

ORIGINAL ARTICLE

Descriptive analysis of road traffic crashes encountered by Tanzanian motorcycle taxi drivers trained in first aid

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ABSTRACT

Introduction: In Dar es Salaam, Tanzania, death from road traffic crashes (RTC) occurs at roughly double the global rate. In this study, we sought to understand the locations and types of vehicles involved in RTC in Dar es Salaam encountered by a cohort of motorcycle taxi drivers previously trained in first aid.

Methods: This was a quasi-non-randomized interventional study, cohort subtype, with three-month follow-up. Some 186 motorcycle taxi drivers were selected by convenience sampling from 16 heavily populated, central wards and trained in a basic hemorrhage control course. Participants reported the location and types of vehicles involved in RTCs they encountered and intervened upon through performing bleeding control interventions. Surveys were designed on KoboToolbox and administered via phone call at monthly intervals over a three-month period. The main outcome measures were the location of crash encounters and types of vehicles involved.

Results: In all 62 unique participants (33.3 %) encountered and provided bleeding control interventions to 83 injured individuals following 69 RTC in at least 31 distinct city wards, despite training only having occurred in 16 wards. Eight crash locations were not recorded. Crashes in distant wards typically contained major roads. Most commonly, crashes involved a motorcycle without the involvement of another vehicle ($n=20$), followed by motorcycle vs. car/three-wheeled vehicle ($n=15$), motorcycle vs. bus/van ($n=10$), motorcycle vs. motorcycle ($n=9$), motorcycle vs. pedestrian ($n=7$), pedestrian vs. bus/van ($n=2$), pedestrian vs. car/three-wheeled vehicle ($n=1$), motorcycle vs. bicycle ($n=1$), multi vehicle ($n=1$), and other ($n=3$).

Conclusions: Motorcycle taxi drivers trained in hemorrhage control frequently encounter and intervene upon RTC in wards where they are based as well as in distant locations, commonly in wards containing major roads. Expanding first aid training for motorcycle taxi drivers could improve timely access to emergency care for RTC victims. Since most crashes involved motorcycles, road safety training should be integrated into future courses.

African relevance

- The burden of road traffic crashes is disproportionately high in Africa.
- In many African countries there are no formalized Emergency Medical Services (EMS). The World Health Organization has recommended training laypersons in first aid where there are no formalized EMS services.
- Training laypersons in first aid is cost effective, and these results suggest laypersons are willing and able to perform basic first aid at the roadside.

Introduction

Road Traffic Crashes (RTC) are a leading cause of death in low- and middle- income countries (LMIC) [1]. In Tanzania, the mortality from RTC is roughly double the global rate [2]. Indeed, in a study of nearly 20,000 trauma patients presenting across 13 regional health facilities in Tanzania, 41 % were due to RTC [2]. Further, in a one day survey of 105 Tanzanian hospitals, which captured over 5000 acute patient encounters, nearly half of all trauma patients seeking care were injured in RTC [3]. Despite this high incidence and mortality, there remains a dearth of data surrounding RTC in Tanzania, which if elucidated could serve to inform evidence-based interventions to reduce RTC incidence and improve care in the immediate aftermath of RTC [2].

