# Piloting a hospital-based road traffic injury surveillance system in Nairobi County, Kenya, 2018–2019

**Valerian Mwenda**[a,b,*], **Merissa A. Yellman**[c], **Elvis Oyugi**[a], **Philip Mwachaka**[d], **Gladwell Gathecha**[b], **Zeinab Gura**[a]

[a]Field Epidemiology and Laboratory Training Program, Ministry of Health, Nairobi, Kenya

[b]Division of Non-communicable Diseases, Ministry of Health, Nairobi, Kenya

[c]Division of Injury Prevention, National Center for Injury Prevention and Control, U.S. Centers for Disease Control and Prevention, Atlanta, GA, USA

[d]Department of Surgery, University of Nairobi, Kenya

## Abstract

**Background:** Kenya's estimated road traffic injury (RTI) death rate is 27.8/100,000 population, which is 1.5 times the global rate. Some RTI data are collected in Kenya; however, a systematic and integrated surveillance system does not exist. Therefore, we adopted and modified the World Health Organization's injury surveillance guidelines to pilot a hospital-based RTI surveillance system in Nairobi County, Kenya.

**Methods:** We prospectively documented all RTI cases presenting at two public trauma hospitals in Nairobi County from October 2018–April 2019. RTI cases were defined as injuries involving ≥1 moving vehicles on public roads. Demographics, injury circumstances, and outcome information were collected using standardized case report forms. The Kampala Trauma Score (KTS) was used to assess injury severity. RTI cases were characterized with descriptive statistics.

**Results:** Of the 1,840 RTI cases reported during the seven-month period, 73.2% were male. The median age was 29.8 years (range 1–89 years). Forty percent ($n = 740$) were taken to the hospital by bystanders. Median time for hospital arrival was 77 min. Pedestrians constituted 54.1% ($n =$

*Corresponding author. valerian.mwenda@health.go.ke (V. Mwenda).

Contributors

VM conceived the study, applied for funding, wrote the study protocol and first draft of the manuscript; EO and PM supported protocol development and execution of the study; MAY, GG and ZG gave technical support and advice for the conception and execution of the study. MAY assisted with additional writing and substantial edits to the manuscript. All the authors read, provided critical feedback, and approved the final version of the manuscript.

Declaration of Competing Interest

Valerian Mwenda reports financial support was provided by Centers for Disease Control and Prevention Center for Global Health.

Disclaimer

The findings and conclusions in this paper are those of the authors and do not necessarily represent the official position of the U.S. Centers for Disease Control and Prevention.

Patient and public involvement

Stakeholders representing the public were involved in the design of the study and the plan for reporting and disseminating results. See the methods section for more information.

Ethics approval

Ethical approval for the study was obtained from the Kenyatta National Hospital/University of Nairobi Ethics and Research Committee (Number P352/05/2018).

995) of cases. Of 400 motorcyclists, 48.0% lacked helmets. Similarly, 65.7% of bicyclists (23/35) lacked helmets. Among 386 motor vehicle occupants, 59.6% were not using seat belts (19.9% unknown). Seven percent of cases ($n$ = 129) reported alcohol use (49.0% unknown), and 8.8% ($n$ = 161) reported mobile phone use (59.7% unknown). Eleven percent of cases ($n$ = 199) were severely injured (KTS <11), and 220 died.

**Conclusion:** We demonstrated feasibility of a hospital-based RTI surveillance system in Nairobi County. Integrating information from crash scenes and hospitals can guide prevention.

### Keywords

Road traffic injury; Road traffic crashes; Motor vehicle crashes; Public health surveillance; Kenya; Pedestrians; Seat belts; Motorcyclists; Helmets; Kampala Trauma Score

## Background

Road traffic injuries (RTIs) cause an estimated 1.35 million deaths globally every year, and they are the leading cause of death among people aged 5–29 years [1]. Approximately 93% of fatal RTIs occur in low- and middle-income countries (LMICs). More than half of RTI deaths are among vulnerable road users such as pedestrians, cyclists, and motorcyclists [1], who have the highest risk of injury or death since they have minimal external protection to absorb crash forces and reduce crash impact [2]. In addition, approximately 50 million people suffer nonfatal RTIs every year, many of which can result in long-term disability [1,3].

