

RESEARCH ARTICLE

Road traffic injury in Lebanon: A prospective study to assess injury characteristics and risk factors

Joseph Ghoubaire¹  | Marwa Diab¹ | Hasan Nassereldine¹ | Hani Tamim² |
Samer Saadeh³ | Raymond Price⁴ | Moustafa Moustafa⁵ | Samar Al-Hajj¹

¹Faculty of Medicine, American University of Beirut, Beirut, Lebanon

²Department of Internal Medicine, American University of Beirut Medical Center, Beirut, Lebanon

³Emergency Department ZHUMC Medical Center, Lebanese University, Beirut, Lebanon

⁴Center for Global Surgery, University of Utah, Salt Lake, Utah, USA

⁵Department of Surgery, The University of Virginia, Richmond, Virginia, USA

Correspondence

Samar Al-Hajj, Faculty of Health Sciences, American University of Beirut, Beirut Lebanon.
Email: sh137@aub.edu.lb

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Abstract

Background: Road traffic injury (RTI) is a significant yet poorly characterized cause of morbidity and mortality in the Middle East. This hospital-based-study examined RTI in Lebanon and provided an understanding of their characteristics.

Methods: We collected prospective RTI data from three participating hospitals over 3 months using a designed tool based on Canadian CHIRPP and WHO tools. We performed logistic regression analysis to examine the relationship between contributing risk factors (age, sex) and injury types as well as the association of safety measures used (seatbelts or helmets) and body parts injured.

Results: A total of 153 patients were collected. Male preponderance with 72%, with mean age 32.6 (SD = 14.9) years. RTI was highest among passengers aged 15 to 29 (48%). Motorcyclists comprised the greatest injury proportion (38%), followed by vehicle-occupants (35%), and pedestrians (25%) ($P = .04$). Hip injuries represented the most affected body part (48.7%), followed by head/neck (38.2%). Only 31% ($n = 47$) of victims applied safety measures (seatbelts or helmets). Six drivers (7%) reported cell phone use at collision. The use of safety measures was associated with a substantial reduction in head/neck injuries ($P = .03$), spine injuries ($P = .049$), and lower risk of traumatic brain injury (TBI) ($P = .02$).

Conclusions: RTI is a major health problem in Lebanon. Safety measures, though poorly adhered to, were associated with less severe injuries, and should be further promoted via awareness campaigns and enforcement. Trauma registries are needed to assess the RTI burden and inform safety interventions and quality-of-care improvement programs.

KEYWORDS

middle eastern region¹ Lebanon, road traffic injury, traumatic brain injury

1 | INTRODUCTION

Road traffic injury (RTI) is one of the leading causes of mortality and morbidity among young adults aged 15 to 29 years globally, yet it

remains a neglected public health problem in many countries.¹⁻³ Approximately 1.35 million RTI related deaths occur annually, making it the eighth leading cause of mortality globally, and predicted to become the fifth leading cause of death by 2030.³ RTI morbidity

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significantly affects 50 million people annually, leaving many with physical functional impairments and long-term disabilities.³ Further to its large burden on victims, RTI imposes financial substantial strains on communities, health care systems, and national economies worldwide, consuming up to 3% on average of the gross domestic product (GDP).³

RTI disproportionately impacts low- and middle-income countries (LMICs), where nearly 90% of global RTI-related fatalities occur.^{3,4} In the Eastern Mediterranean Region specifically, the case-fatality rate resulting from road traffic injuries is among the highest globally, accounting for nearly 27.8 deaths per 100 000 in the year 2015.⁵⁻⁷ These alarming mortality rates may be attributed to many factors including fast urbanization, substandard road networks, inadequate use of road safety measures, and lack of enforcement of road safety regulations.⁸⁻¹⁰ Existing evidence suggests that the appropriate utilization of safety measures by road users (ie, seat belt and helmet use) play a vital role in reducing road injury morbidity and mortality.¹¹⁻¹⁵ Seat belt use is closely associated with the evident prevention of fatal injuries and is linked to a substantial reduction in passengers' severe injuries.^{11,15,16} Compliance with seatbelt use is strongly associated with a major reduction of up to 60% of injury severity and deaths.¹⁵ Regional studies in Saudi Arabia, Qatar, and UAE demonstrated that failure to use a seat belt increased vehicle occupants' risk of severe head injuries resulting from vehicle ejection in high impact collisions.^{12,13,17,18} Similarly, motorcyclists' lack of helmet use adversely decreases riders' survival rates when sustaining acute head trauma.^{19,20} Moreover, distracting behaviors (eg, cell phone use) often act as a catalyst that escalates the risk of being involved in road collisions.¹⁷