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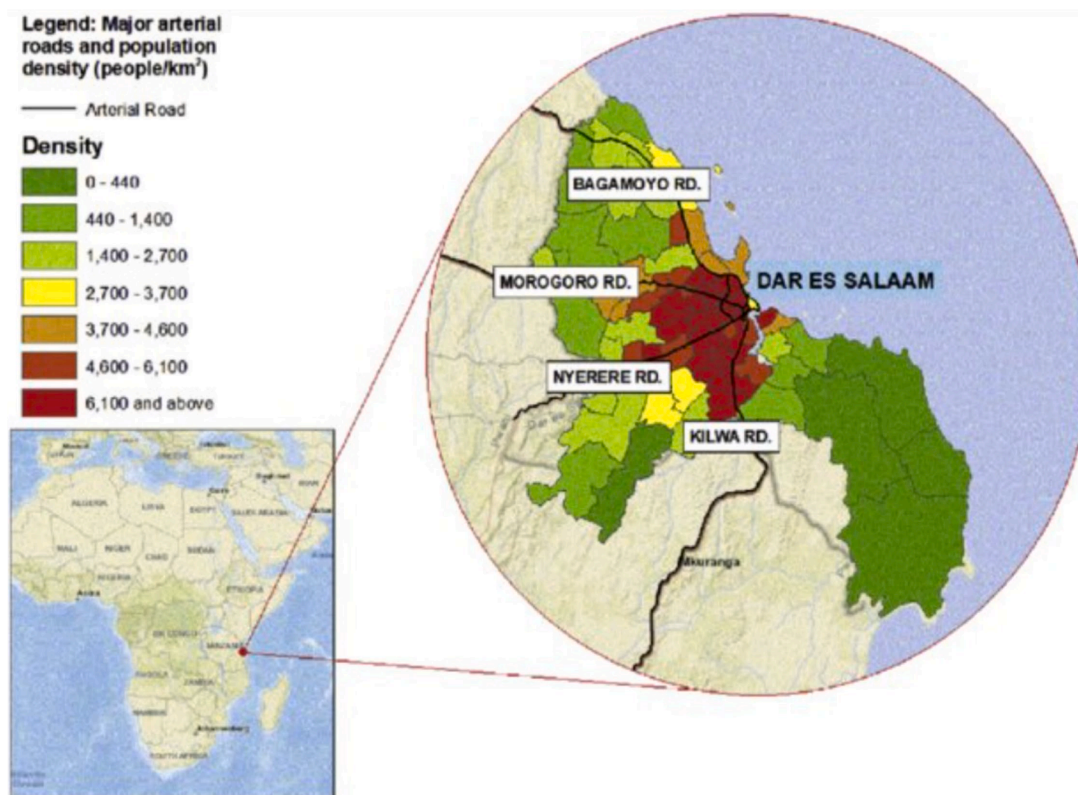


Fig. 1. Map showing average population densities in Dar es Salaam (by ward) and major arterial roads (Bagamoyo, Kilwa, Morogoro and Nyerere). Map was compiled in ArcGIS by authors using ward population data from the 2012 national census report. (Government of Tanzania, 2016b, 2017a).

Myriad factors have been shown to contribute to the high rate of RTC in Tanzania. In Dar es Salaam, Tanzania's largest city and commercial capital, Walugembe et al. [4], retrospectively examined the rates of RTC over a 4 year period and concluded that poor road infrastructure, lack of traffic police presence, and lack of road safety education campaigns were leading contributors to RTC. Francis et al. [5] described the most common locations of motorcycle collisions in the city, demonstrating that densely populated urban areas, mixed use roads, and major roads are the most dangerous, with the latter causing more severe injuries.

Motorcycle taxis are a common mode of transportation in Africa and contribute significantly to the burden of RTC [6]. In a large national study, 68 % of RTC in Tanzania involved motorcycles [2]. In Moshi, Tanzania, motorcycles were found to be involved in 35 % of crashes, with a majority of crashes found to occur at just four intersections, raising the notion that there is predictability to both the locations and types of vehicles involved in RTC [7]. Describing these hotspot areas and crash patterns can help inform strategies to mitigate RTC.

Despite their disproportionately high involvement in RTC in Tanzania, motorcycle taxi drivers are not naïve to the factors that portend crashes. Suggestions for increased road safety from surveying several hundred Tanzanian motorcycle taxi drivers included improved roadway infrastructure, traffic regulation, safe driving behavior, education and training, and law enforcement [8].

Motorcycle taxis have also been shown to be critical in the transportation of the injured to healthcare facilities. In a large study of over 6000 trauma patients who presented to five regional hospitals across Tanzania, over half presented to the emergency department on two or three wheel vehicles [9]. As motorcycle taxi drivers are increasingly recognized for their role as de facto first responders, they are being recruited and trained in first aid [10,11].

In this paper, we describe the crash locations and types of vehicles involved in RTC encountered by participants, and intervened upon through the provision of bleeding control, by a cohort of motorcycle taxi

drivers in Dar es Salaam previously trained in a first aid course. Intervention was defined by performing bleeding control interventions at the scene of the crash, regardless of whether transportation to a healthcare facility was subsequently performed.

Methods

This quasi-non-randomized interventional study, cohort subtype, was performed in Dar es Salaam, Tanzania from 12 November 2022 to 12 February 2023. Dar es Salaam was chosen due to its high burden of RTC [4]. The implementation and evaluation of this bleeding control course is described in detail in a separate article [12].