The RTI death rate in the World Health Organization's (WHO) African Region is estimated at 26.6 per 100,000 population [1]; however, this likely underestimates the true burden due to lack of reliable data, weak RTI surveillance systems, and underreporting [1,4]. The estimated RTI death rate in Kenya is 27.8 per 100,000 population, which is higher than the rate for the WHO African Region and 1.5 times the global average [1]. Additionally, the estimated economic burden of RTIs is substantial. Chen and colleagues predict that RTIs will cost Kenya almost $900 million (in 2010 U.S. dollars) from 2015 to 2030 [5]. Major risk factors for RTIs, such as motorized vehicles traveling at high speeds, insufficient road infrastructure design, and high numbers of vulnerable road users [6], are likely contributing to RTIs in Kenya.

RTI surveillance, inclusion of RTI prevention in public health agendas, and promotion of research on prevention and control of road traffic crashes can help reduce morbidity and mortality from RTIs, especially in LMICs [1,4,7]. RTI surveillance systems provide crucial information to assess RTI burden, identify groups at increased risk, describe risk and protective factors, plan interventions, and monitor intervention impact [8,9]. Setting up a successful RTI surveillance system usually requires establishment of a lead agency [9]. Kenya has both a legal framework and a lead agency [10]; however, it lacks a comprehensive RTI surveillance system due to challenges such as poor data integration between police and emergency departments and lack of critical variables to inform interventions. A few prior studies in Kenya have sought to surveil injuries via hospitals; however, these studies did not focus on a specific geographical location, were not specific to RTIs, had varying levels of inquiry regarding RTI risk factors, and had limited stakeholder engagement [11–13]. Therefore, we designed and piloted a hospital-based RTI surveillance system in the two major public trauma hospitals in Nairobi County, Kenya to determine its feasibility, provide recommendations for potential countrywide scale-up, and collect actionable data about RTIs and related risk factors to inform prevention efforts.

## Methods

### Study design and setting

We conducted a prospective surveillance system pilot study from October 2018–April 2019 in the emergency departments of Kenyatta National Hospital and Mama Lucy Kibaki Hospital in Nairobi County, Kenya. These two public hospitals manage the majority of RTIs that occur in Nairobi County. Nairobi County is the largest urban center in Kenya, with 4.4 million residents [14].

### Study population and approach

Any person injured in a road traffic crash (RTC), defined as a collision involving ≥1 moving vehicles on public roads, was classified as an RTI case. We included and captured all RTI cases who were injured in Nairobi County during the study period, who presented at either of the participating hospitals, and who were Nairobi County residents. RTI referrals from other counties and people who died at the scene were excluded. A similar approach has been used in hospital-based RTI surveillance system pilot studies in other LMICs [15,16]. To set up and implement the pilot surveillance system, we adopted components of WHO’s injury surveillance guidelines [8], modifying them to focus on RTI surveillance (Fig. 1).

### Stakeholder engagement

We engaged key road safety stakeholders in Kenya, including the National Transport and Safety Authority (NTSA), the public road safety agency; the Injury and Violence Prevention Unit, Ministry of Health; Kenya’s Field Epidemiology and Laboratory Training (FELTP) Programme; University of Nairobi’s Surgery Department; Nairobi County Department of Health; and the participating hospitals. Before study initiation, during the study, and upon completion, stakeholders discussed surveillance system objectives, data needs and sources, ethical considerations, reporting and dissemination, and potential sustainability strategies.

### Patient and public involvement

Our stakeholder engagement strategy ensured that study design and objectives would collect information beneficial to the public. Internal dissemination to the Ministry of Health has been conducted, and findings are guiding efforts to implement a national trauma registry system. Additionally, findings will be included in NTSA road safety educational materials.

