International Journal of Emergency Medicine

RESEARCH

Open Access

Epidemiological characteristics of elderly population receiving pre-hospital emergency care after road traffic injuries in Punjab, Pakistan

Kantesh Kumar[1], Sheza Hassan[2], Muhammad Bazil Musharraf[1], Komal Abdul Rahim[1], Sijal Akhtar Sheikh[1], Huba Atiq[1], Muhammad Waqas Ahmed[1,4], Rameez-ur-Rehman Siddiqui[1], Rizwan Naseer[3], Shahnaz Akhter[3], Yasir Shafiq[1] and Junaid Razzak[1,2*]

Abstract

Background Every year, 1.3 million lives are lost to road traffic injuries (RTIs). 90% of these deaths disproportionately occur in Lower-Middle Income Countries (LMICs). Due to frailty and reduced physiological resilience, elderly populations are at higher risk of RTIs and poor outcomes, versus younger populations. Further, according to the World Health Organization (WHO), the global elderly population will double by 2050, indicating that this group will be at an even higher risk of RTIS.

Objectives Our study aims to utilize Emergency Medical Services (EMS) data to better understand the trends, types, injuries, patient characteristics, and outcomes of RTIs involving the elderly, ultimately contributing to more targeted and effective road safety policies and interventions.

Methods We analyzed secondary EMS data during 2022 and 2023 from the Emergency Services Department (Rescue 1122) in the province of Punjab, Pakistan. RTI data in patients aged ≥ 65 years was extracted from the database for age, gender, education, response time, injury type, RTI victim type, location of injury, and victim outcome. Multivariable analysis was carried out using multiple logistic regression to obtain an adjusted odds ratio with a 95% confidence interval for on-scene mortality.

Results From 4.2 million EMS activations, data on 34,345 RTIs in elderly patients was analyzed. Patients had a mean age of 70.12 years, and 77% (26,608) were males. The most common injury type was soft tissue injury (24,166; 70.36%), followed by limb injury (5,126; 14.9%), and head injury (2,590; 7.5%). Most victims suffered injuries as passengers (11,396; 37.2%). The mean response time was 7.19 minutes, and the on-scene mortality rate was 1.3% (443). The odds of on-scene mortality increased with increasing response time (AOR: 1.05, CI: 1.04–1.07), while an increase in the degree of urbanization was associated with decreasing odds of on-scene mortality (AOR: 0.99, CI: 0.98–0.99). Head

*Correspondence:
Junaid Razzak
Junaid.razzak@aku.edu

Full list of author information is available at the end of the article

injuries (OR: 24.49, CI: 20.11–29.93) and pedestrian injuries (Adjusted OR: 1.40, CI: 1.06–1.84) were strongly associated with on-scene mortality.

Conclusion Our study revealed that head and pedestrian injuries emerged as key factors for on-scene mortality in elderly patients of Punjab, Pakistan. These findings necessitate targeted interventions to encourage a rapid pre-hospital response to lower on-scene mortality rates.

Introduction

Road traffic Injuries (RTIs) remain a significant public health issue worldwide, claiming over 1.3 million lives annually [1], with many more sustaining serious injuries. In 2021, RTIs ranked 11th among all causes of mortality globally; out of a total of 4.4 million injury deaths, RTIs ranked 1st [2]. Further, If things continue at this pace RTIs could become the fifth leading cause of death globally by 2030, undermining the World Health Organization (WHO) goal of reducing these fatalities by half within the same timeframe [3, 4]. Alarmingly, the burden of morbidity and mortality for RTIs is disproportionately shared by lower-middle-income countries (LMICs), who witness up to 90% of these deaths, despite these regions having just 60% of the world's vehicles [5]. In our study population of Pakistan, the Pakistan Bureau of Statistics reports that there were 10,429 RTIs in the year 2020, of which over 40% were fatal; this translates to 16 deaths per day [6]. Considering the historical under-reporting of this data, these metrics could even be a gross underestimate of RTI occurrences in the country [7, 8]. The most recent Global Status Report on Road Safety presents the disparity in Government reported fatalities (5,816) against 27,568 estimated by WHO for the year 2021 [9]. Overall, both these global and local findings underscore the urgent need to understand factors contributing to RTIs to formulate effective prevention strategies.

While RTIs predominantly occur in younger individuals, outcomes are often more severe for elderly victims, even if injury severities are similar. This is largely due to the increased frailty and decreased physiological resilience associated with aging [10–12]. In 2021, almost 24% of RTI victims were aged > 60 years [13]. A 2015 study from Iran reported that older adults accounted for nearly 8% of all RTIs and experienced a mortality rate twice as high as younger victims [14]. With projections indicating a doubling in the population size of individuals aged 60 and above, and with 2/3 of this population expected to live in LMICs, RTI occurrences in the elderly are likely to become even more prevalent [15]. As of 2019, our study population of Pakistan was reported to house over 15 million people over 60 years old; this elderly population comprises 7% of the country's total population [16]. Indeed, this number is expected to double to 12% by 2050 [17]. As the global population ages, understanding the unique vulnerabilities of the elderly in traffic incidents becomes increasingly critical for public health planning and intervention.

Despite the relevance of RTIs for at-risk elderly populations, there is a lack of comprehensive research focusing on RTIs among this demographic. Few studies focus specifically on the elderly; those that do most come from High-Income Countries (HICs). There is a paucity of work in this realm that has been conducted in LMICs; to our knowledge, only one study from Iran has been conducted using EMS records [18]. Therefore, our study aims to fill this gap by utilizing EMS data from Punjab, Pakistan to better understand the trends, types, and outcomes of elderly RTIs. In doing so, we hope to ultimately contribute to more specific and effective road safety policies and interventions that can be adopted in LMIC settings.

