RESEARCH

Postmortem Analysis of Fall Victims According to Age Groups: A Comparative Study

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ABSTRACT

Fall represents an important cause of death and its relation with the population aging evidences the need of a broad analysis considering different aspects associated with its occurrence. The objective of this study was to compare fatal victims due to unintentional fall among adults, young olds, olds, and oldest olds, according to sociodemographic data, characteristics, and severity of the trauma. This study is a cross-sectional, comparative study analyzing autopsy reports of fatal victims due to fall, admitted to the Medical Legal Institute of Sao Paulo, Sao Paulo, Brazil, in 2015. The following age groups were: adults (≥18 and <60 years), young olds (≥60 and <70 years), olds (≥70 and <80 years), and oldest olds (≥80 years). The Pearson's χ^2, Fisher's exact, Kruskal–Wallis, and Dunn tests were applied to compare the groups, with a significance level of 5%. Regarding the 469 fatalities analyzed (57.8% males, mean age: 71.3 ± 18.2 years), there was a higher frequency of oldest olds (43.5%), ground-level falls (70.1%), femoral fractures (35.0%), and delayed deaths (79.6%) due to posttraumatic complications (57.2%). Adults, young olds, olds, and oldest olds differed significantly ($p \leq .005$) in relation to the total of analyzed variables, with a special remark on the differences between the age extremes. High frequencies of femoral fractures and delayed deaths due to complications of treatment in low-severity fall victims, especially those older than 70 years, make it necessary to improve fall prevention programs in the older adults and to create a line of care for this population.

Key Words

Elderly, Falls accidents, Mortality, Trauma severity index, Wounds and injuries

Accidental and intentional trauma constitutes a worldwide public health problem (World Health Organization [WHO], 2016). Among the deaths due to accidental trauma in 2016, the main categories were traffic accidents (28.7%), followed by falls (13.5%; WHO, 2018).

The epidemiological research studying mortality in different countries (Hasler, Srivastava, Aghayev, Keel, Exadaktylos, & Schnuriger 2014; Heim et al., 2014; Masud & Morris, 2001; Vieira et al., 2018; Yoshida, 2019) reinforces the importance of analyzing the aspects of this type of trauma due to the prominence of falls as cause of mortality.

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None

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The WHO defines a fall as an event that results in a person inadvertently coming to the ground or at a lower level (WHO, 2018), emphasizing that this type of trauma is intrinsically related to the aging process, that is, the number of falls increases in magnitude as the population grows older (Sao Paulo State Department of Health, 2010).

In this sense, it is important to highlight the alteration of the profile of the world population pyramid due to the increase in life expectancy of the population. In 2006, the estimate of people older than 60 years was 688 million, whereas by 2050, the projections show magnitudes of more than 2 billion elderly people worldwide (Sao Paulo State Department of Health, 2010).

The WHO defines the elderly group according to the chronological age, using a threshold of 60 years or more in developing countries and 65 years or more in developed countries (WHO, 2002).

Studies have shown that the older adults are more susceptible to falls than young people (Bolandparvaz, Yadollahi, Abbasi, & Anvar, 2017; Chen, Mo, Yi, Jiang, & Mao, 2013), with emphasis on individuals older than 80 years, the fastest growing group within the elderly population (Sao Paulo State Department of Health, 2010).

In the hospital context, old age has been identified as one of the main death risk factors for victims who have

suffered some type of fall (Liu, Obermeyer, Chang, & Shankar, 2015; Rodrigues & Ciosak, 2012) and as a result of this mechanism, the mortality rate increases considerably with age (O'Neill, Brady, Kerssens, & Parks, 2012; WHO, 2002).

Another important aspect analyzed in several studies is the comparison of the characteristics of the falls contrasted with the characteristics of the victims, distributed in different age groups. It is interesting to observe in these investigations that there is heterogeneity in the distribution of the categories of victims older than 65 years (Jagnoor et al., 2012; Miu, Curtis, & Balogh, 2016; Orces & Alamgir, 2014).