### Data collection and management

All RTI cases meeting the case definition were documented in a standardized case report form and then entered into a password-protected computer database. The form was modified from WHO’s traffic injury surveillance sample form[8] to fit system objectives and local needs while maintaining simplicity. Two emergency department nurses (one at each participating hospital) were recruited and trained as data clerks responsible for identifying cases, filling out case report forms, and following up with patients. Data clerks extracted information from emergency department and admission records. Additionally, they interviewed patients or their companions for crash scene information unavailable in medical records, such as factors they believed might have contributed to the crash and use of safety equipment. For admitted cases, 30-day outcome was documented. Upon study conclusion, data clerks were interviewed by the principal investigator to provide feedback about the data collection process.

### Variables and data analysis

The core minimum data set included age, sex, injury location, date and time of injury, road user type, hospital transport mode, time elapsed from RTC to hospital arrival, and nature and severity of injury. The optional data set included RTI patient disposition (outpatient treatment or admitted), potential contribution of RTI risk factors, and outcome. Severity was assessed with the Kampala Trauma Score (KTS), which uses patient age category and clinically assessed variables to score the patient's condition. Scores range from 5 to 16; a score of <11 was considered severe injury [17,18]. Descriptive statistics were calculated for all variables. Data were cleaned and analyzed using Epi Info, version 7.2.

### Ethical considerations

Ethical clearance was obtained from the Kenyatta National Hospital/University of Nairobi Ethics and Research Committee (Number P352/05/2018). We sought and documented oral consent from all RTI patients before participation. When patients could not respond due to injury severity, two approaches were adopted: 1) companions were interviewed for nonconfidential information; 2) patients were interviewed when stable enough to respond. Consent was obtained for all eligible RTI cases. No personal identifiers were collected. Case report forms were assigned random serial numbers and stored in a locked cabinet, accessible only to data clerks and the principal investigator.

## Results

### Road traffic injury (RTI) case characteristics

During the seven-month pilot period, 1840 RTI cases were captured by the surveillance system: 1160 (63.0%) at Kenyatta National Hospital and 680 (37.0%) at Mama Lucy Kibaki Hospital. The median age of RTI cases was 29.8 years (range: 1–89). The majority of cases were male ($n = 1346$, 73.2%) (Table 1). Approximately half of cases ($n = 995$, 54.1%) were pedestrians. The most commonly injured body area category was the bony pelvis and extremities, with 40.5% ($n = 745$) of cases experiencing injury only for that body area category. Approximately 11% ($n = 199$) of cases had a KTS score <11, signifying severe injury. Forty percent ($n = 740$) of cases were taken to the hospital by bystanders. Median time for hospital arrival was 77 min. About 78% ($n = 1439$) of cases were discharged within 30 days, while 12% ($n = 220$) of cases died.

The majority of RTI cases occurred among people aged 21–40 years, representing 68.3% of cases among males and 60.5% of cases among females (Fig. 2). We found more male than female cases in the age category 21–50 years, but higher number of females among cases below 21 years or above 50 years.

### Road user type, injury severity, and death

Table 2 displays injury severity by road user type. Motor vehicle drivers had the highest percentage of severe injury cases (22.1%). Among 220 fatal RTI cases, 51.8% were pedestrians ($n = 114$). By road user type, percentage of deaths was highest among motor vehicle drivers (29.1%). Among cases experiencing severe injury, 71.4% (142/199) of cases died, compared with 4.8% (78/1641) of cases experiencing less severe injury (data not shown).

### Factors contributing to RTIs

Mobile phone use while riding/driving/walking in traffic was attributed as a factor contributing to the crash by 8.8% of cases; a similar percent (8.6%) believed that speeding contributed (Table 3). Alcohol use was believed to have contributed to 7.0% of RTIs. Use of other drugs/substances and bad weather were rarely documented as contributing factors. Information for these risk factors was frequently unknown, with four out of five factors being unknown for >40% of cases.

### Safety equipment use

Forty-three percent of motor vehicle drivers and 64.3% of motor vehicle passengers were not using seat belts when the crash occurred (Table 4). For motorcyclists, 35.6% of drivers and 61.5% of passengers were not using helmets. Almost two-thirds of bicyclists were not using helmets. Safety equipment use was more commonly known for motor vehicle occupants (80.1% known) than for motorcyclists (72.0% known) or bicyclists (71.4% known).

