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The burden of road traffic accidents in trauma in low-resource settings: a retrospective cohort analysis of patient admissions to 2 Médecins Sans Frontières trauma facilities

Josephine de Costa, MD, MMed, BA/LLB[a,b,*], Emily Briskin, MPH[b], Miguel Trelles, MD, MPH, PhD[c], Lynette Dominguez, MD[c], Innocent Nyaruhirira, MD[c], Esmatullah Shinwari, MD[d], Ferdinand Niyonzima, MD[e], Akbar Adel, MD[d], Jean-Berchmans Haberisoni, MD[e], Engy Ali, MD, MPH[b]

Introduction: Medecins Sans Frontieres (MSF) is known for its work providing surgical care for victims of violent trauma (VT) in conflict zones. However, the trauma centers also deal with road traffic accidents (RTAs) which may require different staffing, facilities and supplies as compared with those required for VT. This study aimed to compare differences in types of injuries, clinical outcomes, and resources needed to properly operate trauma centers in low and middle-income countries.

Material and methods: This was a retrospective analysis of routine program data of >70,000 patient presentations in the emergency, in-patient, and operating departments of 2 of MSF's major trauma centers, in Kunduz (Afghanistan) and Bujumbura (Burundi), using data from 2011 to 2018.

Results: RTAs comprised a significant proportion of overall presentations to these centers (23% in Kunduz and 56% in Bujumbura). RTA patients presented with different patterns of injury, with higher rates of fractures, extremity injuries, and traumatic brain injury. RTA patients were 2.3 times more likely to have a peripheral injury (extremities and head) as VT patients, and 12.5 times more likely to undergo an orthopedic procedure. VT patients had higher rates of abdominal injury. However, there was no statistically significant difference in overall mortality and length of stay between the 2 groups.

Conclusion: This study demonstrates that trauma centers, even in zones of conflict, need to be prepared and resourced to manage RTA cases. Policy-makers in such centers should be aware of the different injury patterns associated with this patient group and have appropriate, sustainable capacity to manage RTA trauma, particularly in terms of management of orthopedic injuries.

Keywords: Trauma, Road traffic accident, Violent trauma

Key Points

- A high proportion of cases presenting to Medecins Sans Frontieres (MSF) trauma centers in conflict settings come from road-traffic accidents.
- Road traffic accidents are associated with different patterns of injuries to those of violent trauma.
- Trauma centers set up for managing violent trauma in low-resourced settings should also be appropriately resourced to manage injuries from road traffic accidents.

[a]Royal Darwin Hospital, Rapid Creek, NT, Australia, [b]Médecins Sans Frontières, Operational Centre Brussels (OCB), Medical Department, Operational Research Unit (LuxOR), [c]Médecins Sans Frontières, Operational Centre Brussels (OCB), Medical Department, Luxembourg, Belgium, [d]Médecins Sans Frontières, Operational Centre Brussels (OCB), Kunduz Trauma Centre, Kunduz, Afghanistan and [e]Médecins Sans Frontières, Operational Centre Brussels (OCB), Arche Trauma Centre, Bujumbura, Burundi

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**Corresponding author. Address: 85 Ryland Road, Rapid Creek, NT 0810, Australia. E-mail address: josephinedecosta@gmail.com (J. de Costa).*

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Introduction

Approximately 1.3 million people die each year as a result of trauma associated with road traffic accidents (RTAs), and up to 50 million more are injured, with many suffering lifelong disabilities[1]. The bulk of these injuries occur disproportionately in low and middle-income countries (LMICs). They account for 90% of the world's RTA fatalities despite having only 54% of the world's vehicles[2]. Overall, RTAs are the ninth leading cause of death in the world (more than tuberculosis and malaria combined) and are projected to become up to the fourth leading cause of death by 2030[3,4].

Schneider[5] has shown that RTAs remain a significant cause of patient presentations in LMIC trauma centers even during times of significant violent conflict. RTA patients present with typical patterns of injury, often associated with injuries to the extremities and head[6–8]. Injury patterns in the context of violent trauma (VT) (whether as part of conflict or urban violence) vary depending on the specific injury (ie, whether blast-induced or secondary to knife or gunshot wounds), but are often associated with significant abdomino-pelvic and thoracic injuries in addition to high rates of extremity and head injuries[9,10]. Therefore, a large number of RTA presentations to trauma centers may be associated with significantly different resourcing requirements in terms of surgical, medical, and nursing expertise as well as equipment requirements and theater standards. This has important implications for policy makers guiding the management of surgical care centers in low-resourced settings.