In Brazil, more than 107,000 elderly people (older than 60 years) were hospitalized after suffering some type of fall and approximately 10,000 died as a result of this mechanism (Ministry of Health, 2019).

Research has shown that older adults (≥60 years) were more frequently victims of ground-level falls than adults (≥13 and <60 years; Miu et al., 2016), showing that due to older adults frailty associated with extrinsic factors, falls have significant consequences on the physical health of this population, considerably increasing health care costs (Maia, Viana, Arantes, & Alencar, 2011).

The following factors are considered as justifications for this study: the paucity of studies that analyze fatalities due to falls, including the severity of traumatic injuries; the heterogeneity of the categories of older adults used in the investigations; and the lack of Brazilian research that analyzes fall mortality aspects with a focus on the comparison of different age groups.

Those are the reasons that highlight the relevance of this investigation, aimed to answer the following research question: Are there differences in the characteristics and severity of trauma among fatal fall victims according to different age groups?

In this sense, this study compared fatal victims due to unintentional fall among adults, young olds, olds, and oldest olds, according to sociodemographic data, as well as by the characteristics and severity of the trauma.

METHODS

This is a cross-sectional, comparative, quantitative-based study using data from fall fatal victims admitted to the Medical Legal Institute of Sao Paulo, Brazil, from January 1, 2015, to December 31, 2015. All fall victims who evolve to death in Brazil, whether in the pre- or inhospital setting, should be sent to the Medical Legal Institute to perform an autopsy.

The convenience sample was collected through the analysis of the autopsy reports of the victims. The police reports were consulted to complement the reports on information regarding the time and place of the deaths.

The inclusion criteria were age 18 years or more, fatality due to a fall characterized in one of the categories W01-W19 (Falls) of Chapter XX (External causes of morbidity and mortality) of the *International Classification of Diseases, Tenth Revision* (*ICD-10*; WHO, 2010), and presenting anatomical injuries coded by the Abbreviated Injury Scale (AIS; Association for the Advancement of Automotive Medicine [AAAM], 2015). Victims of intentional self-injury were excluded from the sample.

Whereas the data included fall victims referred to only one of the legal medical institutes of Sao Paulo, Brazil, and that the information was based on the retrospective analysis of autopsy reports, the selection bias should be considered as it may impact on the external validity of the results presented later.

An instrument was developed by the researchers to collect the information about the sociodemographic characteristics of the victim and the occurrence of the fall, the injuries identified in the autopsy reports, and the severity of the trauma, in addition to the moment of death. This latter item was broken down in: immediate (death on the accident scene), early (deaths occurring at the hospital within 24 hr of the trauma), and late (deaths that occurred in the hospital after 24 hr of trauma), as well as the cause of death described by the coroner.

The categorization of age groups used the Institute of Applied Economic Research (IPEA, 2016) classification defined as: adults (≥18 and <60 years), young olds (≥60 and <70 years), olds (≥70 and <80 years), and oldest olds (≥80 years). Institute of Applied Economic Research is a public institution that provides technical support to the federal government in the formulation and monitoring of public policies, plans, and development programs based on the realization and dissemination of research results and social and economic studies of the Brazilian population (IPEA, 2016).

The severity of the trauma was defined using the Injury Severity Score (ISS; Baker, O'Neill, Haddon, & Long, 1974) and the New Injury Severity Score (NISS; Osler, Baker, & Long, 1997) identifying the AIS code of each traumatic injury described in the autopsy reports by means of the AIS manual 2008—update 2015 (AAAM, 2015). The AIS scores may vary from 1 to 6. Those AIS injuries of three or more pose a potential threat to the life of the traumatized person (AAAM, 2015).

The data collected were stored in Microsoft Office Excel version 2016 spreadsheets. To ensure the safety of the collected data, patient information was saved on a protected computer with restricted access to study researchers.

To evaluate the relationship between age groups of individuals involved in fatal falls and both demographic and fall characteristics, hypothesis tests were performed using software Statistical Package for the Social Sciences version 20. For all analyzes, significance was reported at a level of 5%.

