REUFSM
REVISTA DE ENFERMAGEM DA UFSM

UFSM
Rev. Enferm. UFSM - REUFSM
Santa Maria, RS, v. 11, e29, p. 1-19, 2021
DOI: 10.5902/2179769247475
ISSN 2179-7692

Original Article Submission: 06/20/2020 Acceptance: 10/8/2020 Publication: 03/30/2021

Factors associated to the time of death of trauma victims: A retrospective cohort study*

Fatores associados ao tempo da morte de vítimas de trauma: estudo de coorte retrospectivo

Factores asociados al momento de la muerte de víctimas de traumatismos: estudio de cohorte retrospectivo

Daniela Vieira de Andrade Batista[I], Carolina Cassiano[II], Luciana Maria Capurro de Queiroz Oberg[III], Daniele Muñoz Gianvecchio[IV], Regina Marcia Cardoso de Sousa[V], Lilia de Souza Nogueira[VI]

Abstract: Objective: to identify factors associated to the time of death of trauma victims. Method: a retrospective cohort that analyzed autopsy reports of trauma victims admitted in 2015 at the Central Institute of Forensic Medicine of São Paulo, Brazil. The time of death was identified from the trauma moment to the confirmation of death. The generalized linear model was applied to analyze the data. **Results:** among the 1,500 fatal victims (75.7% were men; mean age of 49.7 years old), falls prevailed (33.5%), followed by aggressions (27.8%). The factors associated with the time of death were the number of body areas affected ($p<0.001$), type of trauma ($p<0.001$), gender ($p=0.009$), trauma severity according to the New Injury Severity Score ($p<0.001$), assaults ($p>0.001$), and intentionally self-harm injuries ($p<0.001$). **Conclusion:** women, victims of traumas with the intention of causing death and with high severity presented a reduced survival time after the injury(ies).

Descriptors: Wounds and Injuries; Trauma Severity Indices; Autopsy; Risk Factors; Mortality

[I] Nurse, MS in Sciences, PhD student of the Graduate Program in Adult Health Nursing at the School of Nursing, University of São Paulo, São Paulo, SP, Brazil. E-mail: silva.danivieira2@gmail.com. Orcid: https://orcid.org/0000-0003-1035-7620.

II Nurse, specialist in hospital management and in intensive care, MS student of the Graduate Program in Adult Health Nursing at the School of Nursing School, University of São Paulo, São Paulo, SP, Brazil. E-mail: carolina.cassiano@usp.br. Orcid: https://orcid.org/0000-0003-0681-1827.

III Nurse, MS in Sciences, PhD student of the Graduate Program in Adult Health Nursing at the School of Nursing, University of São Paulo, São Paulo, SP, Brazil. E-mail: luciana.oberg@globo.com. Orcid: https://orcid.org/0000-0002-1443-7081.

IV Physician, specialist in forensic medicine and medical examination, Technical Section of the Medical Legal Expertise Team Bem Me Quer of the Institute of Forensic Medicine, São Paulo, SP, Brazil. E-mail: danimunoz@uol.com.br. Orcid: https://orcid.org/0000-0001-6188-6130.

V Nurse, PhD in Nursing, Professor of the Medical-Surgical Nursing Department at the School of Nursing, University of São Paulo, São Paulo, SP, Brazil. E-mail: vian@usp.br. Orcid: https://orcid.org/0000-0002-2575-7937.

VI Nurse, PhD in Sciences, Professor of the Medical-Surgical Nursing Department at the School of Nursing, University of São Paulo, São Paulo, SP, Brazil. E-mail: lilianogueira@usp.br. Orcid: http://orcid.org/0000-0001-5387-3807.

*** Extracted from the dissertation entitled "Time distribution of the deaths of trauma victims and associated factors", Graduate Program in Adult Health Nursing (*Programa de Pós-Graduação em Enfermagem na Saúde do Adulto*, PROESA), School of Nursing, University of São Paulo, 2017.**

Resumo: Objetivo: identificar os fatores associados ao tempo da morte de vítimas de trauma. **Método:** coorte retrospectiva que analisou laudos de autópsia de vítimas de trauma admitidas em 2015 no Instituto Médico Legal Central de São Paulo, Brasil. O tempo da morte foi identificado a partir do momento da ocorrência do trauma até a confirmação do óbito. O modelo linear generalizado foi aplicado para análise dos dados. **Resultados:** entre as 1.500 vítimas fatais (75,7% homens; idade média 49,7 anos), prevaleceram as quedas (33,5%), seguidas das agressões (27,8%). Os fatores associados ao tempo da morte foram número de regiões corporais afetadas (p<0,001), tipo de trauma (p<0,001), sexo (p=0,009), gravidade do trauma segundo *New Injury Severity Score* (p<0,001), agressões (p<0,001) e lesões autoprovocadas intencionalmente (p<0,001). **Conclusão:** mulheres, vítimas de traumas que envolveram intencionalidade de provocar a morte e com elevada gravidade apresentaram tempo de sobrevida reduzido após a(s) lesão(ões).
Descritores: Ferimentos e Lesões; Índices de Gravidade do Trauma; Autopsia; Fatores de Risco; Mortalidade

