim, the present study found that the majority (23%) of the victims were workers followed by students (19.8%) and housewives (19.8%). This was supported by **Chan et al. (2008**) who found that in Hong Kong, the highest number of fall accidents occur among workers. Also, **Elsafty et al. (2012)** found that in Egypt, falls from elevation generally represent the leading cause of a death due to construction related activity, representing about 33% of all construction fatalities among worker.

Meanwhile other studies recorded high rates of fall fatalities among construction or general industry workers, as those done by **Gillen and Gittleman (2010)** in USA, and **Tuma et al. (2013)** in Qatar (90% and 75% respectively).

The high incidence of fall fatalities among workers may be explained by their involvement in more labor work with scaffolds, ladders, steel erection and climbing associated with construction of bridges and buildings **(Rogers et al., 2013).**

In the present study, multiple injuries were the most common (67.4%) injured anatomical region, followed by the head (27.0%), abdomen (2.2%), chest (1.9%), and spine (1.5%). This was in agreement with **Buckman (1991)** in USA; **Yagmur et al. (1999)** in Turkey; **Teh et al. (2003)** in UK; **Turk and Toskos (2004)** in Germany; **Aunon-Martin et al. (2012)** in Spain; **Icer et al. (2013)** in Turkey; **Patil et al. (2013)** in India and **Rau et al. (2014)** in Taiwan, who found that deaths due to fall from height mostly resulted from multiple trauma.

On the other hand, **Murray et al. (2000)** in USA; **Kennedy et al. (2001)** in UK and **Khanbhai et al. (2014)** in Kenya, confirmed that the most common anatomical site of fatal fall from height injuries was the head.

Jagannatha et al. (2010) explained the high incidence of multiple injuries as there were two types of injury due to falls from heights; injury resulting from direct impact mainly head injury due to primary impact of head and deceleration type of injury immediately post-impact that causes visceral and internal injury resulting in multiple injuries including cerebral injury.

In the present study, as regarding to the scene of fall, home was the most common scene (50.7%), followed by work place (34.1%). This was consistent with **Bjornstig and Johnsson (1992)** in Swedish; **Muir and Kanwar (1993)** in UK; **Kent and Pearce (2006)** in Australia, and **Kiran and Srivastava (2013)** in India, who confirmed that the majority of fall from height injuries occurred at home (68%, 61%, 57.4%, and 60%) respectively. In contrast, **Mirza et al. (2013)** in India; **Grivna et al. (2014)** in UAE and **Jain, et al. (2014)** in India, reported that falls from height were more common at work place.

Gulati et al., 2012 stated that the high incidence of home as a scene of fall is due to lack of stringent safety regulations in households while in work place there is increased focus at ensuring workman safety in industrial establishments.

As regarding the height of fall, the present study revealed that the majority (87.4%) of cases sustained high falls

(height >20 feet). This was in accordance with **Mathis et al. (1993**) in USA; **Yagmur et al. (2004)** in Turkey, **and Suarez et al. (2012)** in Spain, who found that the majority of fall from height deaths were seen in high level falls.

On the other hand **Wong et al. (2005)** in Hong Kong and **Kumar et al. (2013)** in India confirmed that the majority of cases fell from a height of less than (2 m, 10 m, 6-9 feet) respectively.

The high incidence of high level falls may be explained by the fact that the majority of victims were working at high rise building projects **(Vigneshkumar, 2014).**

As regarding the manner of death, accidental manner was the most common (37.8%) followed by suicidal (33.3%) then homicidal (28.9%) manner. This was in accordance with **Li and Smialek (1994)** in USA; **Richter et al. (1996)** in Germany and **Prathapan &Umadethan (2015)** in India, who found that most of cases of death due to fall from height were accidental (52%, 90%, 98%) respectively. Also, **AL et al. (2009)** in Turkey and **Sokolewicz et al. (2012)** in Poland, stated that accidental fall from height was the most common manner of death.

In contrast, **Atanasijevic et al. (2005)** reported that in Serbia and Montenegro, the majority of cases were suicidal (56%), while accidental falls represented 44% of cases. Also, **Turk and Toskos (2004)** found that in Germany, suicidal manner was the most common (50%), followed by accidental manner (34%).

Mirza et al. (2013) stated that reporting accidental deaths due to fall from height is one of the ways to avoid confrontation with the police, moreover the family wants to dispose the body immediately as well as the claiming for compensation is another important aspect in such cases.

As regarding the mechanism of death, the present study revealed that the cranio-cerebral damage either alone or combined with hemorrhagic shock were the most common (36.7% for each) followed by hemorrhagic shock (21.9%). This was in accordance with **Aufmkolk et al. (1999)** in Germany and **Yagmur et al. (2004**) in Turkey, who found that cranio-cerebral damage was the most common mechanism of death in fatal falls. Also, **Behera et al. (2010)** in India found that intracranial injury was the most common (85.1%) mechanism of death due to fall from height.