The first comparison was in relation to the patient's gender. Pearson's χ^2 test was used to identify whether age and gender variables could be considered independent (Table 1). Then, to identify where (and if) the dependence between variables was concentrated in specific age groups, the same test was performed considering, now, only two age groups at a time. The results can be found in Table 2.

Equivalently to the previously described, the Pearson's χ^2 test was used for the other nominal variables (when the assumption of five-element expected in all cases was not fulfilled, the Fisher's exact test was performed instead; Tables 3 and 4).

When the statistics indicated dependence among age groups and the variable been analyzed, the pairwise comparison was followed (the results can be seen in Table 2) using the same method. Therefore, this procedure was adopted for the variables fall level, location of more frequent AIS lesions of 3 or more, moment of death, and cause of death.

For continuous variables related to the trauma severity (ISS, NISS, number of affected body regions, and number of injuries AIS score of ≥3), the Kolmogorov–Smirnov test was first performed to assess the normality of the data. Because none of the variables could be considered normal, the Kruskall–Wallis' nonparametric test was used to compare their values among the age groups (Table 5). When the result indicated a statistically significant difference among them, it was followed for pairwise comparison using Dunn' nonparametric test (Table 2).

The research ethics committee of the institution approved this research (Opinion # 2.026.639).

RESULTS

Among the 469 fatalities produced by falls included in the study, there was a predominance of males (57.8%), White (73.1%), with a mean age of 71.3 (18.2) years. Regarding age groups, 123 (26.2%) were adults, 60 (12.8%) young olds, 82 (17.5%) olds, and 204 (43.5%) oldest olds. A total of 329 (70.1%) victims suffered a ground-level fall.

Regarding the severity of the trauma, it was observed that the mean ISS and NISS scores were 13.0 (7.6) and 16.0 (11.1), respectively. In the distribution of the sample by severity category, 333 (71.0%) victims presented mild trauma (ISS ≤15), 52 (11.1%) moderate trauma (ISS ≥16 and <25), and 84 (17.9%) severe trauma (ISS ≥25). Regarding the NISS score, 298 (63.5%) victims presented mild trauma (NISS ≤15). Moderate trauma (NISS ≥16 and <25) and severe trauma (NISS ≥25) were less frequent: 109 (23.3%) and 62 (13.2%), respectively.

The average number of affected body regions was 1.7 (0.9) whereas one (0.2%) victim presented injuries in the six body regions. As for the number of AIS injuries of three or more, the mean was 1.4 (0.9) per victim, ranging from one to seven injuries.

A more detailed distribution of all AIS injuries of three or more identified in the fatal victims due to fall highlights the frequency of femoral fracture (35.0%) as well as subdural (33.5%) and cerebral hematomas (14.3%).

Figure 1 shows the distribution of these deaths over time. It is observed that the great majority occurred after 24 hr of the traumatic event (79.5%) been remarkable a high frequency of these events after 11 days of hospital admission, with 204 (43.5%) cases.

The main cause of death of the victims was due to complications after trauma (57.2%), followed by traumatic brain injury (33.0%). Among posttrauma complications, the infectious ones (59.7%) were predominant.

Considering the comparative analysis of the groups (123 adults, 60 young olds, 82 olds, and 204 oldest olds), the data in Table 1 show that there was a significant difference ($p < .001$) between the age groups in relation to the sex. Male victims were more frequent in the adult (85.4%), young olds (75.0%), and olds (56.1%) age groups. However, there is a prevalence of women

TABLE 1 Fatal Victims by Falls According to Age, Gender and Fall Level, Sao Paulo, Brazil, 2015

Variables	Age Groups				*p*
	Adults, *n* (%)	Young Olds, *n* (%)	Olds, *n* (%)	Oldest Olds, *n* (%)	
Gender					
Female	18 (14.6)	15 (25.0)	36 (43.9)	129 (63.2)	<.001[a]
Male	105 (85.4)	45 (75.0)	46 (56.1)	75 (36.8)	
Fall level					
From a level to another	69 (56.1)	26 (43.3)	23 (28.0)	22 (10.8)	<.001[a]
Ground-level fall	54 (43.9)	34 (56.7)	59 (72.0)	182 (89.2)	