Resumen: Objetivo: identificar los factores asociados al momento de la muerte de víctimas de traumatismos. **Método:** estudio de cohorte retrospectivo que analizó informes de autopsias de víctimas de traumatismos admitidas en 2015 en el Instituto Médico Legal Central de San Pablo, Brasil. El momento de la muerte se identificó a partir del momento en que sucedió el traumatismo hasta la confirmación de la muerte. Se aplicó el modelo lineal generalizado para el análisis de los datos. **Resultados:** entre las 1.500 víctimas fatales (75,7% de ellas hombres; media de edad de 49,7 años), prevalecieron las caídas (33,5%), seguidas por las agresiones (27,8%). Los factores asociados al momento de la muerte fueron la cantidad de áreas del cuerpo afectadas (p<0,001), el tipo de traumatismo (p<0,001), el sexo (p=0,009), la gravedad del traumatismo conforme al *New Injury Severity Score* (p<0,001), agresiones (p<0,001) y lesiones autoprovocadas intencionalmente (p<0,001). **Conclusión:** las mujeres, víctimas de traumatismos con intención de provocar la muerte y de alta gravedad presentaron un tiempo de sobrevida reducido después de la o las lesiones.
Descriptores: Heridas y Traumatismos; Índices de Gravedad del Trauma; Autopsia; Factores de Riesgo; Mortalidad

Introduction

Trauma is a complex and increasing public health problem that affects global society.[1] In Brazil, in 2018, all accidents and acts of violence represented the fourth main cause of death, preceded by cardiovascular diseases, neoplasias, and respiratory diseases.[2] Also in this year, traumatic events mostly harmed individuals between 20 and 49 years old,[2] the economically active population, resulting in a high number of years of potential life lost. In this context, developing research studies that help mitigate the impact of trauma on the population's health and mortality has been a challenge for researchers of various countries.

By analyzing trauma-related deaths, the trimodal distribution of the deaths was proposed, dividing the death occurrence of the trauma victims into three periods or specific peaks: immediate (deaths that occur minutes after the injury), early (deaths that occur between the first

and fourth hour after the injury), and late (deaths that occur days or weeks after the trauma).[3] Since its publication, the classic trimodal distribution of the deaths became a reference for researchers that study this theme.

Recent research studies identified different periods of the time distribution of fatal events due to trauma.[4-10] The period of immediate deaths was confirmed and is well defined in the literature, i.e., the peak of deaths at the trauma scene[5] or within the first hour after the injury.[6-8] However, regarding the early peak, the period identified in the research studies ranges from less than an hour to 48 hours or more and, for the late peak, this period ranges from four hours to more than seven days.[9-10]

Additionally, researchers described a change in the distribution of deaths due to trauma, going from trimodal to bimodal (the late peak was not observed), unimodal (a single acute peak at the trauma scene), or in continuous decline over time.[12] Such change was mainly associated with improvements in initial care and early and definitive treatment of the victims, especially at the "Golden Hour" (first hour after the injury), considered a crucial period and determinant for the survival chances of the severely wounded victims.[13] Accordingly, it is essential that the response time, defined as the time between the notification of the occurrence and the arrival of the pre-hospital team at the scene, is as short as possible so that the conducts that reduce the immediate deaths are carried out, and the quick referral of the victims to services structured for definitive care is ensured.[14]

Researchers that analyzed the survival time (time interval from trauma to death confirmation) of trauma victims due to traffic accidents and homicides identified that most of the deaths occurred within the first minutes after the event. They also noticed a second peak (35 to 40 minutes) among the victims assisted at hospitals, which was considered a possible result of the postponement of death confirmation due to attempts of cardiopulmonary resuscitation of the traumatized victims.[15] A review study concluded that the variation in the time intervals used

to analyze the distribution of deaths due to trauma is so wide that it is difficult to identify which distribution is more assertive.[16]

Recently, researchers advanced in analyzing deaths due to trauma and researched predictor variables of this outcome in the different periods identified based on time distribution. However, as previously described, the diversity in the time of death considered in the time distribution led to different findings of the risk factors in the case selection researched. The following predictor variables stood out: traumatic brain injury, thorax and abdomen injuries, advanced age, and hemorrhagic shock.[6,8,10] By analyzing the studies[6,8,10] on time distribution of deaths due to trauma and their corresponding predictor factors, beyond incongruities in the outcomes, lack of studies was observed seeking to identify factors associated to the time of death of trauma victims considering the period from trauma to death as a continuous variable.

Therefore, this research intends to mitigate this knowledge gap and to answer the following research question: What factors are associated with the time of death of trauma victims? The identification of groups of trauma victims with characteristics that determine the time until their death is essential to create and improve public policies of prevention and assistance to trauma, strategies for training teams that assist trauma victims, and optimize human and material resources, focused on the provision of quality care and reduction of costs and fatal events. Thus, the objective of this study was to identify the factors associated with the time of death of trauma victims.

Method

This is a retrospective cohort research study that analyzed autopsy reports of trauma victims admitted at the Central Institute of Forensic Medicine (*Instituto Médico Legal*, IML) of São Paulo, Brazil. This institute is subordinated to the Technical-Scientific Police Superintendence

and provides technical bases in Legal Medicine to support the judgment of criminal causes. The Central IML covers death cases in the West and Center regions of São Paulo.

The sample was composed of fatal trauma victims admitted at the Central IML in 2015. People who did not have death times identified, as well as those who had descriptions of traumatic injuries in the autopsy reports not recognized by the Abbreviated Injury Scale (AIS). This is a scale used to describe injuries resulting from traumas and identify their severity. Its score can range from 1 (mild injury) to 6 (severe injury, incompatible with life).[17] Drowning or poisoning cases were excluded, as the physiopathology of these conditions differs from the blunt and penetrating traumas included in the study.

