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# A Survival Analysis Based on Forensic Investigation of Motorcycle Road Traffic Accidents in the Athens Metropolitan Area During 2021–2023

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## Abstract

**Background/Objectives**: Motorcycle accidents have grown to become a significant public health thread worldwide. Most of the victims are described to be males of young age, some of lower socioeconomic status. Throughout the literature, head and spinal injuries are described as the most common injuries, while chest injuries and lower extremity fractures are also frequently described. Moreover, driving under the influence of alcohol has been widely described as a major predisposing factor. We conducted a retrospective cohort study to categorize risk factors, including demographic information and alcohol/psychoactive substance consumption, as well as pre-existing medical conditions. Correspondingly, we identified the most common injury patterns and attempted to establish a connection between time to hospital and survival rates. **Methods**: Cases of motorcycle-related road traffic accidents (RTAs) examined by the authors during 2021–2023 were included in the study sample (94 cases in total). This retrospective cohort study assessed survival time (in days) from accident to death. Kaplan–Meier curves, stratified by key categorical variables, were used to analyze survival probabilities over time. Univariate Cox regression was used to assess each variable's effect on survival. The association between exposure and mortality was analyzed using hazard ratios (HRs) and 95% confidence intervals (CIs). **Results**: Head injuries were associated with poorer outcomes. Chest injuries reduced median survival to 1.68 h compared to 5.85 days in cases that had not sustained chest injuries. Abdominal injuries also shortened survival (1.632 h vs. 1.896 h), as did multiple-site injuries (1.584 h vs. 0.2 days for single/double-site). Positive toxicology for psychoactive substances lowered survival to 1.32 h compared to 1.752 h in cases with negative toxicological findings. Multiple-site injuries and head, chest and abdominal injuries appeared to significantly affect the survival of victims. Positive toxicological examination results for psychoactive substances also appeared to heavily impact survival.

**Keywords:** forensic pathology; road traffic accident; post-mortem examination; motorcycles; survival analysis; Greece

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## 1. Introduction

Road traffic accidents (RTAs) represent one of the top five causes of mortality worldwide. RTAs remain a persistent public health hazard even after several improvement measures like safety campaigns and stricter legislation as well as automobile design and traffic regulations [1].

It has been consistently demonstrated that the right type of protective equipment, particularly helmets, reduces the severity of head injuries and overall fatality rates in motorcycle accidents [2,3]. According to epidemiological data, young adult men, especially those of a lower socioeconomic background, are most involved in motorcycle collisions [4,5]. Head injuries are the most frequent injury in motorcycle-related accidents [6]. Alcohol consumption is also a significant contributing factor in many fatal motorcycle RTAs [7].

With this study, we aim to gain a better understanding of the contributing factors while offering evidence-based suggestions for focused adoption of preventive strategies. By comparing our results with data obtained from a variety of international studies from the last 10 years collected from more than 20 countries, we intend to identify some of the characteristics of fatal motorcycle RTAs. Upon comparing our findings with the existing international data, we noted a substantial concordance across most characteristics.

## 2. Materials and Methods

Cases of motorcycle-related RTA fatalities examined by the authors during 2021–2023 were included in the study sample (94 cases in total). Data from cases handled by the authors at the Department of Forensic Medicine and Toxicology (D.F.M.T.) of the School of Medicine, National and Kapodistrian University of Athens (N.K.U.A.) was collected. The data consisted of motorcycle-related fatalities that took place in the Athens area, in which approximately 10% of the entire Greek population resides.

Permission from the Bioethics Committee of the School of Medicine N.K.U.A. was obtained (1003/25 November 2024).

We collected anonymized demographics, medical and social history information, and place of accident, as well as distance and time required to arrive at the hospital. Both external and internal injuries observed during the post-mortem examination were grouped in anatomical regions and were recorded. Toxicological analysis results were collected as well. Toxicological analysis samples included blood, urine, and vitreous humor.

A retrospective cohort study was conducted to analyze survival data, with survival time measured in days until death.

The primary endpoint was survival time, calculated as the number of days from the time the accident took place to the date of death. Kaplan–Meier survival curves were generated to estimate the survival function for the cohort and were stratified by relevant categorical variables, allowing visualization of survival probabilities over time.