In brief, 186 motorcycle taxi drivers were recruited by convenience sampling from 16 heavily populated, central city wards over a period of two days and trained in a 20-minute basic bleeding control course. Course trainers were fourth- and fifth-year medical students recruited from Muhimbili University of Health and Allied Sciences (MUHAS). In a training of trainers model, two Tanzanian physicians instructed 14 medical students in a basic bleeding control course. The skills taught were application of direct pressure and application of a tourniquet to an extremity. Emphasis was placed on distinguishing life-threatening from non-life-threatening bleeding, and the indication for application of a tourniquet in only the former. Medical student trainers were required to appropriately demonstrate skills on one another prior to completing the course. They were compensated Tsh 50,000 for their participation.

With direct oversight from Tanzanian physicians, and with permission from motorcycle taxi union leaders, medical student trainers recruited motorcycle taxi driver participants from taxi stands (kijiwe) in Kinondoni, Ilala, Temeke, and Ubungo districts. The medical student trainers were reimbursed for the cost of fuel required to reach participants. Participants were approached directly by course trainers and informed of the study. Eligibility criteria for training were 18 years old or greater, possession of a working cellphone, and a valid form of

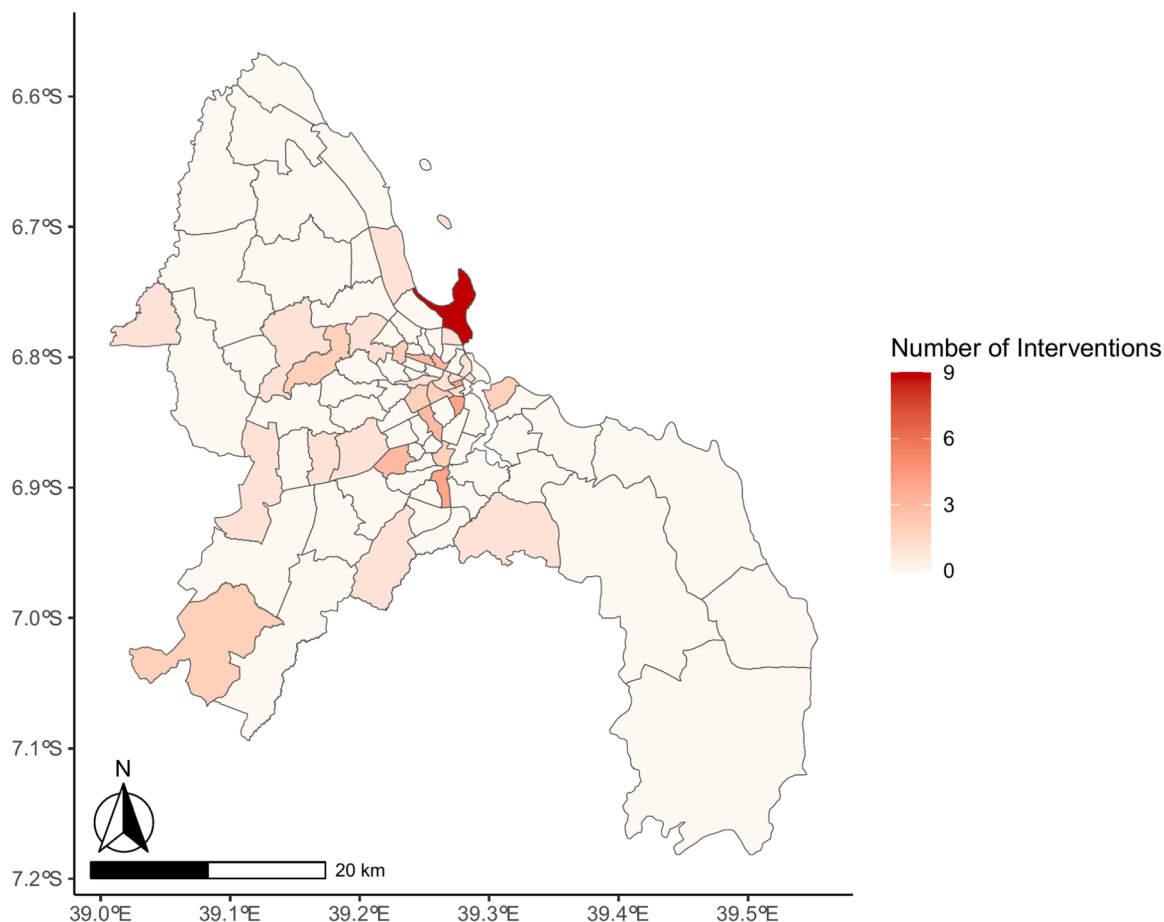


Fig. 2. Number of RTC encountered and intervened upon through the provision of bleeding control skills in Dar es Salaam city wards from November 2022 to February 2023. Darker color corresponds to more crashes.