The research dependent variable was the time of death, i.e., the time between the traumatic event and the confirmation of death. The independent variables analyzed were age, gender, race, type of trauma (blunt or penetrating), external cause of morbidity according to chapter XX of the International Classification of Diseases and Related Health Problems - 10th Review (ICD-10),[18] trauma severity according to the Injury Severity Score (ISS)[17] and the New Injury Severity Score (NISS),[19] number of body areas affected, body area most severely injured, and cause of death described by the forensic physician.

The ISS is an injury severity score identified from the AIS score. In order to calculate the ISS, six body areas are considered (head/neck, face, thorax, abdomen/pelvic content, extremities/pelvic girdle, and external surface), and the index score is obtained by adding the squares of the highest AIS scores from three different body areas.[17] The main criticism to the ISS is that the index does not consider, for its calculation, more than one injury that occurred in the same body area and may underestimate trauma severity. The NISS was created to correct this limitation, calculated from the sum of the squares of the highest AIS scores, regardless of the body area affected.[19] The ISS and NISS indexes range from 1 to 75 points, and scores < 16

characterize mild trauma, ≥ 16 and < 25 moderate trauma, and ≥ 25, severe trauma.[17,19] To calculate both indexes, it is essential to identify all of the victim's traumatic injuries.

Data collection was carried out from March to September 2016, reading the autopsy records, transcribing the traumatic injuries to calculate ISS and NISS, and whenever necessary, the identification of the time of death was supplemented through the access to the victims' police reports. For the descriptive and inferential analysis of the study, the *Statistical Package for the Social Science* – version 22 (SPSS-22®) and R 3.3.2® programs were used. A generalized linear model for gamma distribution and a log function was developed to identify factors associated with the time of death of trauma victims. The Variance Inflation Factor (VIF) was applied to detect the probability of multicollinearity among the variables that remained in the final model, with VIF values ≥ 5 indicating collinearity. *Nagelkerke* pseudo-r^2 test was used to assess the model's predictive capacity. The significance level adopted in the analyses was 5%.

This research was conducted according to the ethical standards required, defined by Resolution 466/2012 of the Ministry of Health, and was approved by the Research Ethics Committee of the institution on 12/11/2015 (opinion No. 1,363,957). As it analyzes fatal victims, the non-application of the free and informed consent to the family members was authorized by this committee.

Results

During the period studied, 1,679 admissions at the Central IML were due to fatal traumatic causes. Among these victims, 179 did not meet the study inclusion criteria and, in 54 cases, it was not possible to identify the time of death; 116 were victims of drowning or poisoning, and nine did not have traumatic injuries recognized by the AIS. Therefore, 1,500 fatal victims participated in the analysis of this research; 89.3% of the total of those admitted to the Central IML in 2015.

In the case selection, there was a predominance of males (75.7%) and white-skinned (59.6%). The mean age of the victims was 49.7 (±23.6) years old. Blunt trauma prevailed (75.7%), and the most frequent external cause was falls (33.5%), followed by assaults (27.8%), and transport accidents (22.5%), which included pedestrians, cyclists, motorcyclists, and car passengers (Table 1).

Table 1- Characteristics of the traumatic event, body area most severely injured, and cause of death of the victims (n=1,500). São Paulo, Brazil, 2015.

Variables	N	%
Type of trauma		
Blunt	1,135	75.7
Penetrating	365	24.3
External cause according to ICD-10*		
Falls (W01 – W19)†	503	33.5
Assaults (X85 – Y09)‡	418	27.8
Transport accident (V01 – V69)§		
Pedestrian/Cyclist	171	11.4
Motorcyclist	100	6.7
Car passenger	66	4.4
Intentionallly self-harm injuries (X70 – X84)‖	157	10.5
Cause of unknown origin	52	3.5
Other causes (X00-X09, X36, W20, W54, W87)¶	33	2.2
Body area most severely injured		
Head/Neck (yes)	810	54.0
Face (yes)	6	0.4
Thorax (yes)	418	27.9
Abdomen/Pelvic content (yes)	152	10.1
Extremities/Pelvic girdle (yes)	259	17.3
External surface (yes)	12	0.8
Cause of death		
Cranial and/or cervical trauma	436	29.0
Post-trauma complications	401	26.7
Severe traumatic hemorrhage	283	18.9
Multiple traumas	244	16.3
Other causes**	133	8.9
Undefined cause	3	0.2

*ICD-10: International Statistical Classification of Diseases and Health-Related Problems - 10th Review; †W01-W19: Fall on the same level due to slip, trip, stumble, roller-skates, or shoves, or fall from one level to another involving chair, bed, furniture, playground equipment, stairs, scaffold, other structures such as slab, tree, cliff, diving into water or any other with no specification; ‡X85-Y09: Aggression through chemical substances, hanging, suffocation, firing of a firearm, explosive material, smoke, fire, flames, gases, sharp or penetrating object, blunt object,

projection from a high place or permanence before a moving object, impact of a motor vehicle, physical force, negligence and abandonment, mistreatment or non-specified; [§]V01-V69: Pedestrian, cyclist, motorcyclist, three-wheeled motor vehicle passenger, car passenger, pick-up truck passenger, or heavy transport vehicle passenger; [‖]X70-X84: Intentionallly self-harm injury by hanging, strangulation and suffocation, submersion, firing of a firearm, explosives, smoke, fire, flames, smoke, gases, sharp or penetrating object, blunt object, precipitation from a high place or permanence before a moving object, impact of a motor vehicle or unspecified means; [¶]X00 – X09: Exposure to fire, smoke, flames and/or combustion of flammable substances; X36:Victim of avalanche, landslide and other movements of the Earth's surface; W20: Impact caused by object thrown, projected, or in free-fall; W54: Byte or strike caused by a dog; W87:Exposure to non-specified electric current; [**]Includes asphyxiation, spinal cord injury, thorax/abdomen injury, extremity injury, burns, electrocution, and carbon monoxide poisoning.