[a]*Pearson's χ^2 test.*

TABLE 2 Comparative Analysis Between Pairs of Groups by Study Variables, Sao Paulo, Brazil, 2015

Variables	Adults × Young Olds, *p* Value	Adults × Olds, *p* Value	Adults × Oldest Olds, *p* Value	Young Olds × Olds, *p* Value	Young Olds × Oldest Olds, *p* Value	Olds × Oldest Olds, *p* Value
Sex	.087[a]	<.001[a]	<.001[a]	.020[a]	<.001[a]	.003[a]
Fall level	.105[a]	<.001[a]	<.001[a]	.058[a]	<.001[a]	<.001[a]
ISS	.079[b]	.005[b]	<.001[b]	1.000[b]	.384[b]	.944[b]
NISS	.327[b]	.002[b]	<.001[b]	1.000[b]	.010[b]	.357[b]
Number of affected body regions	1.000[b]	<.001[b]	<.001[b]	.133[b]	.368[b]	1.000[b]
Number of AIS ≥ 3 injuries	1.000[b]	.001[b]	<.001[b]	.116[b]	.001[b]	1.000[b]
Femur fracture - Yes	.028[a]	<.001[a]	<.001[a]	.028[a]	<.001[a]	.050[a]
Subdural hematoma - Yes	.933[a]	.559[a]	.006[a]	.679[a]	.036[a]	.074[a]
Cerebral hemorrhage - Yes	.833[a]	.023[a]	.001[a]	.027[a]	.002[a]	.804[a]
Basilar skull fracture- Yes	.164[a]	.001[a]	<.001[a]	.070[c]	.011[c]	1.000[c]
Moment of death	.761[c]	.002[c]	<.001[c]	.006[c]	<.001[c]	.703[c]
Cause of death	.856[c]	<.001[c]	<.001[c]	.034[c]	<.001[c]	.167[c]

Note. AIS = Abbreviated Injury Scale; ISS = Injury Severity Score; NISS = New Injury Severity Score.
[a]*Pearson's χ^2 test.*
[b]*Dunn test.*
[c]*Fisher's exact test.*

among the oldest olds (63.2%). These results show that falls happen differently among the elderly when considering age groups and gender.

In the distribution according to age groups and fall level, the data in Table 1 show that the frequency of ground-level events increased with age, being predominant

TABLE 3 Fatal Victims by Fall According to Age Groups and Frequent AIS Injuries of Three or More, Sao Paulo, Brazil, 2015

More Frequent AIS Score of ≥3 Lesions	Category	Age Groups				*p*
		Adults, *n* (%)	Young Olds, *n* (%)	Olds, *n* (%)	Oldest Olds, *n* (%)	
Femoral fracture	Yes	12 (9.8)	13 (21.7)	32 (39.0)	107 (52.5)	<.001[a]
	No	111 (90.2)	47 (78.3)	50 (61.0)	97 (47.5)	
Subdural hematoma	Yes	50 (40.7)	24 (40.0)	30 (36.6)	53 (26.0)	.023[a]
	No	73 (59.3)	36 (60.0)	52 (63.4)	151 (74.0)	
Cerebral hemorrhage	Yes	27 (22.0)	14 (23.3)	8 (9.8)	18 (8.8)	.001[a]
	No	96 (78.0)	46 (76.7)	74 (90.2)	186 (91.2)	
Basilar skull fracture	Yes	22 (17.9)	6 (10.0)	2 (2.4)	4 (2.0)	<.001[b]
	No	101 (82.1)	54 (90.0)	80 (97.6)	200 (98.0)	

Note. AIS = Abbreviated Injury Scale.
[a]*Pearson's χ^2 test.*
[b]*Fisher's exact test.*

TABLE 4 Fatal Victims by Falls According to Age Groups and Moment and Cause of Death, Sao Paulo, Brazil, 2015