For all variables, a univariate Cox proportional hazards regression model was used to evaluate the impact of each variable on survival time. Hazard ratios (HRs) with 95% confidence intervals (CI) were reported to quantify the relationship between continuous variables and the risk of death.

Following the univariate analysis, a multivariate Cox proportional hazards regression model was performed using a stepwise approach, with a $p$-value cut-off of 0.1 to identify significant predictors of survival. Statistical analyses were performed using Stata (version 16). A $p$-value of less than 0.05 was considered statistically significant.

## 3. Results

The study included 94 cases, with the majority being male (94.68%) and only 5.32% female. The median age at death was 40.5 years (IQR: 27–53), and most participants were of Greek nationality (85.11%). Time to arrival at the hospital was almost evenly split, with 54.55% arriving within 60 min and 45.45% arriving after 60 min. The median distance of the incident's location from the closest hospital was 10.4 km (IQR: 5.25–16.65). The minimum survival time was 25 min, while the maximum was 160.3 days.

Based on the social history obtained by relatives of the deceased, 21.13% of cases had previously alcohol abuse-related issues. Smoking history prevalence among the examined cases was 77.50%, with 22.50% categorized as never smokers or having quit smoking. History of psychoactive substance use was detected in 23.46% of cases.

Trauma patterns revealed that 77.66% of cases sustained chest injuries, 73.40% presented head injuries, 57.45%, abdominal injuries, and 22.34%, neck injuries. Extremity (upper and lower) injuries were reported in 30.85% of the cases. Multiple-site injuries were common, as they were reported in 67.02% of cases.

Pre-existing medical conditions, obtained either through the medical history of the deceased or through post-mortem examination (PME) findings, were relatively rare in the study sample. Cardiovascular diseases (cardiomyopathies and coronary disease) were identified in 17.02%, metabolic diseases (diabetes mellitus, etc.) in 2.13%, and mobility impairment issues in 3.19% of cases. Psychiatric conditions (depression disorder, etc.) were also uncommon, identified in only 3.26% of cases.

Toxicological investigation revealed that 41.43% of cases tested positive for psychoactive substances (alcohol, cannabis, cocaine, hallucinogens, and benzodiazepines).

All the descriptive results are summarized in Table 1.

**Table 1.** Descriptive statistics of the study population: Summary of demographic characteristics, toxicology findings, trauma patterns, pre-existing medical conditions, and other relevant variables for the 94 deceased participants in the study. Frequencies and percentages are provided for categorical variables, while medians and interquartile ranges (IQR) are reported for continuous variables.

| Variable | Category | Frequency | Percent | Median (IQR) |
|---|---|---|---|---|
| **General Demographics** | | | | |
| **Sex** | Male | 89 | 94.68% | |
| | Female | 5 | 5.32% | |
| **Age** | | | | 40.5 (27–53) |
| **Nationality** | Greek | 80 | 85.11% | |
| | Other | 14 | 14.89% | |
| **Time and Distance** | | | | |
| **Time to Arrive** | <60 min | 36 | 54.55% | |
| | >60 min | 30 | 45.45% | |
| **Distance to Hospital** | | | | 10.4 (5.25–16.65) |
| **Social History Data (Obtained Through Interviews of the Relatives of the Deceased)** | | | | |
| **Alcohol** | Yes | 15 | 21.13% | |
| | No | 56 | 78.87% | |
| **Smoking** | Yes | 62 | 77.50% | |
| | No or stopped | 18 | 22.50% | |
| **Substance** | Yes | 19 | 23.46% | |
| | No | 62 | 76.54% | |