Head/Neck (54.0%), thorax (27.9%), and extremities/pelvic girdle (17.3%) were the most severely injured body areas. The causes of death with high frequency were cranial and/or cervical trauma (29.0%) and post-trauma complications (26.7%), according to the autopsy reports (Table 1). Regarding deaths due to post-trauma complications (n=401), infectious (64.8%), pulmonary (21.0%), and cardiac (10.7%) complications stood out.

As for trauma severity, the ISS and NISS mean scores were 21.6 (±15.3) and 27.7 (±17.4), respectively, and both ranged from 1 to 75 points. On average, the victims had 2.4 (±1.3) body areas affected, and, in 26 cases (1.7%), all the six areas described in the ISS showed some type of traumatic injury.

The period from injury occurrence to death ranged from two minutes to 374 days. Figure 1 shows that more than 900 victims died within the first five days after the injury (each column of the figure corresponds to five days), with a sharp drop in the number of deaths after this period. One patient remained hospitalized for almost one year due to trauma sequelae and died due to nosocomial infection.

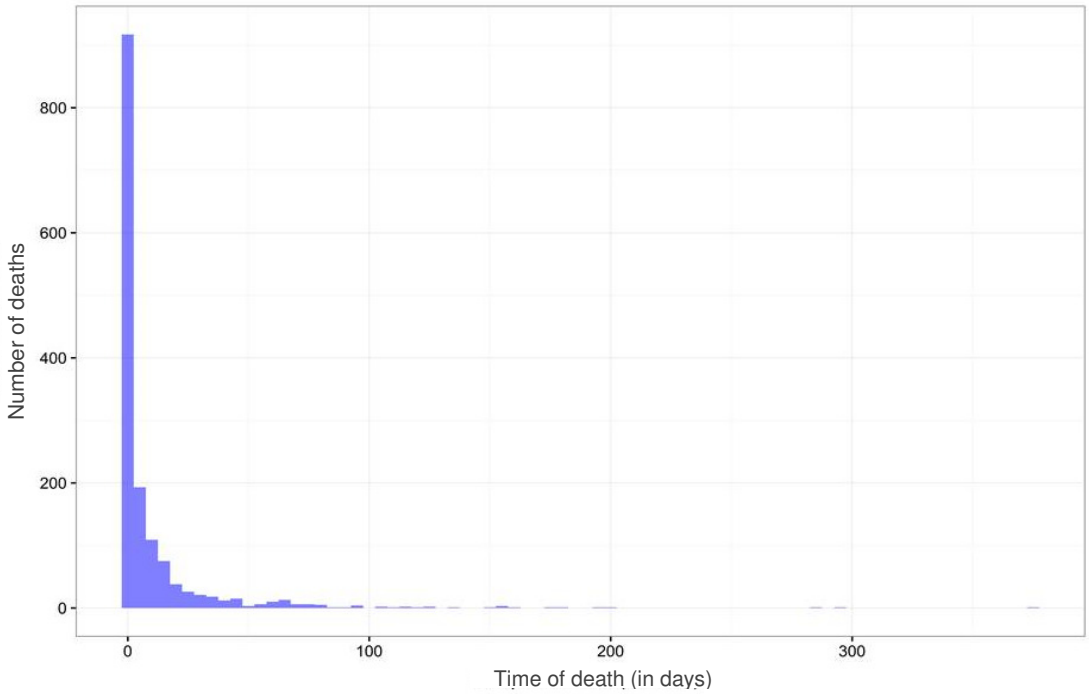

Figure 1 - Distribution of the trauma victims (n=1,500) according to the time of death in days. São Paulo, Brazil, 2015.

A total of 830 victims died within the first 24 hours after the trauma (Figure 2), and 423 of them died at the event scene.