Methods

Study design and setting

We conducted a secondary data analysis to understand the patterns of injuries among RTIs that utilized pre-hospital care in the province of Punjab. Punjab is the largest province of Pakistan, with a population of 110 million representing 57% of the country's population [19]. The province has 10 divisions, 41 districts, and 151 tehsils [20].

In Punjab, Pakistan, RTIs have surged in recent years, fueled by rapid urbanization, a growing number of vehicles, and infrastructure development not at par with population growth [21–23]. The increase in the registration of two-wheelers has significantly outpaced that of four-wheelers, with Pakistan ranking as the fifth largest market for two-wheelers globally [22]. Furthermore, vehicle safety standards are virtually non-existent, particularly in locally assembled cars, which often fail to comply with international safety regulations and Western safety benchmarks [24]. Both two-wheelers and the absence of safety implementation have been linked to increasing RTI mortality [25, 26]. Understanding this local context is crucial for addressing the specific needs and risks associated with RTIs in Punjab, particularly for the growing elderly population.

Data was obtained from EMS records maintained by Rescue 1122 in Punjab, Pakistan. Rescue 1122 responds to approximately 1.8 million emergencies annually and records every call they receive on a digital dashboard. It

was first established in 2004 in Lahore, Punjab, and has now expanded to other provinces as well, such as Sindh.

The EMS system is well-operated by Rescue 1122, focusing on providing pre-hospital care. The EMS activation is done through Rescue 1122 emergency hotline number, when details of the incident, location, and patient condition are logged into a centralized dispatch system. A dispatching team then responds to the emergency by activating the nearest ambulance crew. Once the ambulance reaches the scene, they provide on-scene stabilization and collect data on patient demographics, time of injury and response, cause of activation, initial vitals, and outcomes (on-scene death, shift to hospital etc.).

Study participants and data collection

Deidentified data was obtained from Rescue 1122 Punjab for 2022 to 2023, and individuals over 65 years who had RTIs documented as the mechanism of injury were selected. We excluded entries with missing injury types or locations of injury.

Figure 1 provides the schematic flow of the final patients included in the analysis. Briefly, of the total EMS activations from 2022 to 2023, 0.87 million were due to road traffic injuries, and only 35,640 were aged 65 years and above. After excluding records with no data on injury type, tehsils, and age, the final sample included in the analysis was 34,345.

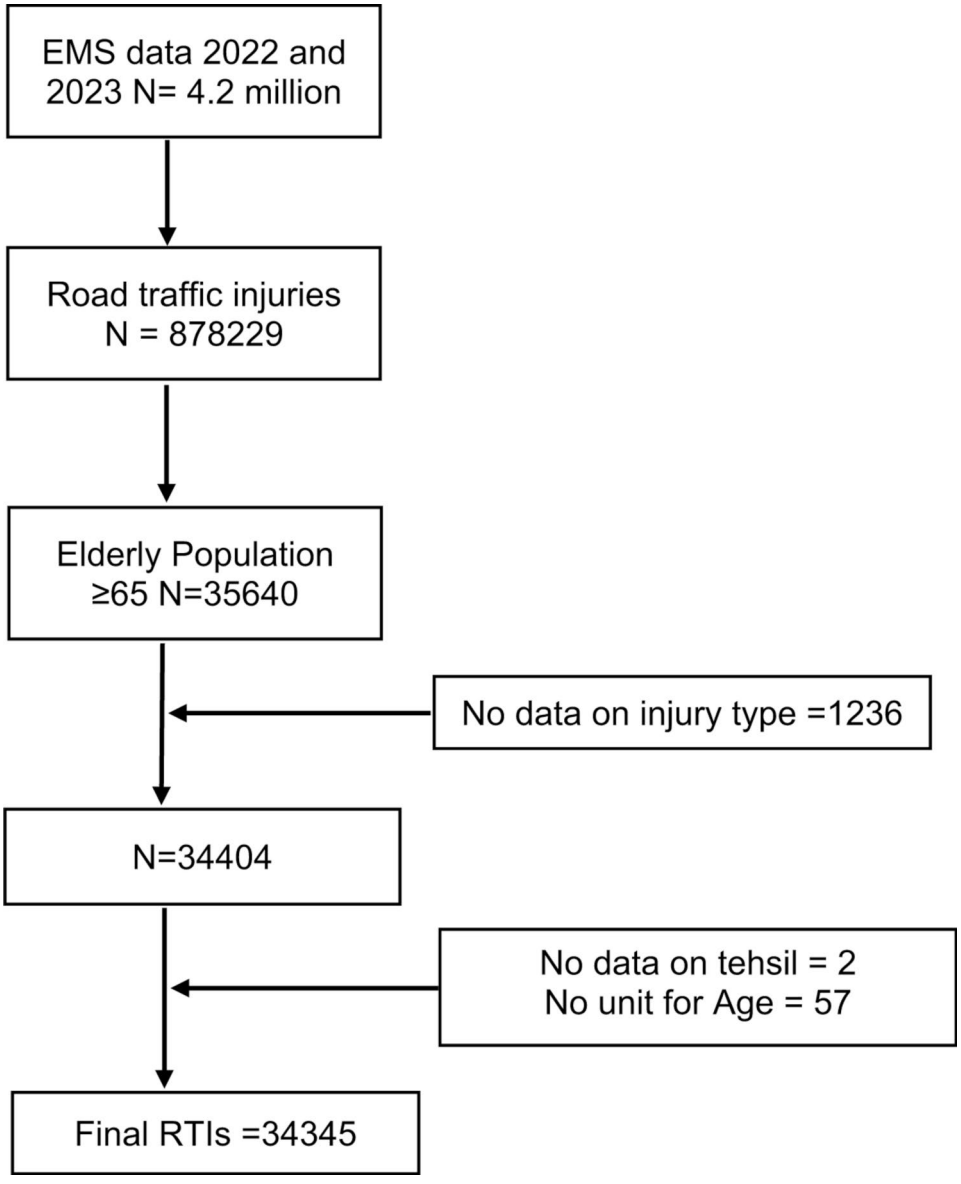

Fig. 1 Schematic flow of patients

Variables of interest

The primary outcome of the study on-scene mortality.