**Table 1.** *Cont.*

| Variable | Category | Frequency | Percent | Median (IQR) |
|---|---|---|---|---|
| **Pre-Existing Medical Conditions (Obtained Through Interview of the Relatives of the Deceased)** | | | | |
| **Cardiovascular Disease** | No | 78 | 82.98% | |
| | Yes | 16 | 17.02% | |
| **Metabolic Disease** | No | 92 | 97.87% | |
| | Yes | 2 | 2.13% | |
| **Decreased Mobility** | No | 91 | 96.81% | |
| | Yes | 3 | 3.19% | |
| **Psychiatric Condition** | No | 89 | 96.74% | |
| | Yes | 3 | 3.26% | |
| **Injuries Sustained, as Ascertained by the Post-Mortem Examination** | | | | |
| **Head Injury** | No | 25 | 26.60% | |
| | Yes | 69 | 73.40% | |
| **Neck Injury** | No | 73 | 77.66% | |
| | Yes | 21 | 22.34% | |
| **Chest Injury** | No | 21 | 22.34% | |
| | Yes | 73 | 77.66% | |
| **Abdominal Injury** | No | 40 | 42.55% | |
| | Yes | 54 | 57.45% | |
| **Upper Limb Injury** | No | 65 | 69.15% | |
| | Yes | 29 | 30.85% | |
| **Lower Limb Injury** | No | 65 | 69.15% | |
| | Yes | 29 | 30.85% | |
| **Multiple Injuries** | No | 31 | 32.98% | |
| | Yes | 63 | 67.02% | |

Figures 1 and 2 depict the Kaplan–Meier estimated survival curves, illustrating survival probabilities based on time to arrival, history of alcohol abuse, neck trauma, abdominal trauma, chest trauma, multiple-site injuries, Central Nervous System (CNS)-affecting positive toxicological examination, and presence of recently ingested food.

Using a univariate Cox proportional hazards model, females presented a longer median survival time (5.9 days) compared to males (1.68 h), but this difference was not statistically significant (HR = 0.44, 95% CI: 0.16–1.23, $p = 0.118$). Similarly, individuals aged >40 years presented a slightly longer median survival time (0.081 days) compared to those aged ≤40 years (0.07 days), but again this difference was not statistically significant (HR = 0.84, 95% CI: 0.56–1.26, $p = 0.396$). Nationality did not present any significant association, with Greek participants having a slightly longer median survival time (0.073 days) compared to other-nationality cases (0.066 days) (HR = 1.43, 95% CI: 0.80–2.55, $p = 0.23$). The results of the univariate Cox analysis are presented in Table 2.

Significant findings were observed for time to arrival, history of alcohol use, neck trauma, chest trauma, abdominal trauma, multiple-site injuries, positive psychoactive toxicological screening, and recently ingested food. Arriving at the hospital after 60 min was associated with significantly better survival compared to arriving within the golden hour (≤60 min) (HR = 0.22, 95% CI: 0.12–0.41, $p < 0.001$). A history of alcohol abuse was linked to poorer survival (HR = 1.74, 95% CI: 1.12–3.11, $p = 0.049$). Similarly, neck trauma (HR = 1.62, 95% CI: 1.04–2.67, $p = 0.047$), chest trauma (HR = 2.15, 95% CI: 1.3–3.56, $p = 0.003$), and abdominal trauma (HR = 1.79, 95% CI: 1.16–2.77, $p = 0.009$) were associated with significantly worse survival outcomes. Multiple-site injuries were also a strong predictor of poor survival (HR = 1.94, 95% CI: 1.24–3.02, $p = 0.004$).