Variables	Age Groups				*p*
	Adults, *n* (%)	Young Olds, *n* (%)	Olds, *n* (%)	Oldest Olds, *n* (%)	
Moment of death					
Immediate	10 (8.1)	3 (5.0)	2 (2.4)	2 (1.0)	<.001[a]
Early	32 (26.0)	17 (28.3)	8 (9.8)	22 (10.8)	
Late	81 (65.9)	40 (66.7)	72 (87.8)	180 (88.2)	
Cause of death					
Posttrauma complications	42 (34.2)	26 (43.3)	53 (64.7)	147 (72.1)	<.001[a]
Traumatic brain injury	62 (50.4)	27 (45.0)	22 (26.8)	44 (21.5)	
Multiple trauma	11 (8.9)	5 (8.3)	2 (2.4)	–	
Limb trauma	1 (0.8)	–	2 (2.4)	9 (4.4)	
Severe traumatic hemorrhage	5 (4.1)	1 (1.7)	1 (1.3)	2 (1.0)	
Other causes	2 (1.6)	1 (1.7)	2 (2.4)	2 (1.0)	

[a]*Fisher's exact test.*

in young olds (56.7%), olds (72.0%), and oldest olds (89.2%). A significant difference was identified between the groups and the fall level ($p < .001$).

The data in Table 5 show a tendency of falling scores of trauma severity indexes (ISS and NISS) and the number of body regions as age increases. Significant differences ($p < .001$) were identified between the age groups and all variables related to the severity of the trauma: ISS, NISS, number of body regions, and AIS injuries of three or more.

The analysis of the more frequent (number of cases >30) AIS injuries of three or more in Table 3 shows that adults presented higher percentages of head injuries than the other groups (except cerebral hemorrhage). On the contrary, femoral fractures prevailed in the oldest olds. There were significant differences among age groups as well as among the more frequent AIS injuries of three or more, namely, femoral fracture ($p < .001$), subdural hematoma ($p = .023$), cerebral hemorrhage ($p = .001$), and basilar skull fracture ($p < .001$).

Analyzing the age groups in relation to the time of death (Table 4), a higher frequency of late deaths was observed in all groups. Among the deaths at the scene of the traumatic event (immediate), the adults (8.1%) were more frequent. There was a statistically significant difference between the groups and the moment of death ($p < .001$).

The data in Table 4 show that the frequency of posttrauma complications as the leading cause of death

TABLE 5 Fatal Victims by Fall According to Age Groups and Severity of Trauma, Sao Paulo, Brazil, 2015

Trauma Severity	Age Groups				*p*
	Adults, Median (Minimum-Maximum)	Young Olds, Median (Minimum-Maximum)	Olds, Median (Minimum-Maximum)	Oldest Olds, Median (Minimum-Maximum)	
ISS	16.0 (4–41)	10.0 (1–35)	9.0 (4–33)	9.0 (1–29)	<.001[a]
NISS	19.0 (4–75)	13.5 (1–59)	10.0 (4–48)	10.0 (1–50)	<.001[a]
Number of affected body regions	2.0 (1–6)	1.5 (1–5)	1.0 (1–4)	1.0 (1–4)	<.001[a]
Number of AIS injuries of three or more	1.0 (1–7)	1.0 (1–4)	1.0 (1–7)	1.0 (1–5)	<.001[a]

Note. AIS = Abbreviated Injury Scale; ISS = Injury Severity Score; NISS = New Injury Severity Score.
[a]*Kruskal–Wallis test.*