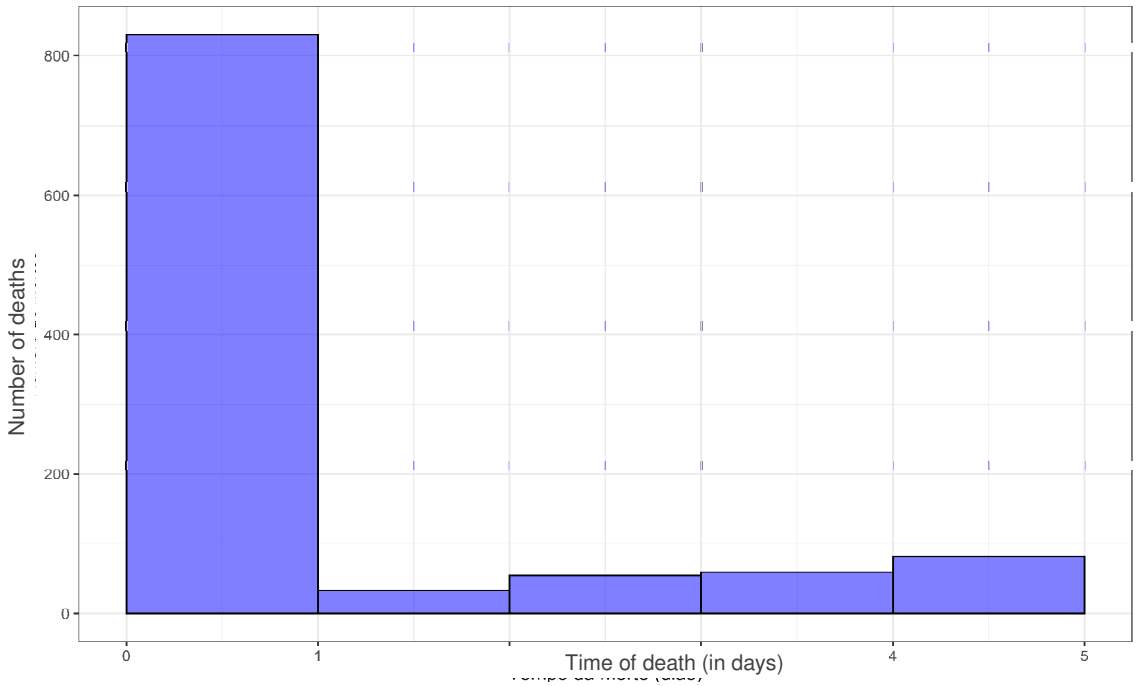

Figure 2 - Distribution of the trauma victims (n=980) who evolved to death within the first five days after the trauma according to the time of death. São Paulo, Brazil, 2015.

The data in Table 2 show that the factors associated to the time of death were the number of body areas affected (p<0.001), type of trauma (p<0.001), gender (p=0.009), NISS (p<0.001) and the external causes, assaults (p<0.001), and intentionally self-harm injuries (p<0.001). On the other hand, variables such as age, race, ISS, body area most severely injured, and cause of death were not associated with the victims' time of death.

Table 2 - Generalized linear model of the factors associated to the time of death of the trauma victims. São Paulo, Brazil, 2015.

Variables	Exp β	CI for Exp β (95%)	p	VIF*
Number of body areas affected	0.50	0.47 – 0.54	**<0.001**	1.09
Type of trauma (ref† blunt)				1.02
Penetrating	0.22	0.16 – 0.30	**<0.001**	
Gender (ref male)				1.17
Female	0.77	0.73 – 0.94	**0.009**	
NISS‡	0.95	0.95 – 0.96	**<0.001**	1.22
External cause (ref falls)				1.15
Pedestrian/Cyclist	0.99	0.75 – 1.32	0.975	
Motorcyclist	0.72	0.49 – 1.06	0.099	
Car passenger	1.19	0.79 – 1.82	0.405	
Assaults	0.45	0.32 – 0.63	**<0.001**	
Intentionally self-harm injuries	0.22	0.16 – 0.30	**<0.001**	
Other causes	1.29	0.73 – 2.25	0.387	
Unknown cause	0.81	0.51 – 1.26	0.384	

*Variance Inflation Factor; †Reference; ‡New Injury Severity Score.

Also according to the data presented in Table 2, it is possible to observe that, at every addition of a NISS point or a body area affected, the survival time of the injured was reduced by 5% and 50%, respectively. Injured women presented less time until death (23%) when compared to men. Victims of assault or intentionally self-harm injuries died earlier than those who fell; this time being reduced by 55% in assaults and 78% in self-harm injuries. Penetrating trauma victims had a reduction of 78% in their survival time when compared to those who suffered from some type of blunt trauma.

The variation of the VIF values (from 1.02 to 1.22) showed that there was no multicollinearity among the variables that remained in the final model (Table 2). The pseudo r^2 value was 0.81, emphasizing the regression model's moderate predictive capacity for factors associated with the time of death of trauma victims.

Discussion

The study that described the time distribution model of deaths due to trauma was a pioneer in exploring how deaths occurred in order to create prevention strategies and improve assistance, which resulted in benefits for those traumatized after its use.[3] However, traumatic injuries still affect thousands of people around the world, with a predominance of males and blunt injuries,[5,20-23] as seen in this research. Historically, young men have been the most frequent trauma victims; however, the epidemiology of external causes has been changing with the aging of the world's population; the mean age being close to 50 years old in this current study.

Among the external causes, falls (33.5%) prevailed in the sample of this research. This result differs from most of the studies that identified traffic accidents[4,9] or injuries due to firearms[24] as the main external causes for fatal victims. However, a research study published in 2017 compared traumatic deaths between two periods (2005-2006 and 2012-2013) and identified that the main cause of death in the first period was traffic accidents while, in the second one, falls prevailed, emphasizing the increase in this type of external cause among the fatal victims.[11] It is important to note that, as a result of aging, falls among older adults, especially in the home environment, represent a significant public health problem, as they result in prolonged hospitalization and in a high mortality rate of this population.[25]

The second most frequent external cause in this research was assault, which affected 27.8% of the sample. In this context, we emphasize the alarming situation related to urban violence in São

Paulo, where this research was carried out. Data from the Secretariat of Public Security show that there were 2,906 intentional homicide victims and 3,364 suicide attempts in the state in 2019.[26]

Regarding the severity of the victims included in this research, the ISS mean was 21.6 (±15.3). The ISS was also applied in other research studies that analyzed traumatic fatal victims and evidenced higher mean scores of the index: from 26.0 to 36.0. Regarding the NISS (27.7±17.4), only one study was identified that analyzed the time distribution of deaths and applied this index, with a mean score of 54.4 (±19.9) and this result was above that found in this research. Compared with other studies, this lower severity can be associated with the high number of individuals, especially victims of falls, who died days after trauma and presented low ISS and NISS scores.