government issued ID. Consent was verbally obtained by course trainers prior to training and the 20-minute bleeding control course was subsequently delivered. Both informed consent and the trainings themselves were conducted entirely in Swahili and occurred at the individual kijiwi where participants were recruited. Participants were compensated Tsh 5000 for work time lost to undergo training.

Course participants were equipped with a first aid kit, which included clean towels, gauze wrapping, nitrile gloves, and a tourniquet [description of kit and photo provided as [Supplementary 1]. Items were enclosed in a plastic container, which could be securely fastened to the back of participants motorcycles. Focus groups were conducted with participants to ensure acceptability of kit size and storage. Enough supplies were purchased to replenish half the first aid kits once. Financial limitations precluded purchasing a larger reserve catchment. Additionally, the phone number of a Tanzanian emergency physician was provided on the kit, which participants could call at any time for questions about the management of an injury.

Following the training, medical student course trainers contacted participants on their cellphones at monthly intervals for three months to verbally administer a survey designed on KoboToolbox (an open-source humanitarian data collection tool based at the Harvard Humanitarian Initiative in Cambridge, Massachusetts). These phone calls were conducted entirely in Swahili. Trainers recorded the locations and the types of vehicles involved in crashes participants encountered and intervened upon through performing bleeding control interventions.

Survey data were exported to Excel (Microsoft Corporation (2018) cleaned, and uploaded to the statistical program R (R version 4.3.2, <https://www.R-project.org/>). In R, the ward locations of RTC encounters were combined with publicly available shape files from the

Tanzania National Bureau of Statistics delineating the boundaries of each ward in Dar es Salaam. A heat map was created using these data and shape files. The training locations of participants who went on to respond to at least one RTC were used to create a second heat map using the same steps. Types of vehicles involved in RTC were also recorded by KoboToolbox surveys and exported to excel, where they were manually aggregated.

Institutional Review Board (IRB) approval was obtained in Tanzania from the Muhimbili University of Health and Allied Sciences in Dar es Salaam. This project was reviewed by the Mass General Brigham Human Research Office in Boston, Massachusetts and determined to not meet the criteria for human subject research and did not require IRB approval. The Regional Medical Officer for Dar es Salaam also approved this project.

Results

Dar es Salaam is a spreading metropolis with ill-defined boundaries. Major roads and ward-level population density estimates in Dar es Salaam are shown in Fig. 1 (borrowed with permission from Luo et al.) [13] The authors considered the red areas in Fig. 1, particularly those closest to the confluence of the four major roads, to be central city wards.

Of the 186 participants initially trained in the bleeding control course, 62 unique participants (33.3 %) encountered and provided bleeding control interventions following 69 RTC across at least 31 different city wards [Fig. 2]. Overall, 83 individuals received bleeding control interventions, as some crashes resulted in multiple injured individuals.