Safety compliance (eg, seat belt use, helmet) varies among countries and is strictly intertwined with local enforcement policies and safety regulations. Compliance with safety measures is limited in many countries around the world and rarely enforced in some, particularly low- and middle-income countries.

Lebanon is a middle-income country in the Mediterranean region with a noticeable prevalence of road injuries. RTI represents the leading cause of unintentional injury and death in Lebanon with an estimated fatality rate of 18.1 per 100 000 population.³ Despite its substantial burden, RTI data are scarce, and consequently, RTI studies are limited in their scope and policy impacts.^{2,5,21,22}

In this paper, we aimed to prospectively capture RTI cases of patients reaching the emergency department in the Greater Beirut area to examine the RTI circumstance, narrative, and potential risk factors affecting road injuries and to assess road users' safety measures adopted. This paper represents the first published attempt to prospectively capture data on RTI in Lebanon, hence, providing an opportunity to understand the multiple factors associated with road injuries and offering powerful evidence to design and implement context-sensitive road safety and RTI preventive strategies.

2 | MATERIALS AND METHODS

This study adopted a convenient sampling strategy to select the participating tertiary hospitals. Hospital selection was intended to reflect

geographically and demographically diverse areas and populations across Beirut and its suburbs. The 3 hospitals selected included: (a) A large university-based teaching hospital located in a densely populated area in central Beirut; (b) a private hospital located in a Beirut suburb, and (c) a university hospital adjacent to a refugee camp. This study was approved by the American University of Beirut Institutional Review Board (IRB) SBS-2018-0294 and by the ethical committees at each participating hospital.

An RTI data surveillance form was designed and developed based on existing forms including the Canadian Hospitals Injury Reporting and Prevention Programs (CHIRPP) tool and the WHO Emergency Unit Chart Trauma tool.^{23,24} Data were collected from RTI patients presenting to any of the participating hospitals. RTI was defined based on the World Health Organization as an injury arising from a collision between one or more vehicles and frequently involves pedestrians.²⁵ Collected data consisted of patients' demographic characteristics, the context in which the injury occurred, clinical presentation, and patient disposition. The demographic background collected included patients' age, sex, and nationality. The injury context was characterized by the vehicle type, road type, injury circumstances, safety measures used (airbag, seatbelt, helmet, etc.), and other risk factors (eg, cell phone use, alcohol consumption). Road injuries were also classified by user category including passenger or driver of a vehicle (private car, motorcycle, bus, trucks, taxis), and pedestrians. The clinical presentation consisted of the nature of the injury, the body part affected, and the severity of the injury assessed by the presence of traumatic brain injury (TBI). The patient disposition was noted as well.

The RTI surveillance form was pilot tested for 1 month at one of the hospitals before beginning the study. The study data collection occurred over 3 months between October 2018 and January 2019. Data entries were obtained from the three tertiary hospitals Emergency Departments by trained Research Assistants (RAs). The RAs were trained using KoBo Toolbox (Cambridge, Massachusetts), a software platform for information gathering in austere environments. RTI victims presenting to the ED of the 3 hospitals, were asked to participate in the study. Emergency Department physicians documented RTI patients' clinical presentations as well as injury circumstances. In case of any missing information about the narrative of the collision, one of the research assistants would follow up with the patients over the phone, asking them open-end questions about the circumstances of the injury and the narrative of the collision to complete the RTI data form.