Head/Neck was identified as the area most severely injured in 54.0% of the sample, and the cause of death described by the forensic physicians confirmed traumatic brain injury as the main cause of the death for the victims (29.0%). Many research studies also described traumatic brain injury as the most frequent death reason among the victims,[5,8-9,11,23] reinforcing that severe injuries in this body area are potentially lethal. It is also important to highlight that post-trauma complications and severe traumatic hemorrhage were expressive as causes of death for the victims included in this study, as well as in other studies.[23,28]

In this research, the survival time ranged from few minutes to 374 days, data similar to the results presented in a study that analyzed 260 autopsy records and identified the injury-death time variation from zero to 305 days.[27] Additionally, the higher percentage of deaths in the case selection occurred within the first five days after the injury, especially within the first 24 hours, followed by a sharp drop in the number of deaths after this period. This death pattern within the first hours after the trauma, with a decline over time, is also evidenced in other studies.[5,16]

The analysis of the factors related to the dependent variable of this study verified that female victims had a survival time 23% lower when compared to males and, at every addition of

an NISS point or a body area affected, this period was reduced by 5% and 50%, respectively. Regarding the external causes, the main highlights were the victims of intentionally self-harm injuries or assaults, who died earlier than those who fell. In addition to that, it was possible to observe that penetrating trauma victims had a survival time 78% lower than those who suffered blunt injuries.

The diversity of the variables studied, as well as the lack of studies analyzing the time from injury to death as a continuous variable, hinders the comparison of these findings. However, some analyses can be compared to research studies carried out in the United States that investigated the risk factors of deaths due to trauma according to time distribution.[6,7,24]

In the analysis of 678 deaths that occurred in 2005, intentionally self-harm injuries (OR = 5.0; 95% CI = 2.7-9.5), alcohol intoxication (OR = 7.0; 95% CI = 2.8-7.2), asphyxiation (OR = 17.8; 95% CI = 2.3-14,2), and head (OR = 2.2; 95% CI = 1.2-4.2) and thorax (OR = 3.6; 95% CI = 1.5-8.8) injuries were independent predictors of immediate deaths.[24] Another study identified that, among the victims that presented penetrating trauma and AIS scores in abdominal region higher or equal to 4, 83% of the deaths occurred within the first 24 hours after the trauma.[7] The research on 44,911 fatal victims due to trauma showed that thorax (OR = 2.03) and abdomen/pelvis (OR = 1.39) injuries, beyond the mechanism of penetrating trauma (OR = 2.55), were predictors of early deaths.[6] Similarly to the results found in this study, the aforementioned research studies evidenced that the severity of the traumatic injuries (AIS ≥ 4),[7] penetrating trauma,[6-7] and intentionally self-harm injuries[24] were risk factors for immediate or early deaths, i.e., less survival time of the victims.

As identified in the logistic regression, the increase in the number of body areas affected in the victim reduced the survival time in the sample. This fact can be associated with a greater probability, within this context, of injuries occurring in different vital organs and, consequently,

leading to multiple organ failure, a condition that significantly reduces the survival chances of the traumatized.[29]

This study showed that the peak of deaths within the first post-trauma hours remained unchanged, even with some progress and improvement in the quality of assistance in pre- and intra-hospital contexts. In this regard, it is important to note that traumas involving intention of causing death (intentionally self-harm injuries, assaults, and penetrating injuries) reduced the survival time of the victims included in the research's, thus emphasizing the need to improve prevention policies and the living conditions of the population, focusing on the reduction of social inequalities and ensuring mental health assistance to the individuals.

Not less important, it was found that falls were the most frequent external cause in this study, whose victims presented longer survival times and low severity. Considering that the increase in the number of falls is related to population aging, which is rising in Brazil,[30] the prevention of these events with simple and efficient measures must be intensified, especially in the home environment.

Additionally, the data of this research revealed a high frequency of deaths due to post-trauma complications, events that can be avoided and are often associated to assistance errors. In this regard, the importance of training and periodic update of the professionals who provide trauma assistance is highlighted, as well as the assurance of adequate working conditions by the institution.

As a limitation of this study, it must be considered that data collection took place in an IML that covers some specific regions of São Paulo, which can result in possible restrictions to the generalization of the results. In addition, some variables that can exert an influence on the victims' time of death were not part of this study analysis, as they are not included in the autopsy reports, primary source of data collection in this research.

Finally, it is important to note that the scarcity of studies portraying the time of death variable results in difficulties to accurately analyze the time from the occurrence of the

traumatic injury to the confirmation of death, especially in immediate deaths. However, the quality of the records (autopsy records and police records) analyzed in this research enabled a precise identification of this time and, complementary, of the associated factors.

Conclusion

The results of this study evidenced, in the analysis of 1,500 autopsy reports, an important peak of deaths within the first post-trauma hour, with a progressive reduction over time; and enabled to identify that the factors related to the time of death of the trauma victims were gender, external causes, intentionally self-harm injuries and assaults, type of trauma, number of body areas affected, and severity of the trauma. Therefore, it can be concluded that women, victims of traumas with the intention of causing death and with high severity presented a reduced survival time after the injury(ies). The concern about the quality of the assistance provided to trauma victims has generated many discussions around the world. Accordingly, the results of this research bring significant evidence for defining public policies to prevent traumatic events and structuring and organizing trauma assistance, focusing on improving the survival of this population.