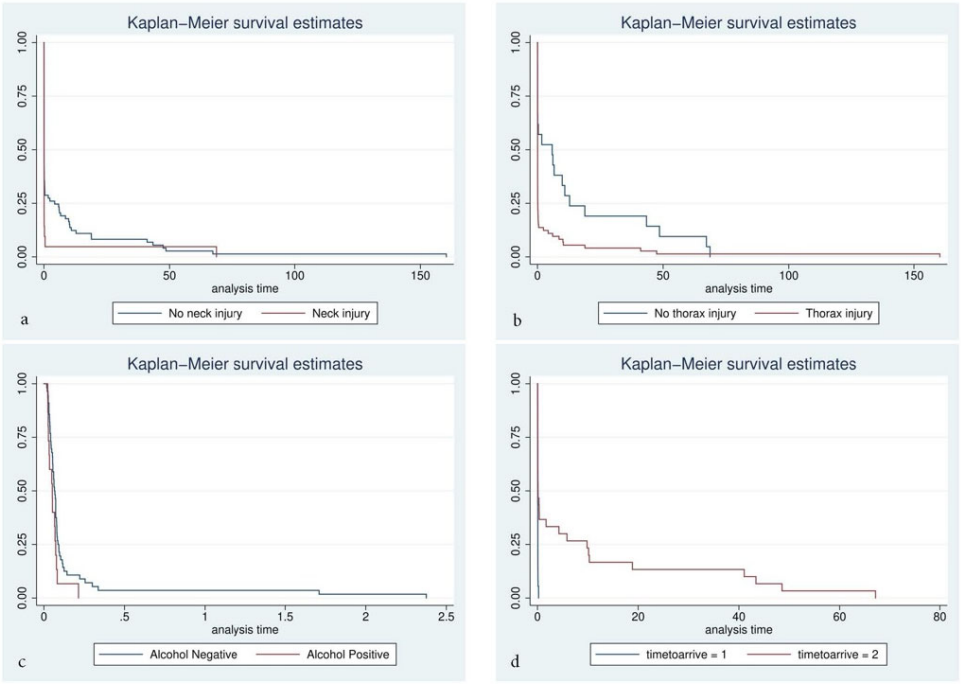


**Figure 1.** Kaplan–Meier survival curves for (**a**) survival probabilities by neck trauma (present vs. absent). (**b**) Survival probabilities by chest trauma (present vs. absent). (**c**) Survival probabilities by history of alcohol abuse (positive vs. negative). (**d**) Survival probabilities by time to arrival at hospital ($\leq$60 min vs. >60 min). The x-axis represents time in days. Each curve demonstrates variations in survival probability across the corresponding clusters.

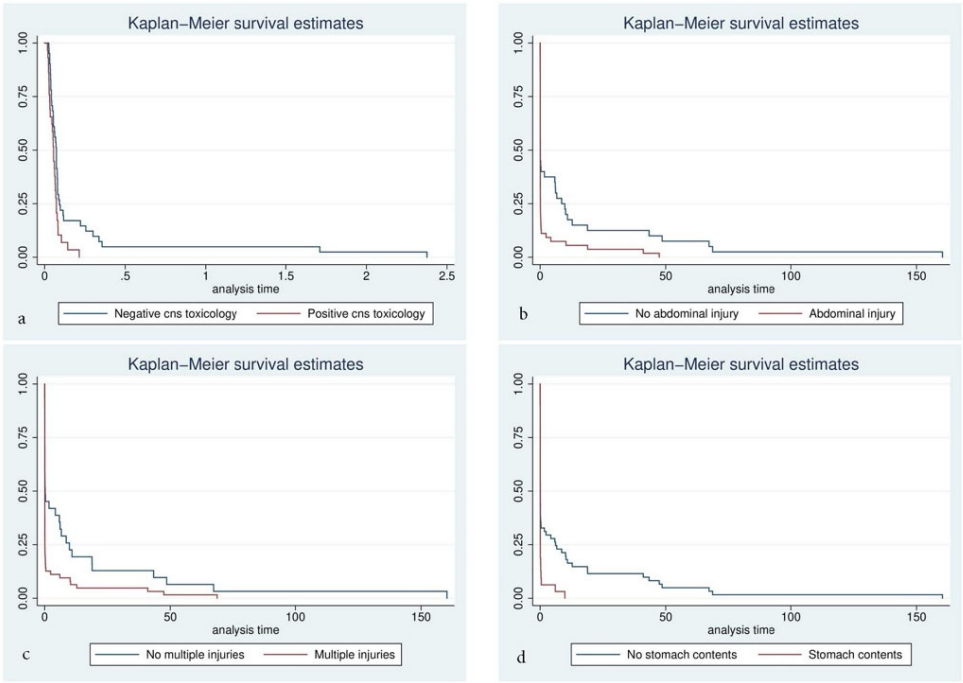


**Figure 2.** Kaplan–Meier survival curves for: (**a**) Survival probabilities by psychoactive toxicology findings (positive vs. negative). (**b**) Survival probabilities by abdominal trauma (present vs. absent). (**c**) Survival probabilities by multiple injuries (present vs. absent). (**d**) Survival probabilities by stomach contents (empty vs. with contents). The x-axis represents time in days. Each curve demonstrates variations in survival probability across the corresponding clusters.