The following variables were extracted from the records: age, gender (males and females), education status (no formal education and formal education), and region (Lahore, Bahawalpur, Dera Ghazi Khan, Faisalabad, Gujranwala, Multan, Rawalpindi, Sahiwal, and Sargodha). Details on injury type included RTI victim type (driver/rider, passenger, and pedestrian), and injury type (abrasions, cuts, abdominal/thoracic, fractures/limbs, head injury, multiple fractures, and spinal injury). The degree of urbanization was defined at the Tehsil level using data from the Pakistan Bureau of Statistics (2017); urbanization proportion (ranging from 0 to 1) was used for each Tehsils and was used as a continuous variable in the dataset, with 0 representing no urbanization and 1 represents fully urbanized.

Response time was calculated from the time of call received at the Rescue 1122 call center until the on-scene ambulance arrival. The response time was taken as a continuous variable. A separate variable for head injury was created and was kept as an independent variable in the final model, as the head injury is directly associated with mortality in trauma patients.

Table 1 Factor affecting On-scene Mortality - Univariate and multivariable logistic regression

Characteristic	Mean ± sd, n (%) (*N* = 34,345)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Gender			
Male	26,608(77.5)		
Female	7,737(22.5)	1.15 (0.92–1.42)	0.94 (0.73–1.21)
Age	70.12(5.83)	1.007 (1.00-1.02)	1.004 (0.98–1.02)
Response time	7.19 (5.82)	1.06 (1.05–1.07)	1.05 (1.04–1.07)
Degree of Urbanization	54.24 (34.17)	0.98 (0.98–0.99)	0.99 (0.98–0.99)
RTA victim type			
Driver/Rider	11,097(36.2)		
Passenger	11,396(37.2)	1.40 (1.10–1.77)	1.27 (0.97–1.65)
Pedestrian	8,175(26.6)	1.28 (0.98–1.66)	1.40 (1.06–1.84)
Divisions			
Lahore	9,655 (28)		
Bahawalpur	2,621 (7.6)	1.85 (1.26–2.68)	1.77 (0.76–1.79)
Dera Ghazi Khan	1,947 (5.7)	2.45 (1.67–3.55)	1.46 (0.93–2.27)
Faisalabad	4,220 (12)	1.36 (0.95–1.93)	0.97 (0.65–1.43)
Gujranwala	5,335 (16)	1.58 (1.15–2.16)	1.13 (0.79–1.62)
Multan	3,855 (11)	1.55 (1.09–2.19)	1.15 (0.78–1.69)
Rawalpindi	2,326 (6.8)	2.04 (1.38–2.95)	1.51 (1.00-2.27)
Sahiwal	2,484 (7.2)	1.53 (1.00-2.27)	0.94 (0.58–1.50)
Sargodha	1,902 (5.5)	1.63 (1.04–2.50)	1.44 (0.68–1.78)
Head Injury *			
No	31,755 (92.5)		
Yes	2,590 (7.5)	24.49 (20.11–29.91)	

*Head Injury was removed from the Multivariable Logistic Model to prevent the skewness

Statistical analysis

Descriptive analysis was conducted using means and standard deviations for continuous variables (e.g., age); for categorical variables (e.g., gender and education status), frequencies and percentages were used. For analysis, injury types were labeled as soft tissue injury (e.g., cuts and abrasions), torso injury (e.g. thoracic, abdominal, back, or spinal injury), and limb injury (e.g., limb injury and fractures). Crude odds ratios with 95% confidence intervals were calculated using simple logistic regression for on-scene deaths. The variables that qualified the screening p-value of ≤ 0.25 then entered the multivariable analysis. Multiple logistic regression was conducted to obtain an adjusted odds ratio along with 95% CI to identify the predictors of on-scene mortality after road injuries among older adults. A two-sided p-value of 0.05 was considered statistically significant. The analysis was conducted on R version 4.4.2.

Results

The data from the Rescue 1122 EMS registry reported 4.2 million EMS activations during the time frame of our study, i.e., January 1st, 2022, to December 31st, 2023. RTIs contributed to 842,962 (20.07%) of these cases, of which 34,345 (0.82% out of 4.2 million and 4.07% out of 842,962) RTIs were reported in the elderly population (≥ 65 years). After data cleaning and extraction, all 34,345 RTI cases were included in the study. The mean age of patients was 70.12 ± 5.83 years. A majority of these RTI victims were males (77.5%). Among reported RTIs, 66.4% (22,227) of the victims had no formal education. Most RTI victims (58.2%; 19,981) were shifted to the hospital, while 40.5% (13,887) of the cases were provided with first aid and discharged from the scene. The overall on-scene mortality was 1.3% (443).