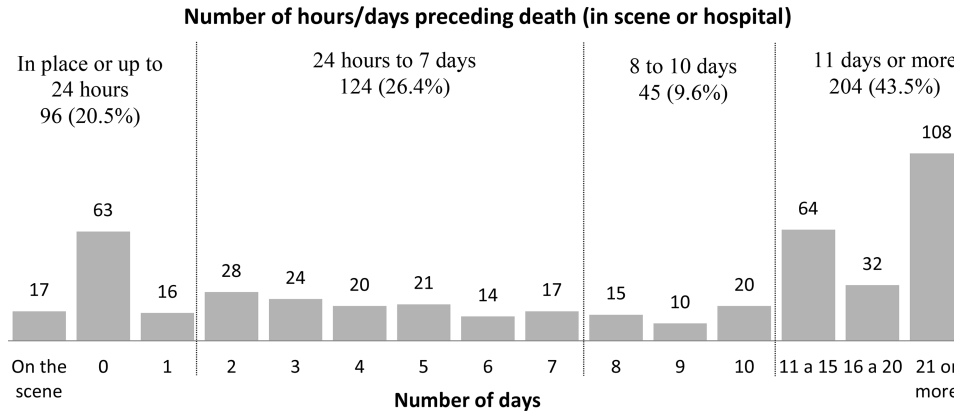

Figure 1. Fatal victims by fall according to time of death. Sao Paulo, Brazil, 2015.

increased with age. On the contrary, the opposite was valid for deaths due to traumatic brain injury: higher frequency in adults. This variable (cause of death) also differed significantly among age groups ($p < .001$).

Table 2 presents a summary of the 12 variables that differed significantly between the analyzed age groups. It was observed that, in the comparison of group pairs, these differences occurred more frequently between extremes of age: adults and oldest olds (12 variables), adults and olds (11 variables), and young olds, and oldest olds (10 variables). Groups that were close to age range (adults vs. young olds, young olds vs. olds, and olds vs. oldest olds) were similar in most of the variables analyzed. We highlight the variable occurrence of femur fracture that differed significantly between all groups.

DISCUSSION

Falls occupy a prominent position in trauma morbidity and mortality, representing the most common injury mechanism in the geriatric population, with an annual incidence of 30% in individuals older than 65 years of age and 50% in those older than 80 years. In addition, a considerable number of investigations carried out in different countries point out to a relationship between morbidity and mortality due to fall and old age (Arslan et al., 2014; Bolandparvaz et al., 2017; Hefny, Abbas, & Abu- Zidan, 2016; Jagnoor et al., 2012), reinforcing the importance of research aimed toward this type of trauma in the elderly population.

In relation to the age groups of the older adults, characterized in this study in three groups (young olds, olds, and oldest olds), a great diversity in the definition of this variable was identified in the literature: older than 50 years (Kent & Pearce, 2006; Korhonen, Kannus, Niemi, Palvanen, & Parkkari, 2013); older than 55 years (Içer, Guloglu, Orak, & Ustundag, 2013); older than 60 years (Hefny et al., 2016; Parreira et al., 2010; Rodrigues & Ciosak, 2012); and 65 years and older (Allen et al., 2015; Kocuvan, Brilej, Stropnik, Lefering, & Komadina, 2016; Liu et al., 2015; Rau et al., 2014; Spaniolas et al., 2010). It should be noted that these studies did not categorize the older adult population in different age groups.

Many studies have used the age of 65 years as a cut-off point for the definition of the older adults, and most of these studies analyzed developed countries (Alamgir, Muazzam & Nasrullah, 2012; Allen et al., 2015; Kramarow, Chen, Hedegaard, & Warner, 2015; Labib et al., 2011; Liu et al., 2015; Moudouni & Phillips, 2013; Rau et al., 2014), where this population is expressive, as well as the prevention programs as in Canada, which in 2001 had already developed more than 50 fall prevention programs (Division of Aging and Seniors, 2001). The disparity in the analysis using diverse age groups breakdown and older adult definitions (Jagnoor et al., 2012; Miu et al., 2016; Orces & Alamgir, 2014; Rodrigues & Ciosak, 2012) often makes it difficult to compare the results.

The present investigation identified a predominance of males among fatal victims due to falls. Compared with the results of other studies, there are contradictions related to the prevalence of each sex (Allen et al., 2015; Bolandparvaz et al., 2017; Nakada, Nakao, Mizushima, & Matsuoka, 2015; O'Neill et al., 2012; Park et al., 2016). Intense pain and presence of chronic diseases are reported as risk factors for falls in both sexes (Gale, Cooper, & Sayer, 2016).