In contrast, **Parreira et al. (2014)** in Brazil found that the more frequent mechanism of death of fall from height was hemorrhagic shock.

Kiran and Srivastava (2013) stated that the high prevalence of cranio-cerebral damage if fall injuries could be explained as the most common part of the body receiving injury was the head, either alone or in combination with the other parts.

The present study showed that in the majority (77%) of cases, toxicological analysis was negative and among fall from height cases with positive toxicological analysis alcohol was the most common (32.3%) followed by sedative hypnotics and opiates (29% and 19.4%) respectively.

This was in accordance with **Girasek et al. (2002)** and **Pressley and Barlow, (2005)** in USA, who found that alcohol was a major contributor to accidents of fatal fall from height. Also, **Thierauf et al. (2010)** in

Germany found that 48.6% of unintentional fall from height fatalities and 35.3% of suicides happened under the influence of alcohol. Meanwhile, **Stenbacka et al. (2002)** found that in Sweden, the use of psychoactive drugs was a predictor of falls. In contrast **Fanton et al. (2007)** in France found that the toxicological analysis in cases of fall from height was positive in 75% of the deaths with undetermined manner and in 70% of the suicides but only in 36% of the accidents.

In the present study, falling at home was significantly common in age groups (≤18), (19-40) and (>60) years, meanwhile falling at work place were significantly common in age group (41-60) years.

Chang and Tsai (2007) found that in Taiwan, the home was the scene for 73% of slips, trips and 86% of falls among children. **Kent and Pearce (2006)** stated that in Australia, there was considerable morbidity and mortality associated with falls from heights especially in the elderly at home. **Prathapan & Umadethan (2015)** stated that in India, most of victims (87.5%) were construction workers in the age group of 20 – 60 years affected at work place. Also, **Chan et al. (2008)** reported that in Serbia and Montenegro, workers aged 45–49 experienced the highest number of fatal fall accidents at work place.

Wong et al. (2005) explained the highest number of fall accidents at work place among workers in the age group of 40–44 due to both their youth behaviors and their higher proportions who working in the construction projects. Meanwhile, **Grivna et al. (2014)** stated that the higher incidence of falling of children at home could be explained by the fact that children were often supervised by maids or older siblings without enough experience on safety precautions for falling from height; and falls in elderly common at home due to narrow steps, stairs with four or more steps, absence of railings on stairs, slippery surfaces, and insufficient lighting.

In the present study, accidental falling was common in age groups (≤18) and (41-60) years, meanwhile suicidal manner was common in age groups (19-40) and (>60) years. This was in accordance with **Patil et al. (2013)** who found that children were commonly exposed to accidents, while adults were attributed to suicide, accident or crime. Also **Abrams et al. (2005)** found that in New York City, the elderly subjects aged ≥ 65 years had preferred jumping from height to commit suicide when compared to their younger counterparts.

De Leo et al. 2001) stated that fall from height is a method readily accessible to elderly dwellers of high-rise apartments and, and it is also easier for frail individuals to accomplish than hanging or asphyxiation. The majority of elderly who attempted suicide were widow(er) s, often living alone.

In the present study, it was noticed that high falls were significantly common among different age groups. **Rau et al. (2014)** found that in Taiwan, high-energy falls were less common among the elderly than in the adult population. Meanwhile **Aschkenasy and Rothenhaus (2006)** in USA, found that low-level falls were the most common reason for injury in geriatric patients. This is because the majority of the elderly sustained a ground-level fall was supposed to occur upon walking or with movement, and more adult patients sustained a nonground- level

fall occurring with more rigorous activity.

The present study illustrated that in multiple injuries were significantly common (74%) in high fall, meanwhile head injuries were common (67.6%) in low falls. Blunt trauma was the most common type of trauma in both high and low falls (76.5% and 75.3% respectively). This was in accordance with **Murray et al. (2000)** who found that in USA, victims who fell less than 15 feet had a higher incidence of intracranial injuries than victims who fell more than 15 feet as multiple injuries were common. **AL et al. (2009)** confirmed that in Turkey, multiple blunt injuries were common in falls from greater heights. **Eryilmaz et al. (2009)** observed that in Ankara, Turkey, the intensity of organ pathology tended to increase significantly as the height of falls increased. Also, **Atanasijevic et al. (2005)** reported that in Serbia and Montenegro, fatal head injuries dominated in falls below 7–10 m. Meanwhile, **Kennedy et al. (2001)** found that in UK, victims of falls from low or high levels had serious head injuries.

Kiran and Srivastava (2013) confirmed that in deaths due to fall from height majority of the victims first struck the ground either by head, or by the side of the body or by feet. Head was commonly the site of primary impact while secondary impacts may involve different parts of the body resulting in multiple injuries especially with high level falls.