MSF trauma hospitals are widely recognized for the work they do in the surgical management of VT, primarily in LMICs.

However, there has been only limited research assessing the burden that RTAs place on such centers, in terms of overall patient presentations and specific resourcing requirements.

The aim of this study was to compare the surgical burden of RTAs as opposed to VT across 2 of MSF's major trauma facilities. Specifically, we aimed to assess the differences in patient presentation between these 2 populations in terms of severity and pattern of injury, length of operating time in theater, length of inpatient stay, and overall mortality.

Materials and methods

Study design

This paper is a multicenter retrospective cohort analysis of routine MSF program data from 2 trauma centers run by MSF—one in Kunduz, Afghanistan and the other in Bujumbura, Burundi. These 2 centers are typical of MSF trauma centers around the world designed to respond to and manage trauma in low-resource settings stemming from conflict and/or urban violence. A research protocol for this study was developed a priori and can be accessed by direct request to the authors. This study has been reported in accordance with the STROCCS criteria[11].

Setting

Kunduz, Afghanistan (2011–2015). The MSF Kunduz trauma center opened in Kunduz in August 2011. Kunduz District in North Eastern Afghanistan has a population of 304,600, and its capital has a population of 268,900. It is the fifth largest city in Afghanistan, with the Kunduz trauma center the only facility providing high-quality care to victims of trauma—both accidental and conflict-related—in the area. On opening, Kunduz hospital had 92 beds. This number increased briefly to 140 beds in September 2015, during the peak of fighting between the Taliban and the Afghan government. The trauma center was bombed by US airstrikes on October 3, 2015, and was subsequently closed, though it has now reopened. This paper only considers data from 2011 to 2015.

Bujumbura, Burundi (2016–2018). The MSF trauma center in Bujumbura, Burundi, opened in July 2015. The initial mission criteria were to treat exclusively victims of violence. These criteria applied for the first 6 months of the center's opening, but were then widened to include victims of accidental trauma, including RTAs. Due to this change, this paper only considers the Bujumbura data for 2016–2018, when RTAs were included in the mission criteria. Given the overall context of urban violence and accident-related trauma in Burundi, violence-related trauma presented relatively intermittently to the Bujumbura trauma facility throughout 2016–2018.

Data and data analysis

It is standard operating procedure for all MSF trauma centers to compile routine program data detailing patient demographics, cause of injuries, diagnoses, degree of severity at arrival to hospital, type(s) of procedure, staff, and anesthetics used. Data was collected at each point of service, emergency department (ED), operating department (OD), and inpatient department (IPD), in separate Excel spreadsheets. It was not possible to link patient records across services, and thus data was analyzed per service. For the purposes of this paper, all data was de-identified. As part of the initial data collection process, causes of injury were documented, including whether the injuries were secondary to RTA, VT or other causes such as falls. Descriptive statistics on key trends were analysed using Excel. Statistical analysis was performed on R Studio, using the student t test, Welch t test, χ^2 or Fisher exact test to compare means and proportions as appropriate. Results were considered significant for P-values <0.05.

Ethics

This research fulfilled the exemption criteria set by the MSF Ethics Review Board (ERB) for a posteriori analyses of routinely collected clinical data and thus did not require full MSF ERB review. It was conducted with permission from Medical Director, Operational Centre Brussels, MSF. In-country ethics approval was granted by the Afghanistan National Public Health Institute Institutional Review Board (IRB Code No. A.0120.0132 23 January 2020, Institutional Review Board of the Afghanistan National Public Health Institute, Cinema Pamir region, Kabul, Afghanistan) and the Comité National d'Éthique of Burundi (Decision CNE/03/2020 18 February 2020, MSF OCB Bujumbura, Burundi).

Results

This study analysed the records of a total of 50,966 ED presentations, 17,537 OD procedures, and 10,913 inpatient admissions of RTA and VT patients across the 2 centers (total: 79,416 patients).