**Table 2.** Univariate Cox proportional hazards analysis of survival predictors: Results of univariate Cox regression analysis evaluating the association between individual variables and survival time. Median survival time in days, hazard ratios (HRs) with 95% confidence intervals (CI) and *p*-values are presented for each variable. Statistically significant associations are highlighted.

| Variable | Group | Median Survival Time (Days) | Hazard Ratio | 95% CI | *p*-Value |
|---|---|---|---|---|---|
| **General Demographics** | | | | | |
| **Sex** | Male (Ref) | 0.07 | 0.44 | 0.16–1.23 | 0.118 |
| | Female | 5.9 | | | |
| **Age** | ≤40 years (median) (ref) | 0.07 | 0.84 | 0.56–1.26 | 0.396 |
| | >40 years | 0.081 | | | |
| **Nationality** | Greek | 0.073 | 1.43 | 0.80–2.55 | 0.23 |
| | Other | 0.066 | | | |
| **Time and Distance** | | | | | |
| **Time to Arrive** | ≤60 min (golden hour) (ref) | 0.05 | **0.22** | **0.12–0.41** | **<0.001** |
| | >60 min | 0.115 | | | |
| **Distance to Hospital** | ≤10 km (median) (ref) | 0.081 | 1.34 | 0.877–2.06 | 0.173 |
| | >10 km | 0.073 | | | |
| **Social History Data (Obtained Through Interview of the Relatives of the Deceased)** | | | | | |
| **Alcohol** | Yes | 0.05 | **1.74** | **1.12–3.11** | **0.049** |
| | No (ref) | 0.07 | | | |
| **Smoking** | Yes (ref) | 0.068 | 0.7 | 0.41–1.21 | 0.204 |
| | No (never or stopped) | 0.097 | | | |
| **Substance** | Yes | 0.073 | 1.04 | 0.62–1.74 | 0.893 |
| | No (ref) | 0.073 | | | |
| **Pre-Existing Medical Conditions (Obtained Through Interview of the Relatives of the Deceased)** | | | | | |
| **Cardiovascular** | Yes | 0.083 | 0.94 | 0.54–1.61 | 0.808 |
| | No (ref) | 0.073 | | | |
| **Metabolic** | Yes | 0.035 | 1.99 | 0.49–8.19 | 0.338 |
| | No (ref) | 0.073 | | | |
| **Decreased Mobility** | Yes | 0.073 | 0.97 | 0.31–3.09 | 0.962 |
| | No (ref) | 0.073 | | | |
| **Psychiatric Condition** | Yes | 0.093 | 0.65 | 0.20–2.08 | 0.473 |
| | No (ref) | 0.073 | | | |
| **Injuries Sustained, as Ascertained by the Post-Mortem Examination** | | | | | |
| **Head Trauma** | Yes | 0.07 | 0.94 | 0.59–1.5 | 0.782 |
| | No (ref) | 0.08 | | | |
| **Neck Trauma** | Yes | 0.066 | **1.62** | **1.04–2.67** | **0.047** |
| | No (ref) | 0.081 | | | |
| **Thorax Trauma** | Yes | 0.07 | **2.15** | **1.3–3.56** | **0.003** |
| | No (ref) | 5.85 | | | |
| **Abdominal Trauma** | Yes | 0.068 | **1.79** | **1.16–2.77** | **0.009** |
| | No (ref) | 0.079 | | | |
| **Upper Limb Trauma** | Yes | 0.073 | 1.09 | 0.69–1.69 | 0.707 |
| | No (ref) | 0.073 | | | |
| **Lower Limb Trauma** | Yes | 0.062 | 1.26 | 0.81–1.96 | 0.312 |
| | No (ref) | 0.078 | | | |
| **Multiple Injuries** | Yes | 0.066 | **1.94** | **1.24–3.02** | **0.004** |
| | No (ref) | 0.2 | | | |

Additionally, positive psychoactive toxicological investigation results (HR = 1.85, 95% CI: 1.12–3.05, $p$ = 0.017) and the presence of recently ingested food (HR = 1.99, 95% CI: 1.26–3.15, $p$ = 0.003) were significantly associated with worse survival. Other variables, such as a history of smoking and psychoactive substance use, head trauma, and upper or lower extremities trauma, as well as pre-existing cardiovascular and metabolic conditions, impaired mobility issues, and psychiatric conditions, were not significantly associated with survival in this analysis.