In this regard, the need is highlighted to increase the training of all the professionals that provide trauma assistance and refine the coordination among the health network services, mainly emergency and urgency, aiming to provide faster, efficient, and integral assistance to the victims. For nursing, which has a prominent role in structuring, organizing, and coordinating pre- and intra-hospital services, knowing the factors associated to the time of death of the victims brings essential contributions that help this team to identify individuals at early death risk and in need of a definitive treatment in a specialized center.

References

1. World Health Organization (WHO). WHO Mortality Database [Internet]. Geneva: WHO; 2020 [cited 2020 Jan 20]. Available from: https://www.who.int/data/data-collection-tools/who-mortality-database

2. Ministério da Saúde (BR), Departamento de Informática do Sistema Único de Saúde (Datasus). Estatísticas Vitais. Óbitos por ocorrência segundo capítulo CID-10 [Internet]. Brasília (DF): Datasus; 2019 [acesso em 2020 jan 20]. Available: http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sim/cnv/obt10br.def

3. Trunkey DD. Trauma. Accidental and intentional injuries account for more years of life lost in U.S. than cancer and heart disease. Among the prescribed remedies are improved preventive efforts, speedier surgery and further research. Sci Am. 1983;249(2):28-35.

4. Abbasi H, Bolandparvaz S, Yadollahi M, Anvar M, Farahgol Z. Time distribution of injury-related in-hospital mortality in a trauma referral center in South of Iran (2010-2015). Medicine (Baltimore). 2017;96(21):e6871. doi: https://doi.org/10.1097/MD.0000000000006871

5. Pfeifer R, Schick S, Holzmann C, Graw M, Teuben M, Pape HC. Analysis of injury and mortality patterns in deceased patients with road traffic injuries: an autopsy study. World J Surg. 2017;41(12):3111-9. doi: https://doi.org/10.1007/s00268-017-4122-4

6. Valdez C, Sarani B, Young H, Amdur R, Dunne J, Chawla LS. Timing of death after traumatic injury - a contemporary assessment of the temporal distribution of death. J Surg Res. 2015;200(2):604-9. doi: https://doi.org/10.1016/j.jss.2015.08.031

7. Bardes JM, Inaba K, Schellenberg M, Grabo D, Strumwasser A, Matsushima K, et al. The contemporary timing of trauma deaths. J Trauma Acute Care Surg. 2018;84(6):893-9. doi: https://doi.org/10.1097/TA.0000000000001882

8. Rauf R, Von Matthey F, Croenlein M, Zyskowski M, Van Griensven M, Biberthaler P, et al. Changes in the temporal distribution of in-hospital mortality in severely injured patients–an analysis of the TraumaRegister DGU. PLoS One. 2019;14(2):e0212095. doi: https://doi.org/10.1371/journal.pone.0212095

9. Hwang K, Jung K, Kwon J, Moon J, Heo Y, Lee JCJ, et al. Distribution of trauma deaths in a province of Korea: is "trimodal" distribution relevant today? Yonsei Med J. 2020;61(3):229-34. doi: https://doi.org/10.3349/ymj.2020.61.3.229

10. Wang T, Wang Y, Xu T, Li L, Huo M, Li X, et al. Epidemiological and clinical characteristics of 3327 cases of traffic trauma deaths in Beijing from 2008 to 2017: a retrospective analysis. Medicine (Baltimore). 2020;99(1):e18567. doi: https://doi.org/10.1097/MD.0000000000018567

11. Oyeniyi BT, Fox EE, Scerbo M, Tomasek JS, Wade CE, Holcomb JB. Trends in 1029 trauma deaths at a level 1 Trauma Center: impact of a bleeding control bundle of care. Injury. 2017;48(1):5-12. doi: https://doi.org/10.1016/j.injury.2016.10.037

12. Negoi I, Paun S, Hostiuc S, Stoica B, Tanase I, Negoi RI, et al. Mortality after acute trauma: progressive decreasing rather than a trimodal distribution. J Acute Dis. 2015;4(3):205-9. doi: https://doi.org/10.1016/j.joad.2015.03.001

13. Abhilash KPP, Sivanandan A. Early management of trauma: the golden hour. Curr Med Issues. 2020;18(1):36-9. doi: https://doi.org/10.4103/cmi.cmi_61_19

14. Cabral ELS, Castro WRS, Florentino DRM, Viana DA, Costa Junior JF, Souza RP, et al. Response time in the emergency services. Systematic review. Acta Cir Bras. 2018;33(12):1110-21. doi: https://doi.org/10.1590/s0102-865020180120000009

15. Clark DE, Qian J, Sihler KC, Hallagan LD, Betensky RA. The distribution of survival times after injury. World J Surg. 2012;36(7):1562-70. doi: https://doi.org/10.1007/s00268-012-1549-5

16. Pfeifer R, Teuben M, Andruszkow H, Barkatali BM, Pape HC. Mortality patterns in patients with multiple trauma: a systematic review of autopsy studies. PLoS One. 2016;11(2):e0148844. doi: https://doi.org/10.1371/journal.pone.0148844

17. Association for the Advancement of Automotive Medicine (AAAM). The Abbreviated Injury Scale (AIS): 2008, update 2015. Des Plaines: AAAM; 2015.