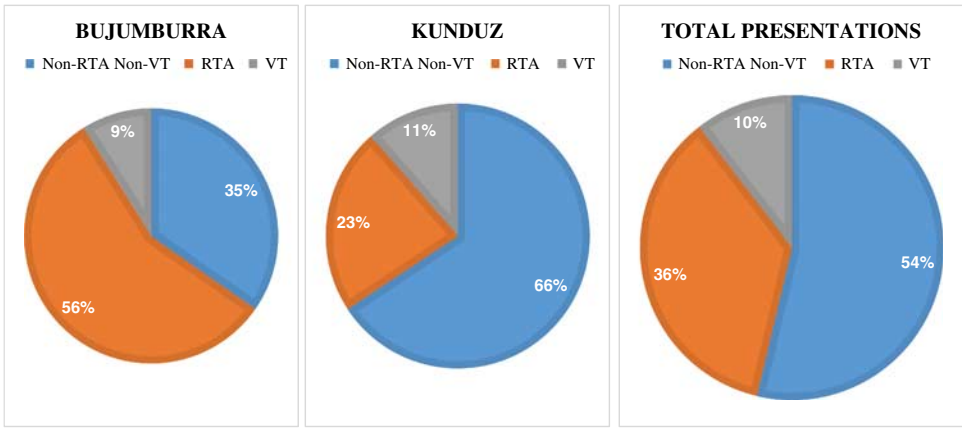

Figure 1. Percentage of presentations to ED for RTAs, VT, and non-RTAs non-VT patients in 2 trauma centers run by Medecins Sans Frontières in Bujumbura, Burundi (2016–2018) and Kundiz, Afghanistan (2011–2015). ED indicates emergency department; RTAs, road traffic accidents; VT, violent trauma.

ED

RTAs formed a substantial proportion of all ED presentations in both centers, ranging from 22.9% of presentations in Kunduz, to 56.4% in Bujumbura. In both centers, RTAs represented a much greater proportion of overall ED presentations than VT, which ranged from 11.4% in Kunduz to 8.9% in Bujumbura (Fig. 1). Among non-RTA non-VT presentations, the most common causes for presentation were falls, burns, and "other" (defined as per MSF protocol as "… *foreign objects, natural catastrophes, hurricanes, earthquakes, spontaneous and stress fractures, work & domestic accidents, sport & game injuries, etc.*").

A higher proportion of patients were male for both RTAs and VT across the centers (RTAs: 79.7% male, 20.3% female; VT: 85.1% male, 14.9% female). However, a greater proportion of VT patients were male (85.1% across all centers) as compared with RTA patients (79.7%). The mean age of patient presentation was 24.4 years (median: 22 y; mode: 20 y). Patients presenting to ED for RTA and VT were predominantly under the age of 25 (RTA: 54.5%; VT: 53.5%). However, VT was especially common among those aged 15–25 years, with 38% of VT presenting to ED within this age group versus 31% of those presenting to ED with an RTA. 53 944 patients, or 31.54% of the total number of patients presenting to ED, were under the age of 15.

The most common types of injury for both RTA and VT were open wounds (RTA: 40.7% of all injuries; VT: 50.6%), followed by fractures (RTA: 25.4% of all injuries; VT: 19.7%) and superficial injuries/contusions (RTA: 14.9% of all injuries; VT: 11.0%). However, a higher proportion of RTA patients suffered fractures compared with VT (25.4% RTA patients; 19.7%VT), and a higher proportion of VT patients had open wounds (50.6% of total VT patients; 40.7% RTA).

RTAs had a higher proportion of injuries to lower extremities (32.1% of total RTA injuries), and higher rates of traumatic brain injury (TBI) (9.6% compared with 5.4% of VT). VT patients most commonly had injuries to their head, face, and neck without TBI (35.6% of all VT patients), chest (7.0%), upper extremity (18.3%), lower extremity (8.8%), and abdomen (4.0%). When location of injury was broken down into central (chest, abdomen, pelvis, hip, buttocks, dorsal, and lumbar region) and peripheral (TBI, head/face/neck without TBI, upper and lower extremities), RTA patients were 2.3 times more likely to have a peripheral injury than VT patients [$P < 2.2e{-}16$, 95% confidence interval (CI): 0.4–0.49].