The multivariate model, adjusted for time to arrival (within the golden hour or not), the presence of multiple-site injuries, and positive psychoactive toxicological screening, identified a significant association along with two notable trends. Specifically, participants with positive psychoactive toxicology findings presented significantly worse survival outcomes (aHR = 2.12, 95% CI: 1.16–3.88, $p$ = 0.015), with more than double the risk of death compared to those without such findings. Surprisingly, time to arrival showed a trend toward better survival outcomes for cases arriving after 60 min compared to those within the golden hour (aHR = 0.54, 95% CI: 0.28–1.03, $p$ = 0.06). Multiple-site injuries also approached statistical significance (aHR = 1.93, 95% CI: 0.97–3.82, $p$ = 0.06), suggesting that patients with injuries across multiple body regions faced a nearly doubled risk of death compared to those with localized injuries. Results of the multivariate Cox analysis are shown in Table 3.

**Table 3.** Multivariate Cox proportional hazards analysis of survival predictors: Results of the multivariate Cox regression analysis identifying significant predictors of survival. Adjusted hazard ratios (HR) with 95% confidence intervals (CI) and $p$-values are presented for each included variable.

| Variable | Adjusted Hazard Ratio | 95% Conf. Interval | $p$-Value |
|---|---|---|---|
| **Time to Arrive** | 0.54 | 0.28–1.03 | 0.06 |
| **Multiple Injuries** | 1.93 | 0.97–3.82 | 0.06 |
| **Positive Toxicological Examination for Psychoactive Substances** | 2.12 | 1.16–3.88 | 0.015 |

## 4. Discussion

This study compares our findings with data from the existing international literature from more than 20 countries to identify the consistency of findings on contributing factors to motorcycle accident fatalities.

The vast majority (94.68%) of our sample were men and relatively young, with a median age of 40.5 years. According to the literature, a pattern of male predominance, with percentages consisting of 89% and 97% of motorcycle fatalities being male, was noted [8–17]. For instance, according to a 10-year study conducted in Croatia, male riders accounted for most of the fatalities (95.7%) [9]. Similarly, in a U.S. Army study, male soldiers had a much higher probability of dying in motorcycle accidents (97%) [10]. In Cambodia, males are involved in motorcycle-related fatalities roughly seven times more frequently than females [12], while in Nigeria, motorcycle-related mortality among men was significantly increased (89.1%) [13]. Correspondingly, in the UK, 92% of motorcycle fatalities or seriously injured casualties were male [18]. Likewise, two Iranian studies [8,14] showed that most drivers of motorcycle fatalities were male (95.3% and 79.2%, respectively). In another study conducted in East Azerbaijan, Iran, men were involved in more than 95% (96.5%) of motorcycle fatalities [15]. In the same manner, in India, almost all motorcycle fatalities involved males (89.09%) [16]. Finally, on the other side of the globe, in Brazil, males were involved in most motorcycle-related fatalities (78.5%), as well as having the highest

hospitalization costs [17]. There are several probable explanations for why men are more prone to motorcycle accidents, including engagement in risky activities like speeding and driving under the influence of alcohol, as well as less frequent use of safety measures (such as wearing a helmet) [19], although the examination of this matter lies outside the scope of this study.

In terms of age, the highest-risk group consists of young males, especially those aged 18–40 [8,9,11,14,16,20–23]. In Nigeria, males with a peak age of 31–40 are the most common victims of motorcycle accident fatalities [21]. Again, in another study conducted in Lagos, it was similarly observed that men under 40 comprised most of the casualties [13]. Likewise, as noted by Roehler et al., motorcycle-related casualties in Cambodia occurred primarily among young men [12]. According to Bakovic et al., males aged 20 to 40 accounted for most of the motorcycle fatalities in the Zagreb metropolitan region [9]. Similarly, among U.S. Army soldiers, younger members (aged 20–29 years) were disproportionately engaged in fatal motorcycle crashes, according to 10. Rappole et al. [10]. In parallel, De Souza et al. in Brazil also support the link between youth and crash fatalities by observing that young adult males (20–39 years old) are the most frequent victims in motorcycle RTAs [11]. In Iran, a study by Ghadipasha et al. found that men aged 19–24 [14] and a study by Barzegar et al. found that young men [8] were the most vulnerable demographic group. Similarly, other studies conducted in East Azerbaijan (mean age of 32.3 $\pm$ 18.5 years) [15] and Isfahan (mean age 26.41 $\pm$ 14.3 years) [22], respectively, suggested that motorcycle fatalities are more common amongst young men. Additionally, in India, Kukde et al. implied that the majority of motorcycle-related fatalities in Mumbai affected those aged 21 to 40 [16]. According to Leitão et al. in Brazil, the working-age male population with a mean age of 29 made up the majority of motorcycle-related fatalities [17]. According to another U.S. study, the age range 30 to 39 years is associated with higher numbers of fatalities [20]. Again, in Australia and New Zealand, most motorcycle fatalities included young men (72.3% were aged less than 40 years old) [23]. Several behavioral, as well as psychological factors, make young motorcycle riders more susceptible to being involved in RTAs. Some of the factors include risk-taking, lack of experience, distracted driving, and lack of protective gear usage, as well as the possibility of driving under the influence of CNS-affecting substances [24].