Research conducted in the United Kingdom identified a higher incidence of female victim survivors of fall, and this is related to the loss of bone mineral density as a consequence of menopause resulting in higher rates of falls and fractures in women (Daly et al., 2013). These data may explain the increased frequency of women who died after falling according to changes in the age brackets in the older adult categories in the present investigation.

Considering the age and gender in individuals who fell and died, we observed that there has been a higher percentage of males in the groups of adults (85.4%), young olds (75.0%), and olds (56.1%). As to females, the

oldest olds group showed expressive higher frequencies (63.2%) than the male group (36.8%).

A Brazilian study (Meschial et al., 2014) evaluated elderly people who fell and were treated by the prehospital and also identified the higher frequency of events in women (35.9%) than in men (21.7%) in the older age group (80 years of age or older).

These results highlight the importance of understanding these differences between age and gender in the incidence of falls and all the circumstances and characteristics associated with these variables, such as costumes, social values, behavioral models, presence of comorbidities, and physical activity among others, that are key points to understand these differences and develop appropriate preventive programs, as risk factors also differ between these groups.

The average age (approximately 71 years) and higher frequency of oldest olds (43.5%) in the casuistic encompassed by this research corroborate with findings of other studies (Arslan et al., 2014; Labib et al., 2011; Liu et al., 2015; O'Neill et al., 2012; Park et al., 2016). Older people are more vulnerable to trauma than young people. With age, less energy of trauma is required for serious injuries to occur. In this sense, older adults who suffer a trauma have greater susceptibility to sequelae and chances of death due to the presence of comorbidities and decreased functional reserve (Champion et al., 1989; Gioffrè-Florio, Murabito, Visalli, Pergolizzi, & Famà, 2018). Research that analyzed data from the National Trauma Data Bank showed that older adults older than 70 years, victims of falls, and presenting a Glasgow Coma Scale score of less than 15 present a significant risk of death during hospitalization (Spaniolas et al., 2010).

In relation to the level of falls, more than 70% of the study's sample were ground-level falls and the victims were mainly among the olds and oldest olds, concurring with findings of the research carried out in Taiwan (Rau et al., 2014). Although ground-level falls are considered low-energy injuries, they become a significant risk factor for morbidity and mortality among the older adults, because from 38% to 47% of patients who fall from their height evolve with fatal outcome (Spaniolas et al., 2010).

It is also emphasized that older adults who suffered a fall from their height are more susceptible to a second event (Chisholm & Harruff, 2010). Nonfatal older adult victims after ground-level falls are more likely to be readmitted at hospital within 1 year after the injury and, therefore, this population should have priority of referral to rehabilitation services in order to minimize the occurrence of these readmissions (Wong et al., 2019).

Regarding the severity of the trauma as measured by the ISS and NISS indexes, a significant difference was identified between the analyzed groups and a trend of falling scores with increasing age. These findings differ from some studies that examined fall victims and identified that the median ISS increased with age (Bhattacharya, Maung, Schuster, & Davis, 2016), and values for both ISS (Allen et al., 2015; Rau et al., 2014; Spaniolas et al., 2010) and NISS (Rau et al., 2014) were significantly higher in the older adults than in the hospitalized adults. Only one research conducted in Singapore has identified that the ISS average decreased with increasing age (Wong et al., 2015).

According to the ISS and NISS averages, the fatal victims of this study were more often classified as mild traumas. American research has shown that ISS of 16 or more is one of the significant risk factors for death up to 30 days after injury from ground-level falls in the elderly (Mangram et al., 2016). Therefore, the results of this study lead us to reflect on the impact of these injuries on fragile individuals susceptible to unfavorable outcomes, development of complications, and even to be underestimated in screening and treatment, because they present injuries that are considered less serious but nonetheless fatal in the end.

Studies have suggested that older adult patients are likely to have their needs underestimated because they present less serious injuries, even in top-level services, irreversibly affecting outcomes and leading to avoidable deaths (Tepas et al., 2000; Zimmer-Gembeck et al., 1995). Avoiding the development of complications and not underestimating the severity of the injuries in this more fragile population are crucial points to increase the probability of survival (Chiang et al., 2012; Smith, Enderson, & Maull, 1990).