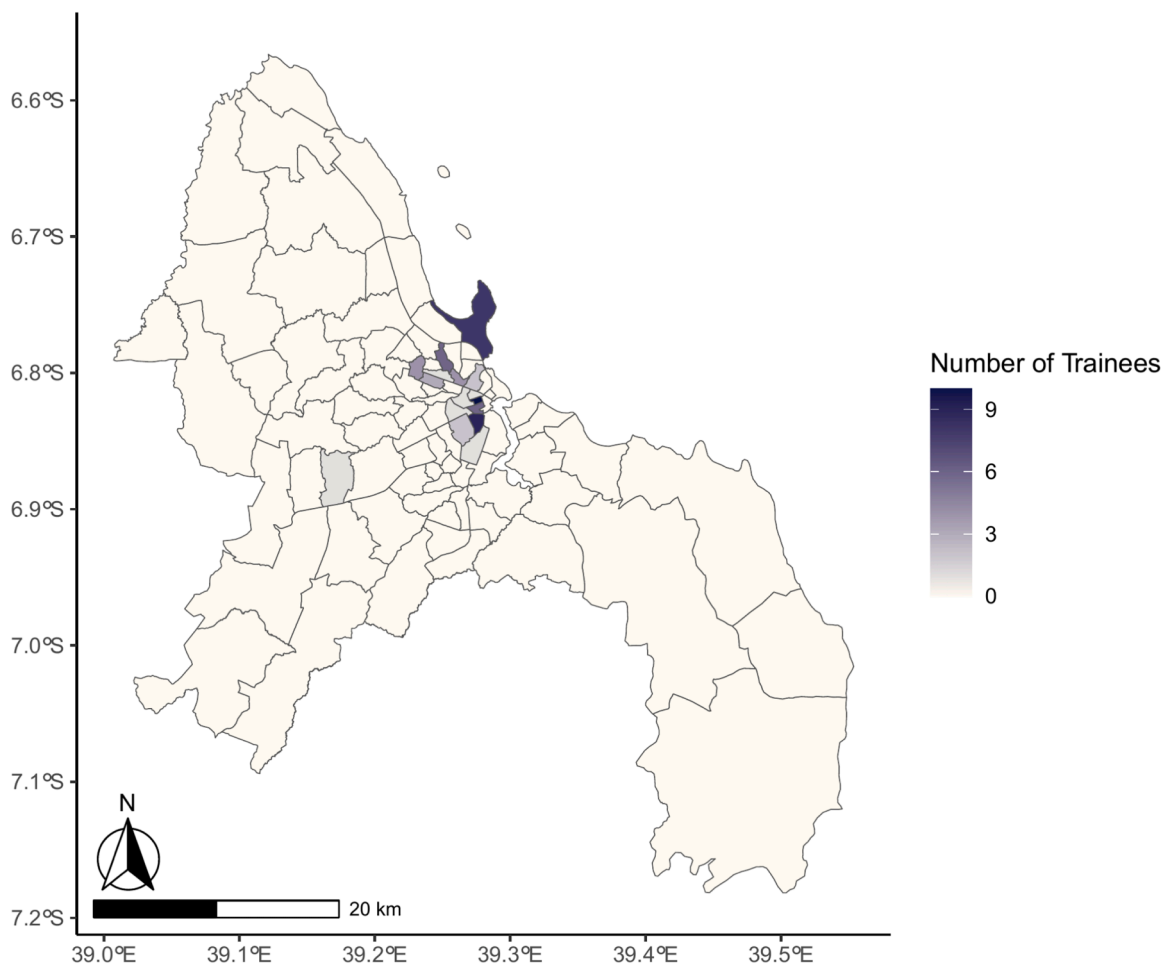


Fig. 3. Training locations of participants who went on to encounter and intervene upon at least one RTC. Darker color corresponds to more participants trained.

Table 1
Type of vehicle(s) involved in road traffic crashes encountered and intervened upon by motorcycle taxi first responders.

Type of Vehicle(s)	Number Encountered (n = 69)
Motorcycle alone	20
Motorcycle vs. car/three-wheel motorcycle	15
Motorcycle vs. bus/van	10
Motorcycle vs. motorcycle	9
Motorcycle vs. pedestrian	7
Pedestrian vs. bus/van	2
Pedestrian vs. car/three-wheel motorcycle	1
Motorcycle vs. bicycle	1
Multi vehicle	1
Other	3
(crash and intervention recorded without mention of types of vehicles involved)	

Some 8 crash locations were not recorded. Outside of the central wards, the wards where crashes were most frequently encountered corresponded to wards that contain or are near major roads.

The location of a participant’s training did portend where they encountered crashes, but RTCs were also frequently encountered far from the 16 central wards where they were based and underwent training [Fig. 3].

The ward where the most crashes were encountered corresponds to the peninsular ward, Msasani, which sticks out like a thumb, where the second most participants were trained. Participants predominantly encountered RTC involving motorcycles, most commonly without the

involvement of another vehicle, while crashes involving cars, three-wheeled motorcycles, bicycles, and pedestrians were encountered less frequently [Table 1].