RTI prevalence was equal among drivers/riders (36.2%) or passengers (37.2%), followed by pedestrian victims (26.6%). No data was present on victim type in 3,677 cases. The most common injury type was soft tissue injuries (70.36%) followed by severe injuries (e.g., limb fractures and head injuries in 14.9% and 7.5% of RTI victims, respectively). Divisions with surrounding peri-urban populations with the greatest number of RTIs included Lahore (28%), Gujranwala (16%), Faisalabad (12%), and Multan (11%) (Table 1).

Table 1 also shows the univariate and multivariable regression analysis to predict on-scene mortality outcomes in RTI patients. In the univariate analysis, gender was not significantly associated with mortality (OR for females: 1.15, 95% CI: 0.92–1.42). This finding remained consistent in the multivariable logistic regression model

(OR: 0.94, 95% CI: 0.73–1.21). Increasing age was found to be significantly associated with mortality in univariate (OR: 1.007, 95% CI: 1.00-1.02), but not in multivariable analyses (OR: 1.004, 95% CI: 0.98–1.02). Response time significantly increased the odds of on-scene mortality in both univariate (OR: 1.06, 95% CI: 1.05–1.07, $p < 0.001$) and multivariable models (OR: 1.05, 95% CI: 1.04–1.07). For the RTI victim type, passengers had higher odds of on-scene mortality in the univariate analysis (OR: 1.39, 95% CI: 1.10–1.77, $p = 0.005$); contrastingly, the multivariable model showed that pedestrians had higher odds of on-scene mortality (OR: 1.29, 95% CI: 1.00-1.68). Response time was associated with increased mortality in both univariate (OR: 1.06, 95% CI: 1.05–1.07) and multivariable models (Adjusted OR: 1.05, 95% CI: 1.04–1.07). Our results show that head injury was strongly associated with on-scene mortality, as determined by univariate analysis (OR: 24.49, 95% CI: 20.11–29.93, $p < 0.001$). An increasing degree of urbanization demonstrated a statistically significant association with decreased on-scene mortality in both univariate (OR: 0.98, 95% CI: 0.98–0.99) and multivariable models (Adjusted OR:0.99, 95% CI:0.98–0.99). Overall, all divisions showed significant associations in both models.

Figure 2 shows the distribution of RTIs across the months of 2022 and 2023. In year 2022 (red), the lowest number of RTIs was reported in January, after which a drastic increase of ~200% in RTIs from was witnessed from February to March. Contrastingly, in the year 2023 (blue), no abrupt increase in RTIs was observed within the same time frame. In both 2022 and 2023, the number of RTIs was consistently low from May-September but later peaked from October-November 2023. Overall, the total number of RTIs in 2023 increased by 25–35%, as compared to the 2022 RTI burden.

Figure 3 illustrates the distribution of outcomes based on injury type. Despite soft tissue injuries being the most common, they resulted in mortality in only 0.1% of cases. Patients with head injury reported 11% on-scene mortality. Torso and other injuries contributed to 3.8% and 5.4% mortality overall. Multiple fractures and limb injuries presented with 3.2% and 0.3% mortality in each category.

Discussion

Our study assessed the distribution of sociodemographic variables among RTI patients aged ≥ 65 years transferred by Rescue 1122 in Punjab. We also analyzed factors associated with higher on-scene mortality. Overall, on-scene mortality was 1.3%. Of the patients who died on the scene, 64% had a head injury. Patients with head injuries had 24 times higher odds of on-scene mortality. Similarly, pedestrians also had higher odds of mortality, even though only 26.6% suffered injuries as pedestrians.