OD

This analysis included 17,537 surgical procedures across the 2 trauma centers, including 7650 procedures done for VT patients and 9887 RTA patients. Of the total number of procedures performed, 7209 (41.1%) were "first" procedures, and 10,328 (58.9%) were returns to theater (either planned or unplanned).

The most common type of procedures performed for both RTA and VT patients was wound debridement (WD), which included fasciotomy and amputation of toes and digits. The top 10 most common procedures for both RTAs and VT are set out in Table 1. These account for 93.6% of all procedures and are demonstrated in Figure 2. While WD was the most common procedure for both categories (RTA: 37.3% of top 10 procedures; VT: 63.2%), a significantly larger proportion of overall cases for VT patients required WD. RTA patients had a higher proportion of orthopedic procedures, including reduction of fractures with a plaster cast (20% of the most common procedures), placement of external fixation (9%), internal fixation (6%), and removal of osteosynthesis hardware (4%). Although overall rates of abdominal injuries were low in these centers, they were slightly higher for VT patients (with exploratory laparotomies being done for 5.8% of VT procedures, and gut resection for 3.2%, as compared with 1.1% and 0.5% for RTA patients, respectively) (Fig. 2). Only a very small number of patients underwent neurosurgical procedures requiring opening of the cranial vault with no difference between RTA and VT patients (72 patients in total, RTA: 0.41% of all procedures; VT: 0.41% of all procedures).

Procedures were categorized into "orthopedic" (internal fixation, external fixation, reduction of fracture with or without plaster, and "other" orthopedic procedures), versus "abdominal" (exploratory laparotomy, gut surgery including resection/repair, and solid viscous repair), and "other." When considering orthopedic versus abdominal procedures, RTAs were 12.5 times as likely to have an orthopedic procedure as compared with VT (P-value = 2.2e−16, 95% CI: 0.068–0.094). This relationship was consistent across the centers.

Average time spent in OT across all centers for RTA was 0.98 hours (59 min), as compared with 1.05 hours (63 min) for VT. Although this difference only constitutes a 4 minute

Table 1

Top 10 most common surgical procedures, Bujumbura and Kunduz.

Procedure	RTA	% Total RTA	VT	% Total VT
Minor procedure: insertion/removal of drain, puncture or drainage of cavity, dressings requiring sedation (MD)	220	2.4	173	2.4
Minor procedures: simple wound treatment (MS)	1469	15.8	825	11.6
Reduction with placement of external fixator (OF)	830	8.9	373	5.2
Osteosynthesis or internal fixation (OO)	558	6.0	74	1.0
Reduction of fracture/dislocation, with or without plaster/traction (OR)	1860	20.0	221	3.1
Osteosynthesis out (removal) (OX)	400	4.3	100	1.4
Exploratory laparotomy with no other surgical action performed (including second-look) (VE)	102	1.1	412	5.8
Gut surgery including resection or repair; includes appendicectomy (VG)	51	0.5	228	3.2
Extensive wound debridement, including fasciotomy; amputation of digits/toes (WD)	3468	37.3	4496	63.2
Graft of skin or muscle (WG)	346	3.7	209	2.9
	9304	100.0	7111	100.0

ED indicates emergency department; RTA, road traffic accident; VT, violent trauma.

difference, with minimal resulting clinical impact, this was a statistically significant finding when considering data across the centers (P-value = 6.06e–09, 95% CI: – 0.09 to 0.04).

Overall OD mortality rates were very low for each center. Mortality following operations for VT patients was slightly higher than for RTA patients (VT: 29 patients, 0.4% total deceased following surgery, as compared with 22, or 0.2%, of RTA patients). This difference was not significant when assessing overall data (OR: 1.71, $P = 0.07$, CI: 0.95–3.12), but was significant when considering the data for the Kunduz center individually where VT patients were 2.4 times as likely to be deceased at the end of a procedure than RTA patients ($P = 0.02$, CI: 1.11–6.06). This trend holds when only considering first procedures in OT. Overall, VT patients were 1.81 times more likely as RTA patients to be deceased following first operative intervention. This finding trended toward significance ($P = 0.054$, CI: 0.97–3.41). Although mortality was slightly higher for VT patients, (both overall and when considering only first procedures), this was only significant in the Kunduz center.