Data were cleaned and analyzed using descriptive and inferential statistical analysis to describe the causes and patterns of RTI injuries. Analysis of continuous variables used to explore RTI injury risks by age, gender, and injury type. Categorical variables were analyzed using Chi-Square to help compare RTI injury incidents between gender and age groups. Logistic regression was conducted to analyze the association between contributing risk factors (eg, age, sex) and injury types as well as the association of safety measures used (eg, seatbelts or helmets), with body parts injured. STATA 14.2 was used for the analysis.

3 | RESULTS

A total of 153 patients sustained a road injury during the 3 months period, of which 110 were male (72%), with a mean age of 32.6 years (SD 14.9). Although the general population of Lebanon has a male to female ratio of 1.01:1, the RTI ratio in our study was found to be 2.6:1. The highest occurrence of RTI was in the age group 15 to 29 years (48%), followed by 30 to 49 years (31%). Nearly 9% (n = 13) of the RTI patients were under the driving age of 18 (legal driving age in Lebanon), with almost 77% of between the age of 15 to 29 were males (Table 1).

The mechanism of injury varied significantly among road users. The majority of injured patients were motorcyclists (38%), followed closely by drivers or front-seat passengers (35%), and pedestrians (25%) (P = .04). Among the non-pedestrian RTI injuries, the percentage of drivers was

significantly higher than passengers, with 84% and 16% respectively. Nearly 63% of the collisions took place on side streets, with 36% occurring on highways and 1% on sidewalks (Figure 1). Midday (10 AM-6 PM) had the highest incident of crashes (57%) (n = 82), with Thursday being the most common day of crashes (22%) (n = 32) (Figure 2).

Motorcycle RTI was most prominent in the age group 15 to 29, showing a slight decrease in the 30 to 49 age group. Among the elderly, a private car was the most common road crash category. Motorcycle use was evidently the most common transportation type among male RTI victims 96% (49/52), compared to females representing only 4% of the injuries (Table 2).

Most patients were of Lebanese origin (83%) (n = 111). Compared to the Lebanese population, non-Lebanese patients were over-represented as motorcycle riders (22%) (n = 11) and pedestrians (22%) (n = 7) and underrepresented among car crashes (4%) (n = 2). Fifty percent of non-Lebanese were injured from a motorcycle crash, a significantly higher prevalence compared to Lebanese (35%) (P < .001). Similarly, 32% of non-Lebanese RTI patients were pedestrians, compared to 25% of Lebanese (Table 2).

The most common injury type was superficial bruises or abrasions (67.3%), followed by soft tissue injury (47.1%), fractures (22.9%), and open wounds (16.3%). Hip injuries represented the most affected body area (48.7%), followed by the head and neck (38.2%). Shoulder injuries were also common (29%), followed by spine (18.4%), and trunk (17.1%) (Tables 3 and 4).

TABLE 1 Demographics of RTI victims in Lebanon

Characteristic age, y	Male (N, %)	Female (N, %)	Total (N, %)
<14	6 (85.7)	1 (14.3)	7 (4.6)
15-29	56 (76.7)	17 (23.3)	73 (48.0)
30-49	34 (70.8)	14 (29.2)	48 (31.6)
50-64	10 (55.5)	8 (44.5)	18 (11.8)
>65	4 (66.6)	2 (33.3)	6 (3.9)
Total	110 (72)	42 (28)	152