Discussion

In this study, 62 Tanzanian motorcycle taxi drivers previously trained in a hemorrhage control course encountered and provided bleeding control interventions to 83 injured individuals following 69 RTC in Dar es Salaam during a three-month period. Participants were trained in 16 city wards and went on to respond to crashes in at least 31 distinct wards. These included wards where participants were based and underwent training as well as distant wards. Comparing Fig. 2 with Fig. 1, it is evident that wards outside of the central city wards where crashes were encountered overlapped considerably with wards containing major roads. These findings demonstrate that motorcycle taxi drivers trained in basic first aid are able to apply skills to civilians injured in RTC across the city, providing urgently needed prehospital care in a municipality without formalized, public Emergency Medical Services (EMS).

Approximately one-quarter of global RTC fatalities involve motorcycles, according to the 2023 WHO Global Status Report on Road Safety [6]. In four of the five districts in Dar es Salaam, more than 70 % of all incidents involving trauma were road traffic crashes, predominantly involving motorcyclists [2]. Our results reaffirm this disproportionate burden of RTC borne by motorcyclists, with 42 of 69 crashes (60.9 %) encountered in this study involving at least one motorcycle. Further, motorcycle crashes encountered in the present study most commonly

occurred without the involvement of another vehicle. These individual crashes were likely in the setting of factors described above by Walugembe et al., and Francis et al., which are known to be associated with increased crash risk [4,5]. Concomitantly, they may have been due to suddenly avoiding other vehicles or pedestrians, slipping out on corners or wet roads, or lack of attention, thus highlighting motorcyclists' unique vulnerability. Ultimately, this finding raises the importance of including road safety training in future first aid courses directed at motorcycle taxis.

Outside of crashes encountered in the most central wards of Dar es Salaam, our findings corroborate previous findings by Zimmerman et al. [14], that most motorcycle crashes in Dar es Salaam occur along major roads. This is further supported by Francis et al. [5], who found that nearly half of the 46 identified motorcycle crash hotspots in Dar es Salaam were located along major roads. This highlights the need for increased road safety measures along major roads. Additionally, since all groups of participants were trained in heavily populated, central city wards, this finding demonstrates that motorcycle taxi drivers trained in first aid are highly mobile and can respond to crashes they encounter in many areas of the city, not solely in the ward in which they are based.

Importantly, a dispatch system was not used. The 69 crashes in which participants provided bleeding control interventions were encountered by participants at random over the three-month study period. While the time from crash to arrival at a healthcare facility was not assessed in the current study, it has previously been shown that most injured patients in Dar es Salaam arrive to healthcare facilities after the golden hour [2]. If more motorcycle taxis were trained in first aid, there would be broader crash surveillance and increased potential to encounter crashes, which could ultimately reduce the length of time from injury to definitive management.

Limitations

This study had several limitations. GPS software was not used to map exact locations of crashes. Rather, participants were surveyed about the locations and types of vehicles involved in RTC they encountered. Therefore, it is possible participants could have provided inexact information, particularly if they were surveyed long after the incident. Attempts were made to mitigate this memory bias by calling all participants at monthly intervals and prompting them to describe incidents to which they responded in detail. Our data only captured the wards in which crashes were encountered. It cannot be confirmed that crashes which occurred in wards containing major roads actually occurred on those roads, only suggested that they did based on the pattern of overlap. The circumstances by which participants encountered and responded to crashes were not assessed. While participants likely witnessed collisions and responded immediately, it is also possible they were called to help by another individual who witnessed a crash. The specific mechanism of action by which crashes occurred was not assessed, only the vehicles involved are known.

Conclusion

One-third of motorcycle taxi drivers in Dar es Salaam who completed a first aid training course encountered and provided bleeding control interventions following at least one RTC within a three-month period. RTC encounters occurred widely throughout the city, beyond where the drivers were trained. These findings suggest that first aid training for motorcycle taxi drivers could improve timely access to emergency care in settings without formal prehospital systems. Future research should be directed at expanding the number of trainees in Dar es Salaam and other analogous regions, characterizing the outcomes of patients who receive prehospital care versus those who do not, and assessing the time from crash encounter to arrival at a healthcare facility.

Dissemination of results

Results of this study were shared via informal presentations to the Harvard Humanitarian Initiative and to the MUHAS medical student course trainers.

Authors contribution

Authors contributed as follows to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: JD 50%; DK, GK, FM, and SK contributed 12.5 % each. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

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Declaration of competing interest

The authors declared no conflicts of interest.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.afjem.2024.08.002](https://doi.org/10.1016/j.afjem.2024.08.002).

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