In the analysis of the most frequent severe injuries in fall victims, a significant difference was identified between the groups in relation to the presence of a femoral fracture. The oldest olds presented a higher frequency of this injury. A study that analyzed approximately 57,000 hospitalized fall victims showed that the older adults older than 70 years had a significantly higher frequency (53.4%) of long bone fractures than adults (33.4%; Spaniolas et al., 2010). The incidence of femoral fracture is higher in women and in the age group of 80 years or older (Oliveira & Borba, 2017). American research has shown that older people who fell presented more severe injuries on limbs and pelvic ring (Sterling, O'Connor, & Bonadies, 2001). In this sense, it is worth highlighting some data of this study: expressive elevation of the frequency of fatal cases in women, ground-level falls, and occurrence of femur fracture after 70 years of age.

Analyzing the moment of death, this study observed a higher frequency of late deaths in all groups, with higher percentages in the olds and oldest olds. A study conducted in Germany found that of the 201 fall victims admitted to the hospital, 106 died between 1 and 120 days of hospitalization (Arbes & Berzlanovich, 2015). Researchers

reported that late inhospital mortality was influenced by the "increased age effect" of low-height fall victims (Wong et al., 2015).

The most frequent cause of death observed in this study was the occurrence of complications after trauma (57.2%), with emphasis on infectious complications. Infections are the most frequent hospital complications in victims of trauma (Lopes, Aguiar, & Whitaker, 2019). A comparative study on the impact of falls in adults and the older adults identified that deaths in the geriatric population occurred mainly due to complications, the main one being pneumonia (Sterling et al., 2001). American research that analyzed the causes of deaths among adults and older adult victims of falls identified a higher percentage of complications due to injury in patients older than 64 years, the main one being multiple organ failure (Allen et al., 2015).

It is worth mentioning that the occurrence of complications in trauma victims, besides increasing up to 2.7 times the probability of death (Moore et al., 2016), is considered one of the main quality indicators described by the American College of Surgeons Committee on Trauma, recommending its monitoring, due to the impact on the clinical outcomes of these patients, as well as been assessed related to the adherence of the professionals to the guidelines for improved practices and quality in trauma care (Glance, Stone, Mukamel, & Dick, 2011).

Finally, the findings of this study highlight the frailty of the older adults, especially the oldest olds, who suffered a fall, reinforcing the importance of fall prevention programs in this population, in addition to the early recognition and daily evaluation of these patients while they are still hospitalized, eligible for inclusion in home-based prevention programs after hospital discharge, as a strategy for monitoring, follow-up, and reduction of potential harm (Ontengco, 2019).

Limitations of the Study

Some limitations should be considered: the data refer to only one institution that serves the north and central regions of the city of Sao Paulo, bringing possible restrictions to the generalization of results. In addition, because it is a retrospective analysis of the autopsy reports, the findings depend on the quality of the records and some information, such as the height of the fall, was not able to be analyzed.

CONCLUSION

Adults, young olds, olds, and oldest old fatalities due to unintentional fall presented significant differences in relation to sex and the variables on the characteristics and severity of the trauma, especially when comparing extremes of age. High frequencies of femoral fractures and delayed deaths due to complications of treatment in low-severity victims, especially those older than 70 years, advise in favor of improving and intensifying fall prevention programs addressed to the older adults and to create a line of care for this population group affected by trauma events resulting from falls, with emphasis on quality care guided by best practices and patient safety.

KEY POINTS

- Falls are among the main causes of death in the older adult population.
- The characteristics and severity of trauma between fatal victims due to fall differ among age groups, showing that older adults are more susceptible to unfavorable outcomes, even in the presence of mild trauma.
- The occurrence of complications in hospitalized older adults after a fall has a high incidence, directly impacting the death rate; therefore, it is crucial to develop a specific care line for the older adult population affected by this disease, thus optimizing assertiveness in treatment and clinical evolution.
- Falls are multifactorial events and, therefore, the development of prevention programs must respect the specificities of each age group to obtain more effective results.

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