### Feedback from data clerks

Data clerks reported that the case report form was easy and quick to fill out. Most clinically assessed variables could be obtained from emergency department records; only follow-up for admitted cases required connecting with other departments. Data on contributing factors was incomplete; this information was frequently difficult to elicit from RTI cases or their companions via interviews.

## Discussion

This RTI surveillance system pilot study sought to systematically document RTI cases in Nairobi County to identify areas for public health intervention. We found that such a system is feasible in Nairobi County and could be feasible in similar low- and middle-income country (LMIC) settings. Data obtained from this pilot RTI surveillance system and future similar RTI surveillance systems can be useful for guiding and evaluating interventions. However, information on RTC contributing factors was difficult to obtain, which could demonstrate the need for integrated surveillance systems that bring together crash scene and hospital data.

Overall, comparison of our findings with studies in other LMICs is mixed. In our study, almost two-thirds of RTI cases were among young adults aged 21–40 years, and almost three-fourths were males. Similarly, a hospital-based RTI surveillance system in Cameroon found that 76.6% of RTI cases were among young adults (aged 15–45 years), and 73.5% were males [16]. This could be due to the fact that this demographic group often represents the most mobile segment of the population, especially in LMICs, with frequent road use for commuting and economic activities. However, in this study, among cases aged ≤20 years, the percentage of females was higher than that of males. This is similar to an RTI study in Rawalpindi, Pakistan, although the age cutoffs differed slightly. In that study, the proportion of female RTI cases was twice that of males for people aged ≤15 years [19].

Over three-fourths of RTI cases were vulnerable road users: pedestrians, bicyclists, or motorcyclists. Fifty-four percent of cases were pedestrians. Pedestrians are particularly vulnerable since they lack a protective vehicle shell and do not use safety equipment; thus, they are highly susceptible to severe injury and death even when struck by vehicles at moderate speeds [20]. Pedestrians are commonly injured while walking on streets or highways, especially where there are no protected walkways, crossings, or other infrastructure to separate them from motor vehicle traffic. Being a city with rapidly expanding transportation and mobility needs, Nairobi County could benefit from more protected walkways and crossings to keep pedestrians safe and more utilization of walkways and crossings where they do exist. Nairobi County could also consider conducting a roadway safety assessment, which would identify roadways in greatest need of improvements and provide recommendations to protect all road users [21,22].

Only 24% of motorcyclists were known to be using helmets when the RTC occurred, despite legislation requiring helmet use by all motorcyclists in Kenya. This could be due to limited enforcement, low risk perception, or perceived inconvenience, especially for short trips. Although our study demonstrated low helmet use, studies from cities in Tanzania (22.7%) and Pakistan (7.0%) documented motorcyclist helmet use among RTI cases that was even lower than what we observed [15,23]. Seat belt use was also low, with only 20.5% of motor vehicle occupants documented as using seat belts when the crash occurred. Similarly, a study in Cape Town, South Africa found that 25.2% of injured motor vehicle occupants used seat belts [24]. Existing law requires all vehicles in Kenya to have seat belts and all occupants to use them. Nonetheless, our study indicates that nonuse of seat belts is widespread. Adherence to and enhanced enforcement of Kenya’s helmet and seat belt laws, in addition to educational/awareness campaigns emphasizing the importance of safety equipment and relevant laws, could likely reduce RTI severity in Nairobi County. Although documented seat belt use among motor vehicle drivers was low (45.3%), seat belt use among motor vehicle passengers was 30 percentage points lower than that of drivers. Thus, particular emphasis on seat belt use among motor vehicle passengers is warranted. Future studies could also assess seat belt use among front seat versus rear seat passengers.

In our study, we observed that it took about 77 min for RTI cases to reach either of the two public emergency departments in Nairobi County. Janeway and colleagues (2019) reported a similar median time to care (70 min) at a private tertiary hospital in Nairobi, although their study was not limited to RTIs [11]. In contrast, a study in Taiwan (a high-income country) documented an average hospital arrival time of 18 min for RTI patients [25]. Although the study in Taiwan only captured transport times for patients transported by emergency medical services (EMS), almost three-fourths of patients in that study were transported in that manner. Delayed timing and poor quality of post-crash care response increases adverse outcomes for RTI victims [1], and a well-organized, rapid response to RTI management including prompt hospital transport is vital to reduce deaths and disabilities [26].