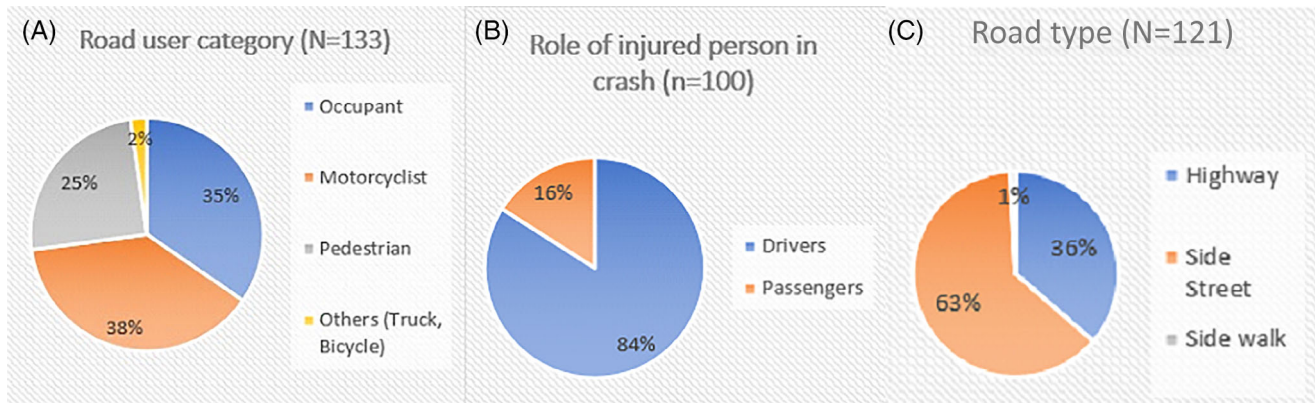


FIGURE 1 (A) Mechanisms of RTI by road users; (B) Mechanisms of RTI by road victim involved; (C) Mechanisms of RTI by road type

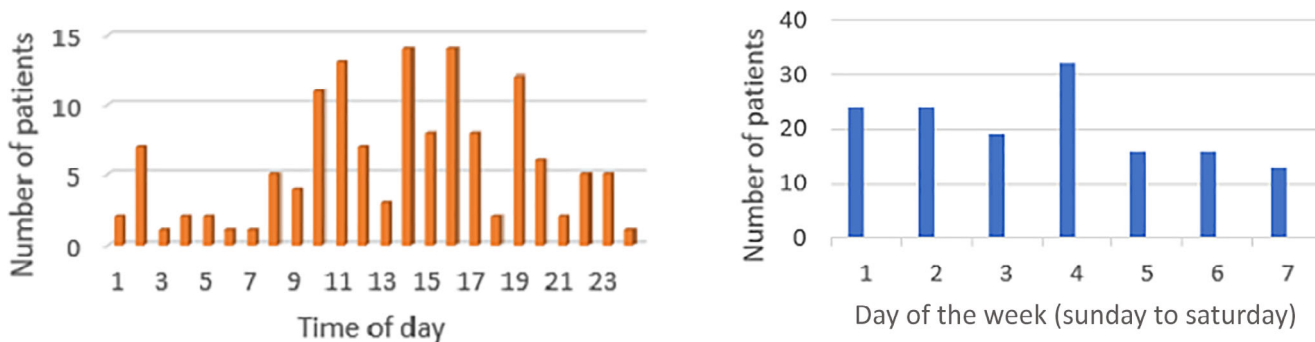


FIGURE 2 (A) Distribution of RTI in Lebanon by hour; (B) Distribution of RTI in Lebanon by day