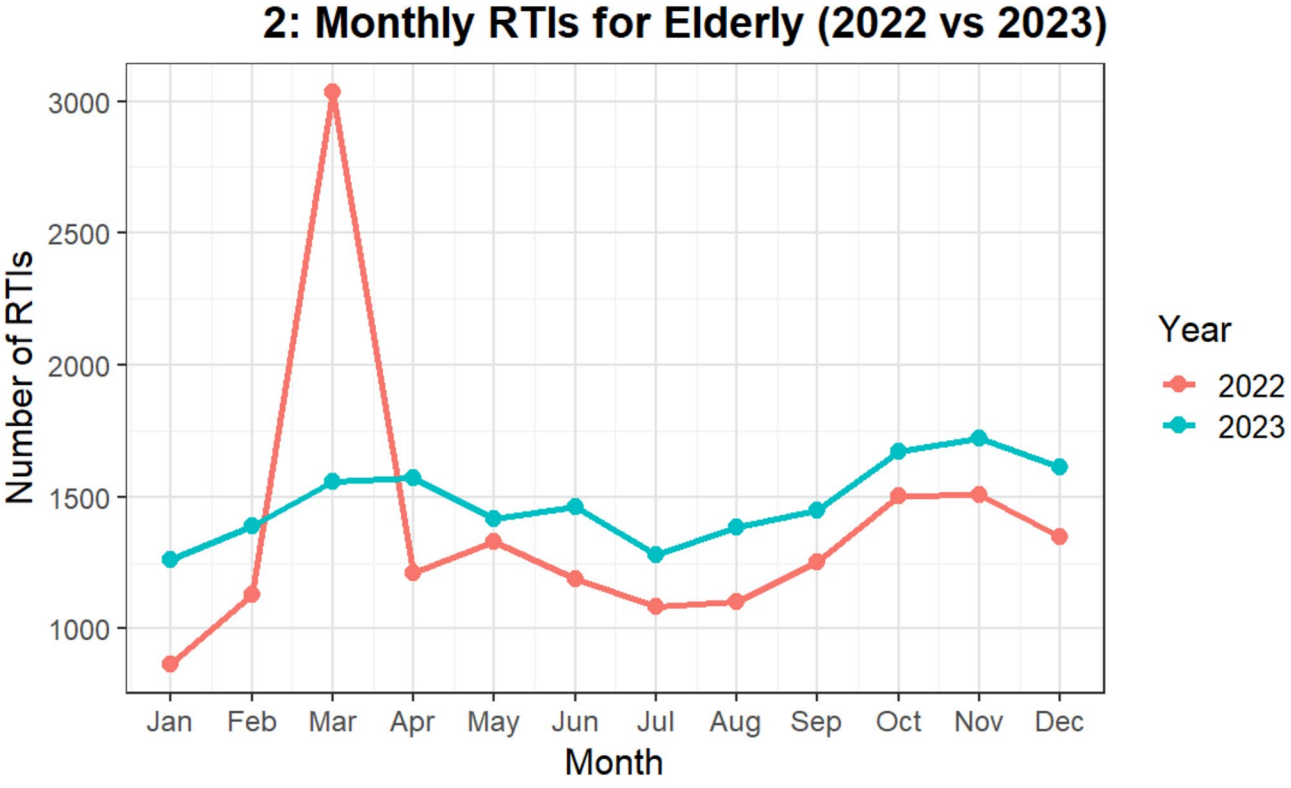

Fig. 2 Monthly RTIs for elderly (2022 vs. 2023)

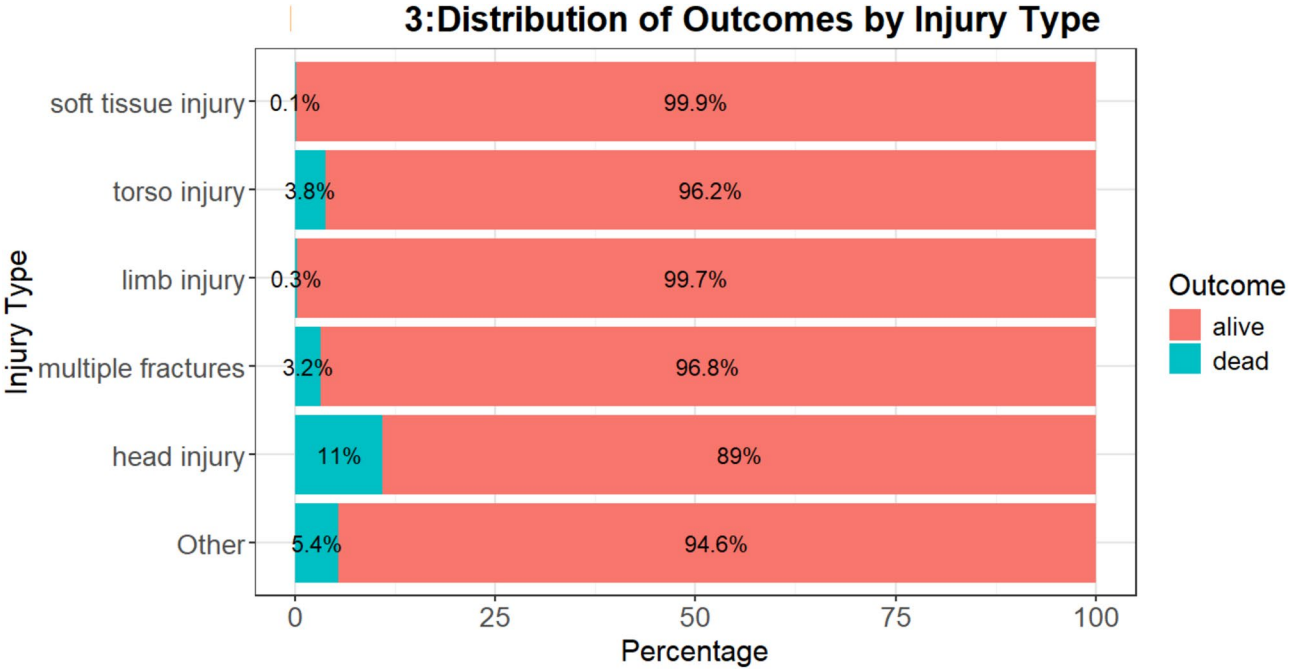

Fig. 3 Distribution of outcomes by injury type

There is a dearth of literature on the on-scene or prehospital mortality in RTI elderly victims. However, numerous studies have quantified hospital mortality in elderly RTI victims. For example, one study in India reported an emergency department mortality rate of 0.5% for older adults. Other studies reporting on overall in-hospital mortality, such as a systemic review and one study in Iran, reported 14% and 10.1% mortality rates, respectively [27, 28]. Our study had an on-scene mortality of 1.3%. One reason behind this low mortality rate finding may be due to underreporting; patients who die even minutes after EMS pick-up may not be documented as dead. Another reason may be survivorship bias, which stems from the higher utilization of EMS services by survivors, while non-survivors are taken home via other available transport [29]. Although these issues do contribute to underreporting, EMS data does play a pivotal role in understanding the trends and impacts of RTIs. Although many RTIs are non-fatal and do not warrant hospital admission, EMS activations are able to capture overall RTI prevalence; this is particularly significant as hospital data only captures critical victims requiring hospitalization. Further, although global police data is utilized to assess road safety, EMS data may prove more fruitful in LMIC settings, where police data often underreport RTIs (30–31). Overall, EMS data provides a more representative picture of RTI epidemiology in our setting.