In total, 56.6% (or 14,962 cases) of total operations performed in Kunduz and Burundi were planned returns to theater, and 0.2% (or 53 cases) were unplanned returns to theater. There was no statistically significant difference in number of overall returns to theater across the centers between RTAs and VT. However, on individual center analysis there were differences noted: in Kunduz the rates of return were comparable, but in Bujumbura, VT was 1.63 times more likely to return to theatre, ($P \leq$ 2.2e–16, CI: 1.5–1.8). When breaking down returns to theater by planned versus unplanned, VT was 1.9 times more likely to have an unplanned rather than planned return to theater, ($P = 0.05$, CI: 0.97–3.84). Findings within individual centers were also consistent, though this was only statistically significant in Bujumbura ($P = 0.02$, CI: 1.1–8.3).

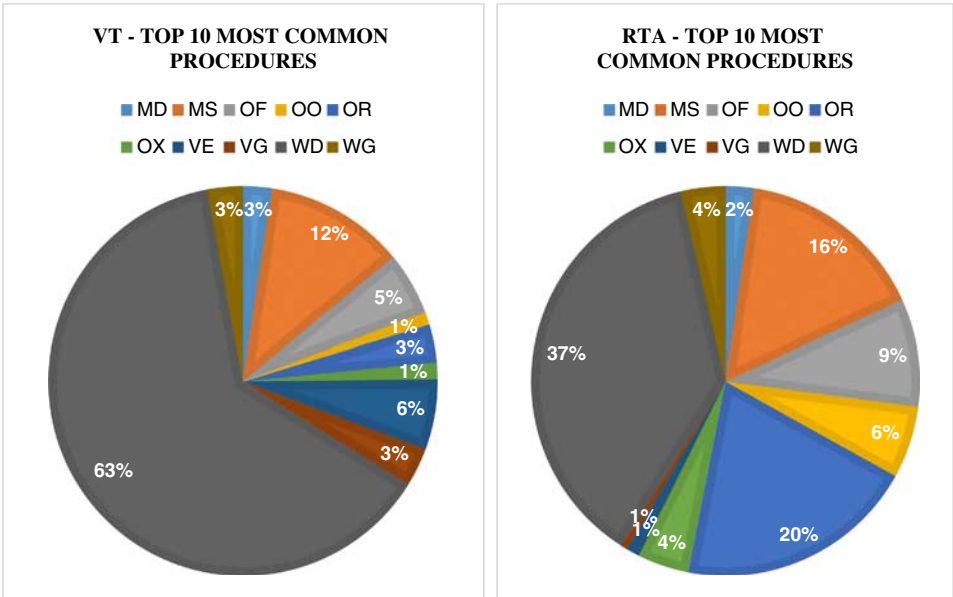

Figure 2. Percentage of presentations to ED for RTA, VT, and non-RTA non-VT Patients. MD indicates minor procedure: insertion/removal of drain, puncture or drainage of cavity, dressings requiring sedation (MD); MS, minor procedures: simple wound treatment; OF, reduction with placement of external fixation; OO, osteosynthesis or internal fixation; OR, reduction of fracture/dislocation, with or without plaster/traction; OX, osteosynthesis hardware removal; VE, exploratory laparotomy with no other surgical action performed (including second-look); VG, gut surgery including resection or repair; including appendicectomy; WG, graft of skin or muscle; WD, extensive wound debridement, including fasciotomy; amputation of digits/toes.

IPD

Analysis of time spent as an inpatient (length of stay) was completed using assessment of variance of the distribution of RTA versus VT data (using the *t* test); this showed variances at both the overall and individual center level, so the Welch *t* test was used to assess statistical significance in the difference of means. When data was analyzed overall, there was no significant difference between time spent as an inpatient across the centers for RTA and VT patients ($P = 0.33$, CI: – 0.04 to 0.11). However, both centers did have statistically significant differences when considered at the individual level, but in different directions: in Kunduz. VT patients had a longer mean stay (7.8 d vs. 6.6 d for RTA patients; $P = 1.23e{-}07$, CI: – 0.2 to – 0.1), whereas in Bujumbura RTA patients had a statistically significantly longer mean stay (8.6 d vs. 8.4 d for VT patients, $P = 0.3$, CI: – 0.04 to 0.1).