TABLE 2 Road users characteristics

Vehicle type	Motorcyclist N (%)	Occupant N (%)	Pedestrian N (%)	Other N (%)	Total N (%)	P value
Gender						
Male	49 (49.5)	26 (26.3)	21 (21.2)	3 (3.0)	99 (74.4)	<.001
Female	2 (5.9)	21 (61.8)	11 (32.3)	0 (0)	34 (25.6)	
Total	51 (38.3)	47 (35.3)	32 (24.1)	3 (2.3)	133	
Age group						
<14	0 (0)	2 (28.6)	4 (57.1)	1 (14.3)	7 (5.3)	.006
15-29	31 (51.66)	16 (26.66)	12 (20.0)	1 (1.66)	60 (45.1)	
30-49	18 (41.9)	15 (34.9)	9 (20.9)	1 (2.3)	43 (32.3)	
50-65	1 (5.9)	11 (64.7)	5 (29.4)	0 (0)	17 (12.8)	
65+	1 (16.6)	3 (50.0)	2 (33.3)	0 (0)	6 (4.5)	
Total	51 (38.3)	47 (35.3)	32 (24.1)	3 (2.3)	133	
Nationality						
Lebanese	40 (36.0)	45 (40.5)	25 (22.5)	1 (0.9)	111 (83.5)	<.001
Non-Lebanese	11 (50.0)	2 (9.1)	7 (31.8)	2 (9.1)	22 (16.5)	
Total	51 (38.3)	47 (35.3)	32 (24.1)	3 (2.3)	133	

TABLE 3 Nature of injury

Injury type	Frequency (%)
Superficial bruises/abrasions	103 (67.3)
Open wound	25 (16.3)
Fracture	35 (22.9)
Dislocation	5 (3.3)
Sprain	11 (7.2)
Nerve injury	1 (0.7)
Blood vessel	11 (7.2)
Burn	1 (0.7)
Internal organ	2 (1.3)
Soft tissue injury	72 (47.1)
Foreign body	1 (0.7)
Head trauma	24 (15.7)
No injury	8 (5.2)
Unspecified	10 (6.5)

Note: Please note that some patients presented with multiple injury types and were counted in multiple fields.

Of the 153 sustained injuries, only 31% (n = 47) of the patients applied safety measures. Fifty-eight percent (n = 21) of car drivers used seatbelts, compared to only 23% (n = 3) of car passengers. Forty-six percent (n = 22) of motorcyclists' drivers were wearing helmets, compared to only one third (33%) of the pillion passengers. Six drivers (7%) reported cell phone use at the time of the crash. Alcohol use was reported for only 2 patients (Table 4).

The use of safety measures was associated with a substantial reduction in head and neck injuries ($P = .03$) and spine injuries ($P = .04$). The use of safety measures was also associated with a lower

risk of traumatic brain injury (TBI) across all levels (mild, moderate, severe) ($P = .02$).

The disposition of all RTI patients was documented (n = 153). Patients were mostly treated at the Emergency Department and discharged (81%), while the remaining 11% were admitted to the general hospital, 4% left the ED without being seen, 3.3% were advised and referred to a general practitioner, and less than 1% were reported dead on admission (Table 4).

4 | DISCUSSION

Road traffic injury continues to be a major cause of death and disabilities in the Eastern Mediterranean Region, though published studies on the topic remain scarce.^{2,7} This time first prospective RTI data will offer an understanding of RTI characteristics and outcomes and more importantly lay the foundation for establishing injury surveillance systems integrated at hospital emergency departments to accurately and reliably capture RTI data.

Aligning with existing regional road injury studies,^{18,26} RTI's in Lebanon occurred more commonly among young males with a steady decline in injury prevalence with increasing age, peaking at the age of 15 to 29. Similarly, there was a dramatic strong male preponderance among motorcycle-associated injuries (96%), plausibly explained by male increased mobility, higher chance of working outside the home, and increased risk-taking behaviors manifest by young male drivers^{27,28} coupled with emotional excitement and poor judgment.²⁹⁻³²

The minimum age for acquiring a driver's license in Lebanon is set at 18 years. In our study, 9% of the RTI patients were underaged. Several studies have demonstrated risky driving behaviors such as speeding to be highly associated with young drivers RTI.³¹ In Lebanon, many families tend to ignore the legal need for a license and allow

TABLE 4 Body parts affected, traumatic brain injury (TBI) level, and patients' disposition