The most common cause of death in our study was attributed to head injuries. At baseline, elderly populations are more vulnerable to severe head injuries due to the aging process, which shrinks brain matter, and increases the risk of blood vessel rupture even following minor trauma [38–40]. We report that 2/3 of dead patients in our study had head injuries. This finding is in line with one study conducted in Iran, which stated that head injuries caused 61.2% of prehospital deaths after RTIs [32]. In contrast, another study in India revealed head injuries as the second most common RTI injury in elderly patients [33]. The higher incidence of head injuries in these patients may be associated with several factors, such as more frequent use of motorbikes as compared to cars. Indeed, in Pakistan, there are over three times as many registered bikes than cars [34] Other contributing factors might be the limited use of helmets, careless or reckless driving, and drunk driving [35–37].

In our study, only 27% of pedestrian participants suffered injuries. In contrast to this finding, two studies conducted in Iran revealed that in elderly RTIs, pedestrians were the most injured [32, 41]. This difference may stem from a higher proportion of working older adults in our Pakistani population, who may rely more on vehicles for transport in comparison to walking, due to reduced mobility and Pakistan-specific infrastructure. Despite pedestrian participants being a minority of the injured victims, they also had the highest odds of mortality in our study. This is in contrast to one study in Australia, which showed that elderly pedestrians had lower mortality as compared to drivers and passengers [42]. Lastly, one interesting finding of our study was that there were twice as many RTIs in March 2022 as in any other month in our dataset. This unusually high number of RTIs may be associated with traffic congestion due to protests resulting

from political instability [43, 44]. In totality, these findings indicate that RTI morbidity and mortality may often be context-specific; reported statistics may fluctuate based on a variety of diverse social, cultural, geographic, and infrastructural factors.

Our study has multiple policy implications. Several policy changes are required to ensure the safety of vulnerable road users. Strategies like installing overhead cross-overs, guard rails, traffic signals, and low-speed limits in densely populated areas are required to reduce pedestrian injuries [45]. Furthermore, improved lighting (both for drivers/passengers and pedestrians and guard rails will reduce mortality in rural areas [46]. Our findings reported the highest mortality due to head injuries; strict enforcement ensuring compliance with traffic rules, including helmet use for both drivers/riders and passengers, may reduce head injury incidence and associated mortality. Future studies can be conducted to identify and validate potential interventions that would be effective in preventing RTIs in older adults, or in improving RTI outcomes. Further studies measuring hospital and long-term outcomes in older adults after RTIs are also required; such work can assist in better understanding the overall trauma response and impact on quality of life within this population.

Our study has several strengths and limitations. Our study leverages provincial-level data with a large sample size, thereby gaining more power. Due to the size and coverage of our cohort, our work can be significantly generalized to the population in Punjab. However, our study is also limited in that it only includes on-scene mortality and lacks information on en-route and in-hospital mortality. The collected data is also prone EMS biases, such as survivorship bias. Due to varying numbers of ambulances, and disparate utilization of EMS services in different districts of Punjab, there is also unequal representation among all the districts in our study. Finally, this report relies on secondary data; as such, we could not capture additional relevant variables, such as vehicle type involved, severity of injury, in-hospital mortality, etc.

Conclusion

Overall, on-scene mortality in elderly RTI victims is highly correlated with head injuries. These findings necessitate targeted interventions to prevent on-scene deaths and have a rapid pre-hospital response in this vulnerable group. Within this group, pedestrians were another high-risk group to experience on-scene deaths, mandating policies to improve pedestrian safety and infrastructure improvements.

Acknowledgements
We would like to extend our gratitude to Mr. Naeem from Rescue 1122 for their help with data curation.

Author contributions
KK, SH, HA, and JR were involved in the study's conception and design. RN, SA, MW, RRS, and HA helped acquire data. KK and KAR performed the analysis with supervision from YS. KK, SH, MBM, KAR, and SAS wrote the first draft of the manuscript. All the authors were involved in revising and editing the final draft. HA and JR supervised the entire project.

Funding
There was no funding in this study.

Data availability
Data generated during this study can not be shared openly, but available from the corresponding author at a reasonable request.

Declarations

Ethics approval and consent to participate
Our study received exemption from Aga Khan University Ethical Approval Committee under the reference no: 2023-8369-25256.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Disclaimer
An abstract summarizing the findings of this paper was presented as a poster at the 2024 Weill Cornell Emergency Medicine Symposium.

Author details
[1]Centre of Excellence for Trauma and Emergencies, The Aga Khan University, Karachi, Sindh, Pakistan
[2]Department of Emergency Medicine, Weill Cornell Medicine, New York, NY, USA
[3]Emergency Services Department, Government of Punjab, Lahore, Pakistan
[4]UHasselt, Transportation Research Institute (IMOB), Martelarenlaan 42, Hasselt 3500, Belgium

Received: 17 January 2025 / Accepted: 27 April 2025
Published online: 01 August 2025