Discussion

The paper is one of the first studies to highlight the burden of RTAs in 2 humanitarian trauma centers initially designed to manage injuries secondary to violent trauma in the setting of conflict. Our results demonstrate that RTAs place a significant burden on these trauma centers, which were originally designed to manage victims of trauma in the setting of conflict and/or urban violence. While both patient groups are similar in terms of demographics, there were differences in the presentation and pattern of injury of RTA patients as compared with VT patients.

Within the ED, RTA patients more commonly presented with fractures as their primary injury, and were more than twice as likely to have a peripheral injury (including to extremities and/or head, including TBI) than VT patients. This is consistent with previous research in LMICs and high-income countries on mechanism of injury, showing extremity injuries and head/face injuries are common presentations of RTA patients[6,12]. Patterns of injury for VT patients is dependent upon the cause of injury, with differing patterns for blast injury versus gunshot and knife wounds[9].

Within the OD, while there was a statistically significant difference in time in OT, the actual difference of ~4 minutes longer for VT patients is unlikely to make a significant clinical difference to the practice of trauma management in these centers. While rates of abdominal injuries were low in these centers, they were slightly higher for VT patients. The procedures required to manage abdominal injuries (exploratory laparotomy, with potential for gut resection and solid organ removal) procedures are complex and often performed for hemodynamically unstable patients, which may account for the return-to-theater rate.

RTA patients were 12 times more likely to undergo an orthopedic procedure than VT patients. This is consistent with RTA patients having higher numbers of extremity injuries and fractures. However, it has important implications for the staffing and resource needs of these centers particularly for management of external versus internal orthopedic fixation. All MSF trauma centers provide external fixation for open fractures. While a very effective therapy, it is associated with long inpatient stays as patients must remain bed-bound on the ward for up to 6 weeks after the procedure to allow for fracture healing. Internal fixation can provide an alternative to reduce the time for mobilization but is more resource intensive to offer. MSF has strict standards in place for accrediting surgical facilities to perform internal fixation for closed fractures[13]. They include criteria for medical and nursing staff training as well as physical theater resources and availability of intraoperative imaging. In Kunduz, facilities for performing internal fixation were introduced in 2014; Bujumbura was not accredited to perform internal fixation. Given the high rates of RTA presenting to both centers and the strong association between RTA and orthopedic injuries, this data supports planning for provision of internal fixation in trauma centers. However, this planning will need to take into account the significant cost of training local orthopedic surgeons and nonmedical staff versus importing foreign-trained ones to support higher rates of orthopedic intervention.

Although this study took place in MSF hospitals, the broad findings that emerge are likely to be applicable to other providers of trauma care in low-resource settings. Importantly, this research indicates a number of important considerations for policy-makers in this area. Planning for trauma centers in low-resourced settings, even those whose primary objective is to care for victims of VT, should take into account the likely large burden of RTA presentations and the needs of this patient population for orthopedic management. Planning to provide specialized orthopedic procedures such as internal fixation, within the medium to long-term, should therefore be prioritized. Moreover, the large burden of RTA presentations in these centers highlights the need to advocate for implementation of preventative measures aimed at improving road safety in low-resource settings.

This study is the first retrospective analysis of multiple trauma centers looking at the burden of RTAs on trauma centers originally resourced for violent trauma. A key strength is in the size of the data set, with a total of 79,416 patient presentations. A key weakness of this data set is that the patient's role in the original RTA was not recorded —thus, we were unable to differentiate if patients were riding in the vehicle that crashed, or whether they were pedestrians. As Frydenberg et al[12] demonstrated, pedestrians typically had higher rates of extremity injury while in-vehicle patients often had significant rates of thoracic injury. Moreover, we did not differentiate among VT patients between those who suffered blast injury versus gunshot or knife injury. Finally, this was a retrospective study of routinely collected data with the inherent weaknesses in data collection, including rates of missed and/or improperly documented data, as well as potential recall bias.