Variables	Total (N, %) N = 153	Safety measure		P value
		No (N, %) N = 106	Yes (N, %) N = 47	
Body part				
Head/neck	58 (38.2)	46 (43.8)	12 (25.5)	.03
Spine	28 (18.4)	15 (14.3)	13 (27.7)	.049
Trunk	26 (17.1)	18 (17.1)	8 (17.0)	1.00
Shoulder	44 (28.9)	32 (30.5)	12 (25.5)	.57
Hip	74 (48.7)	53 (50.5)	21 (44.7)	.60
Unspecified	4 (2.6)	3 (2.9)	1 (2.1)	1.00
TBI level				
Yes	11 (7.2)	11 (10.4)	0 (0.0)	.02
Mild	7 (4.6)	7 (6.6)	0 (0.0)	
Moderate	3 (2.0)	3 (2.8)	0 (0.0)	
Severe	1 (0.7)	1 (0.9)	0 (0.0)	
Patient disposition				
Left without being seen	6 (3.9)	5 (4.7)	1 (2.1)	.06
Advised, referred to GP	5 (3.3)	4 (3.8)	1 (2.1)	
ED treat/release	124 (81.0)	80 (75.5)	44 (93.6)	
Admitted	17 (11.1)	16 (15.1)	1 (2.1)	
DOA/died ED	1 (0.7)	1 (0.9)	0 (0.0)	

adolescents to drive, particularly for brief trips. Furthermore, all underaged drivers in this study were involved in motorcycle collisions. Findings from this study call for strong safety regulations and restrictions to be imposed on novice drivers to ensure that they undergo proper training and obtain a license before operating any vehicle to reduce adolescent hazardous driving behaviors on the road.

This present study indicated that low compliance with safety measures is a predictive factor for road injuries. The findings revealed that the use of seat belts and helmets were strongly correlated with a decreased likelihood of severe head and neck injuries. Patients who applied safety measures had a significantly reduced risk for head, neck, and spine injuries ($P < .05$).

Another key finding in this study is the significant reduction in traumatic brain injury (TBI) across all severity levels with the use of safety measures. Only those who did not apply safety measures presented with TBI ($P = .02$). Evidence from the literature confirms that safety measures considerably reduce the risk of injury in the setting of a road collision. Seatbelt use helps to prevent ejection from the vehicle and reduces contact with the vehicle interior.^{11,33} It's well established that motorcycle helmet use is correlated with lower severity of crash injury and mortality rate.³⁴

Even though seat belt and helmet laws exist in Lebanon, the absence of government strict enforcement results in weak compliance of all road safety measures among road users.³⁵ Efforts to increase enforcement of driving safety laws in Lebanon remain limited and are clearly reflected by the inconsistent use of safety measures. This was evident in this study where low prevalence (31%) of road injury patients who applied any form of safety measures, with passengers

less likely than drivers to use seatbelts. A series of countermeasures should be implemented in Lebanon to increase the use of seat belts and helmets and the adoption of safer behaviors on the road. These countermeasures include public education and awareness programs aiming at increasing knowledge, perceptions, and practices of safety behaviors on the road. Public education campaigns are crucial in promoting the use of seatbelts and helmets and advocating for safe driving practices. Strong enforcement of existing road safety measures in Lebanon is crucial to mitigate the impact of injury frequencies and outcomes on individuals. Successful road safety programs adopted in many LMICs such as Rwanda, Vietnam, Cambodia, and Uganda provide powerful evidence on the effectiveness of enforcing safety compliance among road users.^{14,36}

Compared to local residents, non-Lebanese road injuries were associated with motorcycle and pedestrian RTI. Pedestrians comprised nearly 25% of RTIs reported in this study, highlighting the evidence that pedestrians are vulnerable road users. This result agrees with local studies³⁷ and strongly reflects the lack of designated sidewalks, resulting in pedestrians often sharing the road with vehicles and motorcycles.³⁸ Most pedestrians RTI patients were non-Lebanese, owing to the fact that non-Lebanese tend toward being less privileged workers who often use cheaper forms of transportation (motorcycles or walking). Motorcyclists comprised the largest cohort of RTI patients in this study. The motorcycle is increasingly popular as means of transport in Lebanon, in part because of its usefulness in navigating a high volume of traffics and driving in complex road networks.^{39,40} Motorcyclists' ability to drive through narrow roads with minimal compliance with road safety regulations increases their vulnerability

to crashes.⁴¹ Evidence generated from this study will enable the country to gain insights into the multiple contributing factors that shape the frequency and severity of the road traffic injury burden in Lebanon and help to set priorities and to develop effective preventive strategies that can curtail the impact of this major health problem on individuals and communities.