References

1. Global status report on road. safety 2023. [cited 2025 Apr 7]. Available from: https://www.who.int/teams/social-determinants-of-health/safety-and-mobility/global-status-report-on-road-safety-2023
2. Naghavi M, Ong KL, Aali A, Ababneh HS, Abate YH, Abbafati C et al. Global burden of 288 causes of death and life expectancy decomposition in 204 countries and territories and 811 subnational locations, 1990–2021: a systematic analysis for the Global Burden of Disease Study 2021. The Lancet. 2024 May 18 [cited 2025 Apr 7];403(10440):2100–32. Available from: https://www.thelancet.com/action/showFullText?pii=S0140673624003672
3. United Nations. Resolution adopted by the General Assembly. 2020 [cited 2025 Apr 7]. Available from: https://docs.un.org/en/A/RES/74/299
4. Decade of Action for Road. Safety 2021–2030. [cited 2025 Apr 7]. Available from: https://www.who.int/teams/social-determinants-of-health/safety-and-mobility/decade-of-action-for-road-safety-2021-2030
5. Road traffic injuries. [cited 2025 Jan 7]. Available from: https://www.who.int/news-room/fact-sheets/detail/road-traffic-injuries
6. Data on Traffic Accidents Year/Month. Total Number of Accidents Accident Persons Total Number of Vehicles. 2021.
7. Younis MW, Batool Z, Bukhari M, Rehman Z ur, Shahzad S, Rehman A, ur et al. Pattern of underreporting of Road Traffic Injuries (RTIs): An investigation of missing burden of RTIs in Pakistan. J Transp Health. 2019;14:100575.
8. Khurshid A, Sohail A, Khurshid M, Shah MU, Jaffry AA. Analysis of Road Traffic Accident Fatalities in Karachi, Pakistan: An Autopsy-Based Study. Cureus. 2021 Apr 13 [cited 2025 Apr 7];13(4):e14459. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC8115190/