18. World Health Organization (WHO). International Statistical Classification of Diseases and Related Health Problems - 10th Revision [Internet]. Geneva: WHO; 2010 [cited 2020 Jan 10]. Available from: https://www.who.int/classifications/classification-of-diseases

19. Osler T, Baker SP, Long W. A modification of the injury severity score that both improves accuracy and simplifies scoring. J Trauma Acute Care Surg. 1997;43(6):922-5. doi: https://doi.org/10.1097/00005373-199712000-00009

20. Miller RT, Nazir N, McDonald T, Cannon CM. The modified rapid emergency medicine score: a novel trauma triage tool to predict in-hospital mortality. Injury. 2017;48(9):1870-77. doi: https://doi.org/10.1016/j.injury.2017.04.048

21. Kimura A, Tanaka N. Reverse shock index multiplied by Glasgow Coma Scale score (rSIG) is a simple measure with high discriminant ability for mortality risk in trauma patients: an analysis of the Japan Trauma Data Bank. Crit Care. 2018;22(1):87. doi: https://doi.org/10.1186/s13054-018-2014-0

22. Serviá L, Badia M, Montserrat N, Trujillano J. Gravedad em pacientes traumáticos ingressados em UCI. Modelos fisiológicos y anatómicos. Med Intensiva. 2019;43(1):26-34. doi: https://doi.org/10.1016/j.medin.2017.11.008

23. Callcut RA, Kornblith LZ, Conroy AS, Robles AJ, Meizoso JP, Namias N, et al. The why & how our trauma patients die: a prospective Multicenter Western Trauma Association study. J Trauma Acute Care Surg. 2019;86(5):864-70. doi: https://doi.org/10.1097/TA.0000000000002205

24. Gunst M, Ghaemmaghami V, Gruszeki A, Urban J, Frankel H, Shafi S. Changing epidemiology of trauma deaths leads to a bimodal distribution. Proc (Bayl Univ Med Cent). 2010;23(4):349-54. doi: https://doi.org/10.1080/08998280.2010.11928649

25. Whiteman C, Davidov DM, Sikora R, Paulson D, Schaefer G. Major Trauma and the Elder West Virginian: a six-year review at a Level I Trauma Center. W V Med J [Internet]. 2016 [cited 2020 Feb 20];112(3):94-9. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4926309/pdf/nihms-796357.pdf

26. Estado de São Paulo, Secretaria de Segurança Pública. Dados estatísticos do estado de São Paulo [Internet]. São Paulo (SP): Secretaria de Segurança Pública; 2020 [acesso em 2020 set 05]. Disponível em: https://www.ssp.sp.gov.br/estatistica/mapas.aspx

27. Soreide K, Krüger AJ, Vardal AL, Ellingsen CL, Soreide E, Lossius HM. Epidemiology and contemporary patterns of trauma deaths: changing place, similar place, older face. World J Surg. 2007;31(11):2092-103. doi: https://doi.org/10.1007/s00268-007-9226-9

28. Abe T, Komori A, Shiraishi A, Sugiyama T, Iriyama H, Kainoh T, et al. Trauma complications and in-hospital mortality: failure-to-rescue. Crit Care. 2020;24:223. doi: https://doi.org/10.1186/s13054-020-02951-1

29. Hutchings L, Watkinson P, Young JD, Willett K. Defining multiple organ failure after major trauma: a comparison of the Denver, Sequential Organ Failure Assessment and Marshall scoring systems. J Trauma Acute Care Surg. 2017;82(3):534-41. doi: https://doi.org/10.1097/TA.0000000000001328

30. Veras RP, Oliveira M. Envelhecer no Brasil: a construção de um modelo de cuidado. Ciênc Saúde Colet. 2018;23(6):1929-36. doi: https://doi.org/10.1590/1413-81232018236.04722018

Scientific Editor: Tânia Solange Bosi de Souza Magnago
Associated Editor: Etiane de Oliveira Freitas

Funding/Acknowledgment: This paper was carried out with the support of the Coordination for the Improvement of Higher Education Personnel - Brazil (CAPES) - Financing Code 001

Corresponding author
Lilia de Souza Nogueira
E-mail: lilianogueira@usp.br
Address: Avenida Doutor Enéas de Carvalho Aguiar, 419. Cerqueira César, São Paulo, SP, Brazil.
CEP: 05403-000

Authorship Contributions

1 – Daniela Vieira de Andrade Batista
Conception and design of the study/research, data analysis and interpretation, final review with critical and intellectual participation in the manuscript.

2 – Carolina Cassiano
Data analysis and interpretation; final review with critical and intellectual participation in the manuscript.

3 – Luciana Maria Capurro de Queiroz Oberg
Data analysis and interpretation; final review with critical and intellectual participation in the manuscript.

4 – Daniele Muñoz Gianvecchio
Data analysis and interpretation; final review with critical and intellectual participation in the manuscript.

5 – Regina Marcia Cardoso de Sousa
Data analysis and interpretation; final review with critical and intellectual participation in the manuscript.

6 – Lilia de Souza Nogueira
Conception and design of the study/research, data analysis and interpretation, final review with critical and intellectual participation in the manuscript.

How to cite this article

Batista DVA, Cassiano C, Oberg LMC, Gianvecchio DM, Sousa RMC, Nogueira LS. Factors associated to the time of death of trauma victims: A retrospective cohort study. Rev. Enferm. UFSM. 2021 [Accessed on: Year Month Day]; vol.11 e29: 1-19. DOI: https://doi.org/10.5902/2179769247475