However, a double-peak distribution of risk was also observed since a few studies also noted an increase in mortality among older riders (over 45 years). A Polish study by Genowska et al. observed that older riders have a higher chance of succumbing due to RTAs, implying that age is a significant risk factor in fatalities due to motorcycle collisions [25]. Additionally, a study by Granieri et al., after examining trauma data of 1725 patients from a single-center hospital in Milan, also verified that fatality rates increased with age [26]. Finally, according to a Thai study by Champahom et al., older riders, even though they are more experienced, are also more susceptible to serious injuries due to their physical vulnerability [27]. In China, an age older than 60 years is considered to be a factor associated with a substantially higher fatality [28]. According to a Japanese study, the average age of victims was 62.3 years [29], while in another, the mortality rate was highest in those aged above 75 years [30]. In a Taiwanese study, older age was considered to be a risk factor for fatality [31]. Another study analyzed the age and period-independent cohort effect of baby boomers (born 1946–1964), showing a disproportionately high risk of death in motorcycle crashes, with middle-aged men most affected [32]. Because of their age-related fragility and comorbidities, older riders may not necessarily crash more frequently, but they are more likely to succumb if they do so [33]. Additional factors contributing to this double peak distribution include the use of heavier, more powerful motorcycles, skill overestimation, and delayed reaction time and sensory decline [33].

In our study, a significant portion of our sample had a history of alcohol abuse (21.13%). Correspondingly, after relevant testing, a significant portion of our sample was found to be positive for psychoactive substances (41.43%), suggesting that positive psychoactive toxicological screening is a strong predictor of poor survival (aHR = 2.12, $p = 0.015$). The psychoactive substances covered by the screening were restricted to commonly misused substances like opioids, heroin, cannabis, hallucinogens, and related illegal drugs; thus, we did not include centrally acting pharmaceuticals administered within hospital settings, as those were excluded after the interpretation of results based on available information relevant to the administration of drugs during hospitalization. Our results are consistent with numerous global studies. Studies have established alcohol positivity rates that range from 21% to over 50% [9,34–37]. As stated by Bakovic et al., in 53.8% of cases, the rider's BAC was above the legal limit for driving (>0.50 mg/L) [9]. Similarly, increased BAC was directly linked to higher in-hospital mortality as stated by Ahmed et al. [34]. Likewise, Sarmiento et al. (2020) emphasized that drug and alcohol use are common in fatal motorcycle incidents and probably contribute to dangerous behavior like speeding [35]. This was further expanded by Lu et al., who suggested that a significant percentage of possibly survivable fatalities include drunk drivers [36]. These conclusions were supported by Mohd Saman et al., who noted that detection of alcohol and/or other CNS-affecting substances among motorcycle fatalities was associated with the presence of severe head and multi-system injuries [37]. Likewise, in a Chinese study, alcohol played a significant role [38]. In general, alcohol consumption was found to increase the possibility of an RTA as well as worsen survival outcomes [39].

Although illicit drug use was lower compared to alcohol use, its contribution to fatal outcomes was also prominent. According to Bakovic et al., use of psychoactive substances (illegal drugs or nontherapeutic use of legal drugs) was not common and was only detected in 10.4% of fatally injured riders [9]. On the contrary, according to Sarmiento et al. and a study consisting of 227 motorcycle fatalities, 44% tested positive for alcohol/illicit substances. Additionally, they were more likely to be found at fault for the crashes [35]. Similarly, according to a Malaysian study, about 31% of fatally injured riders were positive for illicit drugs and/or alcohol [37]. In this Norwegian study, drugs were discovered in 15.3 percent of fatalities [40]. To summarize, these studies highlight the contribution of alcohol and psychoactive substances to RTA fatalities.