Conclusions

This study shows that RTA presentations place a significant burden on MSF trauma centers originally designed to manage victims of VT. RTA patients are significantly more likely to have peripheral injuries and to require orthopedic surgical intervention. Policy-makers responsible for resourcing trauma care in these contexts need to be aware of the characteristics of this patient group and the surgical resources required, especially to ensure sustainable orthopedic capacity.

Ethical approval

This research fulfilled the exemption criteria set by the Médecins Sans Frontiéres Ethics Review Board (ERB) for a posteriori analyses of routinely collected clinical data and thus did not require full MSF ERB review. It was conducted with permission from Medical Director, Operational Centre Brussels, Médecins Sans Frontiéres. In country ethics approval was granted by the Afghanistan National Public Health Institute Institutional Review Board (IRB Code No. A.0120.0132 23 January 2020, Institutional Review Board of the Afghanistan National Public Health Institute, Cinema Pamir region, Kabul, Afghanistan) and the Comité National d'Éthique of Burundi (Decision CNE/03/2020 18 February 2020, MSF OCB Bujumbura, Burundi).

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Author contribution

J.D.C., L.D., and M.T. conceptualized the work. E.A., E.B., M.T., and L.D. provided up-to-date statistics and assisted with statistical analysis and result interpretation. M.T., L.D., and E.A. assisted with the ethics application process. J.D.C. and E.B. completed all statistical analysis. J.D.C. wrote the first draft of the paper and subsequent versions with input from all authors. All authors reviewed the paper and provided input. All authors approved and read the final version.

Conflicts of interest disclosure

The authors declare that they have no financial conflict of interest with regard to the content of this report.

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Guarantor

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References

[1] WHO. Save LIVES: A Road Safety Technical Package. Geneva: W. Press, Editor; 2017.
[2] WHO. Road Traffic Injuries: Fact Sheet. Geneva: W.M. Centre, Editor; 2017.
[3] WHO. Post-crash Response: Supporting Those Affected by Road Traffic Crashes. Geneva: W. Press, Editor; 2016.
[4] Bliss T, Breen J. Meeting the management challenges of the Decade of Action for Road Safety. IATSS Res 2012;35:48–55.
[5] Schneider M. War wounded and victims of traffic accidents in a surgical hospital in Africa: an observation on injuries. Prehosp Disaster Med 2015;30:618–20.
[6] Chichom-Mefire A, Palle-Ngunde J, Fokam PG, *et al*. Injury patterns in road traffic victims comparing road user categories: analysis of 811 consecutive cases in the emergency department of a level I institution in a low-income country. Int J Surg Open 2018;10:30–36.
[7] Dewan MC, Rattani A, Gupta S, *et al*. Estimating the global incidence of traumatic brain injury. J Neurosurg 2019;130:1080–97.
[8] Zimmerman K, Mzige AA, Kibatala PL, *et al*. Road traffic injury incidence and crash characteristics in Dar es Salaam: a population based study. Accid Anal Prev 2012;45:204–10.
[9] Wild H, Stewart BT, LeBoa C, *et al*. Epidemiology of injuries sustained by civilians and local combatants in contemporary armed conflict: an appeal for a shared trauma registry among humanitarian actors. World J Surg 2020;44:1863–73.
[10] Al-Koudmani I, Darwish B, Al-Kateb K, *et al*. Chest trauma experience over eleven-year period at al-mouassat university teaching hospital-Damascus: a retrospective review of 888 cases. J Cardiothorac Surg 2012;7:35.
[11] Mathew G, Agha R, STROCSS Group. STROCSS 2021: strengthening the reporting of cohort, cross-sectional and case-control studies in surgery. Int J Surg 2021;96:106165.
[12] Frydenberg E, Curtis K, Chong S, *et al*. Road trauma, patterns of injury and mortality in an Australian trauma centre. J Austral Coll Road Safety 2012;23:7.
[13] Alvarado O, Trelles M, Tayler-Smith K, *et al*. Orthopaedic surgery in natural disaster and conflict settings: how can quality care be ensured? Int Orthop 2015;39:1901–8.