9. Road safety Pakistan. 2023 country profile. [cited 2025 Apr 7]. Available from: https://www.who.int/publications/m/item/road-safety-pak-2023-country-profile
10. What Age Group Has the Most Car. Accidents?. [cited 2025 Jan 7]. Available from: https://www.chainlaw.com/what-age-group-causes-the-most-car-accidents/
11. Ahn JY, Ryoo HW, Park JB, Kim JK, Lee MJ, Lee DE et al. Comparison of traffic collision victims between older and younger drivers in South Korea: Epidemiologic characteristics, risk factors and types of collisions. PLoS One. 2019 Apr 1 [cited 2025 Jan 7];14(4):e0214205. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0214205
12. Cunha-Diniz F, Taveira-Gomes T, Santos A, Teixeira JM, Magalhães T. Are There Any Differences in Road Traffic Injury Outcomes between Older and Younger Adults? Setting the Grounds for Posttraumatic Senior Personal Injury Assessment Guidelines. J Clin Med. 2023 Mar 1 [cited 2025 Jan 7];12(6). Available from: https://pubmed.ncbi.nlm.nih.gov/36983355/
13. Mortality. and global health estimates. [cited 2025 Apr 7]. Available from: https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates
14. Etehad H, Yousefzadeh-Chabok S, Davoudi-Kiakalaye A, Moghadam DA, Hemati H, Mohtasham-Amiri Z. Impact of road traffic accidents on the elderly. Arch Gerontol Geriatr. 2015;61(3):489–93. Available from: https://pubmed.ncbi.nlm.nih.gov/26321733/
15. Ageing. and health. [cited 2025 Jan 7]. Available from: https://www.who.int/news-room/fact-sheets/detail/ageing-and-health
16. Pakistan. [cited 2025 Jan 14]. Available from: https://data.who.int/countries/586
17. Ageing population in. Pakistan| HelpAge Asia. [cited 2025 Jan 7]. Available from: https://ageingasia.org/ageing-population-pakistan/
18. Azami-Aghdash S, Aghaei MH, Sadeghi-Bazarghani H. Epidemiology of Road Traffic Injuries among Elderly People; A Systematic Review and Meta-Analysis. Bull Emerg Trauma. 2018 Oct 1 [cited 2025 Jan 7];6(4):279–91. Available from: https://pubmed.ncbi.nlm.nih.gov/30402515/
19. Population Profile Punjab.| Population Welfare Department. [cited 2025 Jan 7]. Available from: https://pwd.punjab.gov.pk/population_profile
20. New Administrative. Division 2023 of Punjab Province.
21. Urbanisation in Pakistan.| United Nations Development Programme. [cited 2025 Jan 7]. Available from: https://www.undp.org/pakistan/urbanisation-pakistan
22. Vehicles in Pakistan. Over Half of All Households Own Motorcycles in 2019| Pakistan Defence. [cited 2025 Jan 7]. Available from: https://defence.pk/threads/vehicles-in-pakistan-over-half-of-all-households-own-motorcycles-in-2019.623617/
23. Anwaar A, Anastasopoulos P, Ong GP, Labi S, Islam M, Bin. Factors Affecting Highway Safety, Health Care Services, and Motorization—An Exploratory Empirical Analysis using Aggregate Data. Journal of Transportation Safety & Security. 2012 Jan 1 [cited 2025 Jan 7];4(2):94. Available from: https://digitalcommons.usf.edu/cutr_facpub/107
24. Sherin A, Road Safety: A major public, health issue. Khyber medical university journal. 2021 Mar 31 [cited 2025 Jan 7];13(1):1–3. Available from: https://www.kmuj.kmu.edu.pk/article/view/21475
25. Global status report on road. safety 2015| WHO| Regional Office for Africa. [cited 2025 Jan 7]. Available from: https://www.afro.who.int/publications/global-status-report-road-safety-2015
26. Margie Peden Rsdsdmaahej. and CM. World report on road traffic injury prevention.
27. Etehad H, Yousefzadeh-Chabok S, Davoudi-Kiakalaye A, Moghadam DA, Hemati H, Mohtasham-Amiri Z. Impact of road traffic accidents on the elderly. Arch Gerontol Geriatr. 2015 Nov 1 [cited 2025 Jan 7];61(3):489–93. Available from: https://pubmed.ncbi.nlm.nih.gov/26321733/
28. Ang BH, Chen WS, Lee SWH. Global burden of road traffic accidents in older adults: A systematic review and meta-regression analysis. Arch Gerontol Geriatr. 2017 Sep 1 [cited 2025 Jan 7];72:32–8. Available from: https://pubmed.ncbi.nlm.nih.gov/28527382/
29. Stephanian D, Brubacher J. P022: Use of police and SAR records to identify cases and reduce survivorship bias in prehospital care research. Canadian Journal of Emergency Medicine. 2020 May [cited 2025 Jan 7];22(S1):S72–S72. Available from: https://www.cambridge.org/core/journals/canadian-journal-of-emergency-medicine/article/p022-use-of-police-and-sar-records-to-identify-cases-and-reduce-survivorship-bias-in-prehospital-care-research/816A97F2E0818E687243F1783E7D5F86
30. Hosseinzadeh A, Karimpour A, Kluger R, Orthober R. Data linkage for crash outcome assessment: linking police-reported crashes, emergency response data, and trauma registry records. J Saf Res. 2022;81:21–35.
31. Hyder AA, Ghaffar A, Masood TI. Motor vehicle crashes in Pakistan: the emerging epidemic. Inj Prev. 2000 Sep [cited 2025 Jan 7];6(3):199–202. Available from: https://pubmed.ncbi.nlm.nih.gov/11003185/
32. Sadeghi-Bazargani H, Samadirad B, Moslemi F. A decade of road traffic fatalities among the elderly in north-West Iran. BMC Public Health. 2018 Jan 8 [cited 2025 Jan 7];18(1):1–7. Available from: https://bmcpublichealth.biomedcentral.com/articles/https://doi.org/10.1186/s12889-017-4976-2
33. Abhilash KPP, Pradeeptha S, Cris A, Hazra D, Jindal A, Selvan J. Severe or not so severe? The gravity of geriatric trauma. J Family Med Prim Care. 2021 Jul [cited 2025 Jan 8];10(7):2614. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC8415650/
34. Neki K, Mitra S, Wambulwa WM, Job RFS. Profile of low and middle-income countries with increases versus decreases in road crash fatality population rates and necessity of motorcycle safety. J Saf Res. 2023;84:129–37.
35. Abdi N, Robertson T, Petrucka P, Crizzle AM. Do motorcycle helmets reduce road traffic injuries, hospitalizations and mortalities in low and lower-middle income countries in Africa? A systematic review and meta-analysis. BMC Public Health. 2022 Dec 1 [cited 2025 Jan 8];22(1):1–20. Available from: https://bmcpublichealth.biomedcentral.com/articles/https://doi.org/10.1186/s12889-022-13138-4
36. Sadeghi-Bazargani H, Samadirad B, Moslemi F. A decade of road traffic fatalities among the elderly in north-West Iran. BMC Public Health. 2018 Jan 8 [cited 2025 Jan 8];18(1):1–7. Available from: https://bmcpublichealth.biomedcentral.com/articles/https://doi.org/10.1186/s12889-017-4976-2
37. Das A, Gjerde H, Gopalan SS, Normann PT. Alcohol, drugs, and road traffic crashes in India: a systematic review. Traffic Inj Prev. 2012 Nov [cited 2025 Jan 8];13(6):544–53. Available from: https://pubmed.ncbi.nlm.nih.gov/23137084/
38. Abdi H, Sanchez-Molina D, Garcia-Vilana S, Rahimi-Movaghar V. Quantifying the effect of cerebral atrophy on head injury risk in elderly individuals: insights from computational biomechanics and experimental analysis of bridging veins. Injury. 2023;54(12):111125.
39. Zhou Z, Li X, Kleiven S. Biomechanics of Acute Subdural Hematoma in the Elderly: A Fluid-Structure Interaction Study. J Neurotrauma. 2019 Jul 1 [cited 2025 Jan 8];36(13):2099–108. Available from: https://pubmed.ncbi.nlm.nih.gov/30717617/
40. Brain Atrophy. What It Is, Causes, Symptoms & Treatment. 2022 [cited 2025 Apr 7]. Available from: https://my.clevelandclinic.org/health/diseases/22515-brain-atrophy
41. Etehad H, Yousefzadeh-Chabok S, Davoudi-Kiakalaye A, Moghadam DA, Hemati H, Mohtasham-Amiri Z. Impact of road traffic accidents on the elderly. Arch Gerontol Geriatr. 2015;61(3):489–93.
42. Yee WY, Cameron PA, Bailey MJ. Road traffic injuries in the elderly. Emerg Med J. 2006 Jan [cited 2025 Jan 7];23(1):42. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC2564127/
43. ARY News. PM Imran Khan addresses rally in Hafizabad| 13th March 2022 - YouTube. 2022 [cited 2025 Apr 9]. Available from: https://www.youtube.com/watch?v=bYteWp4EMK8
44. Q Zaman. Thousands rally in Pakistani capital as pressure grows on PM Khan| Imran Khan News| Al Jazeera. 2022 [cited 2025 Apr 9]. Available from: https://www.aljazeera.com/news/2022/3/27/pakistan-islamabad-rally-imran-khan
45. Pollack KM, Gielen AC, Mohd Ismail MN, Mitzner M, Wu M, Links JM. Investigating and improving pedestrian safety in an urban environment. Inj Epidemiol. 2014 Dec 18 [cited 2025 Jan 7];1(1):11. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC5005641/
46. Pezeshknejad P, Rowangould D, Sullivan J. Policy Brief: Evaluation of the Safety of Pedestrian Crossing Treatments in Small and Rural Communities. University of Vermont Transportation Research Center. 2024 Jan 1 [cited 2025 Jan 7]; Available from: https://scholarworks.uvm.edu/trc/291

Publisher's note