Another major threat to road safety is cellphone use while driving, which showed a prevalence of 7% in this study. Cellphone usage is associated with increased severity and a higher probability of disability following an RTI injury.¹⁷ Alcohol usage was another major factor that influences the frequency and outcomes of road injuries. Only 2 patients were identified in this study as individuals driving under the influence. Similar to many countries in the Eastern Mediterranean Region, the reported low number of impaired drivers may correlate in part with religious factors, such as adherence to the Islamic prohibition on alcohol in part of the population which is influential on the low alcohol consumption among individuals and the strict control policies on the general drinking culture and practices among Arab countries in the region.⁴²

One of the main limitations of this study is the relatively small sample size. Although the study encompasses several hospitals with a diverse population, the study findings may not be generalizable to the entire Lebanese population. Another limitation is linked to the crash narratives which might be a source of self-reporting biases, that can affect the accuracy of the reported data including the preventive measures used. In addition, case fatality rates were not calculated due to the lack of accurate data on death rates for road traffic injuries reported at the hospital level. Moreover, the exclusion of injured persons who did not visit the hospital limits the generalization of the results.⁴³

5 | CONCLUSIONS

Road Traffic Injury remains a major cause of morbidity and mortality that warrants urgent prevention initiatives to be implemented (eg, seatbelt, helmet use) to halt the growing burden of RTI in Lebanon.; The use of seat belts and helmets use will reduce severe injuries; hence, enforcement should be further promoted via political, legal, and cultural campaigns. Additionally, improved access to timely emergency, trauma, and surgical care may help alleviate the RTI burden in LMICs. Data from trauma registries would serve to highlight the system needs, optimize the quality-of-care programs, and strengthen tailored and strategic interventions. Future research warrants the collection of national RTI data that will serve as a platform to design and implement prevention programs and safety interventions to reduce the risks of deaths on the roads.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest. All authors affirms that this manuscript is an honest, accurate, and transparent

account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

AUTHOR CONTRIBUTIONS

Conceptualization: Samar Al-Hajj

Data Curation: Joseph Ghoubaire, Marwa Diab, Hassan Nassereldine, Hani Tamim

Formal Analysis: Samar Al-Hajj, Joseph Ghoubaire

Funding Acquisition: Samar Al-Hajj

Investigation: Samar Al-Hajj

Methodology: Hani Tamim, Samer Saadeh

Resources: Samar Al-Hajj, Marwa Diab, Hassan Nassereldine, Samer Saadeh

Supervision: Samar Al-Hajj

Writing-Original Draft: Joseph Ghoubaire, Marwa Diab, Hassan Nassereldine

Writing-Review & Editing: Samar Al-Hajj, Joseph Ghoubaire, Raymond Price, Moustafa Moustafa

All authors have read and approved the final version of the manuscript.

Dr. Samar Al-Hajj had full access to all the data in this study and takes complete responsibility for the integrity of the data and the accuracy of the data analysis.

ETHICS APPROVAL STATEMENTS

This study was approved by the Institutional Review Board (IRB) at the American University of Beirut (AUB) SBS-2018-0294 and from the ethical committees of each participating hospital.

TRANSPARENCY STATEMENT

The authors would like to confirm that this manuscript is an honest, accurate, and transparent account of the study being reported and no important aspects of the study have been omitted.

DATA AVAILABILITY STATEMENT

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials (Data S1).

ORCID

Joseph Ghoubaire  <https://orcid.org/0000-0003-4006-2743>

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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