According to our data, chest and head injuries were the most common injuries. Chest trauma was present in 77.66% of the cases, while head trauma was present in 73.4%. Throughout the literature, head trauma consistently emerges as the leading cause of death [8,9,13,15,16,21,39]. Though our study focused on the variation in post-crash survival times in correlation to the distribution and pattern of injuries, our results are consistent with studies also reporting immediate (brought in deceased) cases. These underline the fact that survival is not just directly linked to the severity of injuries but is rather a continuum affected not only by the general health condition of the victim but also the dynamics of the accident itself [6,21,37]. According to Faduyile et al., head injuries were the most common (41.4%), and most of the victims died of head injuries (50.7%) [21]. Similarly, as stated by Barzegar et al., the most common cause of death out of the 28,356 motorcycle fatalities studied was head trauma (59.0%) [8]. According to Bakovic et al., the most common cause of death in motorcycle fatalities was multiple injuries (55.8%) followed by isolated head trauma (23.3%) [9]. Similar results have been noted in Lagos (head injury was the most common injury and cause of death (51.6%)) [13]. On the contrary, in a Malaysian study, the most common injuries were lung lacerations (85.7%), followed by thoracic hemorrhage (73%) and intracranial hemorrhage (74%) [37]. Several studies reported high rates (above 50%) of head injuries alongside chest, abdominal, and extremity trauma [13,37,41,42]. As

stated by an Italian study, the limbs were the most frequently affected body part, followed by the head (87.4%) and the thorax (85.7%) [41]. In another Italian study, consisting of 1862 cases of motorcycle accidents, limbs (53.9%) were again the most common site of injury, followed by the head (53.8%) [42]. In our study, the presence of multiple-site injuries (polytrauma) was associated with approximately double the risk of mortality (HR = 1.94), while 67.02% of the sample presented with multiple injuries. In the same fashion, throughout the literature, polytrauma was more common than isolated injuries and correlated with increased fatality risk [9,26,43]. In an epidemiological study from Togo, 136 of 190 cases suffered polytrauma before succumbing [43]. In terms of age and injuries, younger riders were more prone to severe head injuries, while older riders demonstrated a higher prevalence of chest injuries [26]. The former probably occurs due to young drivers' lack of helmet use. In our study, information about helmet use was not provided.

It is well established that pre-existing medical conditions can contribute to post-crash fatalities [44–46], contributing not only to crash causality but also to poor survival. In our sample, 17.02% of participants had pre-existing cardiovascular disorders, 2.13% had metabolic diseases, and 3.19% had mobility impairments, highlighting that pre-existing medical conditions are comparatively uncommon. Additionally, only 3.26% of subjects suffered from psychiatric disorders.

Remarkably, while the concept of the "golden hour" is considered critical for survival, in our study, it was shown that delayed arrival to the hospital (>60 min) was associated with slightly greater survival rates. According to our analysis, 54.55% of the deceased arrived within 60 min, and 45.45% arrived after 60 min. This may be related to the fact that the most seriously injured individuals are usually transported faster to the hospital than those with fewer injuries, resulting in the former being transported faster but succumbing earlier. According to a systematic review consisting of data extracted from a total of 89 papers from multiple continents, the terms "Golden Hour" and "Platinum 10 Minutes" in post-crash settings were infrequently used. At the same time, the results suggested they were not linked with improved outcomes, underlining that other aspects, like the overall quality of hospital care, are also significant [47].

## 5. Conclusions

By combining local and international data, our research demonstrates how the interaction between epidemiological factors, psychoactive substance use, and injury patterns contributes to mortality rates. The majority of our study's decedents were male and relatively young. The presence of polytrauma as well as chest, head, and abdominal injuries appear to significantly affect the survival of victims. Additionally, the use of psychoactive substances also appears to heavily impact mortality. The data suggests that there is need for adoption of prevention strategies such as gender- and age-targeted education that will focus on protective gear as well as other mortality-contributing factors such as substance use. Toxicological screening and zero-tolerance drug policies are also essential. Emergency medical services and hospital aid settings are also crucial for survival improvement.

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**Data Availability Statement:** The raw data supporting the conclusions of this article will be made available by the authors on request.

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