In the present study, it was revealed that home as a scene of crime was more common in females, while male falling from height was common in work place. This was in accordance with the study carried out by **Grivna et al. (2014)** revealing that the highest risk for falls for UAE nationals and females was at home, while work related falls were more for expatriate males. In contrast **Kent and Pearce (2006)** found that in Australia, male predominance (91%) was seen in falls both at work and at home.

In the present study, accidental manner was significantly prevalent among males (44.4%) on the other hand suicidal manner was common among females (40.3%). This was in agreement with **Turk and Toskos (2004)** who found that in Germany, in fall accidents, there were almost exclusively male victims (91%) in fall accidents. However, **Fanton et al. (2007)** confirmed that in France, most of the suicide victims in cases of fall from height were women. Additionally, **Goren et al. (2003)** reported that in Diyarbakir, Turkey, females had a higher suicide rate than males.

In the present study, high fall was the most common type of fall (86.7% in males, 88.2% in females). This was in contrast with **Kennedy et al. (2001)** who found that in UK, one of the most frequent types of falling from heights was falls from a low height and that this type of fall was more frequent in women especially of advanced age.

CONCLUSION

The current study concluded that:

1. Fall from height deaths constituted 3.25% of all deaths (8,317) that were autopsied in the same period of the study with the majority of them were males in age group (19-40) years.

2. The highest incidence of fall from height occurred in Cairo (45.9%), followed by Giza (31.9%), then Qalubia (22.2).

3. The majority (75.6%) of cases sustained blunt trauma. Home was the most common (50.7%) scene for fall injury, followed by work place (34.1%).

4. The most common injured anatomical region was multiple injuries (67.4%), followed by the head (27.0%). Accidental manner represented 37.8% of cases, suicidal and homicidal manners represented 33.3% and 28.9% respectively and the majority of cases (87.4%) sustained high falls (height >20 feet).

RECOMMENDATIONS

1) Health authorities in all governorates of Egypt should conduct basic surveillance of fall-related deaths to monitor trends in all deaths from falls.

2) The populations at high risk for falls need to be clearly identified and targeted by prevention programs.

LIMITATIONS

The results of present study were limited by the fact that not all fatal injuries are referred to Cairo Department of Forensic Medicine (Zenhum morgue), Ministry of Justice, Egypt, as only criminal suspected cases are referred; therefore, many of the fatal accidental falls from height cases were not dissected and subsequently not included in the present study.

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الملخص العربى

نمط الاصابات القاتلة للسقوط من علو بالقاهرة الكبرى: دراسة تحليلية مرجعية (2009-2013)

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إن حالات الوفاة الناجمة عن السقوط من علو تتزايد سنويا. وضحايا السقوط من ارتفاع تميل للحفاظ على نمط فريد من الإصابات التي تعتمد على العديد من العوامل مثل القصور الذاتي للجسم، وطبيعة الأرض التي سقط عليها الجسم. لذلك فقد اجريت هذه الدراسة لتحديد وتحليل نمط الاصابات القاتلة للسقوط من علو في القاهرة الكبرى فى الفترة من اول يناير 2009 الى نهاية ديسمبر 2013 ، من خلال دراسة التقارير الطبية الشرعية المحفوظة بقسم الطب الشرعي بالقاهرة (مشرحة زينهم) لهذه الحالات. وقد اشتملت هذه البيانات على (معدل الحدوث، و الخصائص الديموجرافية "كالعمر، و الجنس، و محل الإقامة، و المهنة"، و مسرح الجريمة، و نوع الاصابة، و مكان الاصابة، و نمط و آلية الوفاة، .....). **وقد اظهرت نتائج الدراسه ما يلى**: مثلت الوفيات الناشئة عن الإصابات القاتلة للسقوط من علو نسبة 3.25% من المجموع الكلى للوفيات خلال فترة الدراسة واعلى نسبة حدوث كانت بعام 2009 وهي 4.5%. معظم الحالات كانت فى الفئه العمرية من 19 – 40 عام (59.5%)، واقل فئه عمريه كانت اكثر من 60عام (4.8%). ارتفاع نسبة الضحايا من الرجال (55.9%) مقارنة بالنساء. و كانت أهم الإصابات الناتجه من السقوط من علو هي الإصابات المتعددة وتمثل 67.4% ثم الاصابات الدماغيه (27%) والبطن (2.2%) والصدر (1.9%) واخيرا العمود الفقارى (1.5%). ارتفاع نسبة الأسباب العرضية (حوادث) حوالى 37.8%. مكان السقوط في معظم الحالات كان المنزل بنسبة (50.7%) ويليه السقوط من علو فى اماكن العمل بنسبة (34.1%). **وقد خلصت الدراسة إلى** إتفاق النتائج التي تم رصدها مع ما انتهت إليه المراجع العلمية من حيث ارتفاع الإصابات الناتجه عن السقوط من علو، مع زيادة الأسباب العرضيه لها، وصغرمتوسط العمر لضحايا السقوط من علو، و كذلك نوع ونمط الإصابة وكيفية حدوثها وأسبابها.