Transportation to hospitals by bystanders was also common in our study. Bystanders typically lack specialized knowledge and equipment to safely handle crash victims. Only 26% of RTI victims were taken to the hospital by ambulance. This could be due to lack of paramedical/ambulance teams or long waiting times before crash scene arrival. Indeed, a literature review of pre-hospital care published in 2016 found that among 48 LMICs, only one-third had documented information about EMS systems [27]. Educating bystanders to activate prompt transport to hospitals can expedite post-crash response, thereby reducing adverse outcomes [1]. Training and equipping community health workers, police officers, and some members of the general public (through strategic opportunities) to offer basic post-crash care is another possible approach, since these individuals are often at crash scenes before specialized medical personnel arrive [26,28–32]. Such training can improve the general public's knowledge and skills on basic emergency care and may reduce RTI mortality [32]. Of note, localities considering training the general public to offer basic medical assistance outside of an official capacity may need to consider the status of bystander protection laws in their region [1,26].

In our study, information on potential risk factors for RTC occurrence and/or severity (e.g., mobile phone use, speeding, and alcohol use) was difficult to obtain. RTI cases frequently stated they did not know whether these factors contributed to the crash. This may be true for many cases. However, it is also possible that some cases were hesitant to report on these factors for fear of possible legal consequences. We lacked any way of objectively verifying the information provided. Future studies could attempt to verify crash scene information with what patients self-report in hospitals, especially if high-quality crash scene data are available. As an example, a national RTI surveillance system in Cambodia succeeded in collecting risk factor information, and an evaluation of the system attributed 13% of crashes to alcohol use and 49% to speeding [33]. This information was available because the unified system integrated data from multiple sources including crash scenes and health facilities [33].

## Strengths

First, we involved key stakeholders, including the lead road safety agency, the Ministry of Health, and participating hospitals. This inclusive approach can enhance acceptance of RTI surveillance systems and utilization of findings to improve road safety and RTI management [9]. Second, adopting and modifying WHO guidelines to establish the surveillance system enabled us to compare with and build upon previous work [34]. Lastly, we attempted to expand on core minimum data set variables for RTI surveillance systems by capturing associated factors. When LMICs do have functioning RTI surveillance systems, they typically focus on minimum variables [35].

### Limitations

Although the pilot surveillance system involved the two main public hospitals in Nairobi County, less severe RTI cases might have presented at other facilities or not sought healthcare at all; therefore, this system might not have captured all RTI cases occurring in Nairobi County during the study period. Data on contribution of alcohol and other drugs/substances and safety equipment nonuse are invaluable; however, it was not possible to obtain complete and verified information on these variables. Additionally, although we captured 1840 cases, the seven-month pilot testing period might have been inadequate to evaluate the usefulness and performance of the surveillance system.

## Conclusion

We demonstrated that a hospital-based RTI surveillance system in Nairobi County is feasible and data collected can guide prevention. Our findings offer lessons on how such systems can be implemented, especially in Sub-Saharan Africa where one-third of trauma cases are due to RTIs [36]. An integrated surveillance system incorporating crash scene and hospital data can provide reliable information on key variables to inform public health action, and inform a robust RTI monitoring, prediction and prevention mechanism. A standardized case reporting tool for use by police and medical teams could improve data completeness and quality.

Enhanced enforcement of and increased education about existing laws on safety equipment use, speeding, and driving after using alcohol and/or other drugs/substances could reduce RTIs in Nairobi County; higher fines could improve compliance [37]. Shortening pre-hospital time could improve RTI outcomes. Additional research on innovative systematic approaches for collecting information on safety equipment use and RTI risk factors in LMIC settings would be beneficial.

## Acknowledgments

We acknowledge the data clerks and hospital management at Kenyatta National Hospital and Mama Lucy Kibaki Hospital; the Kenyan Ministry of Health's Division of Non-communicable Diseases, which houses the Injury and Violence Prevention Unit; the National Transport and Safety Authority (NTSA), the Nairobi County Department of Health, and the Kenya Field Epidemiology and Laboratory Training Program (FELTP) faculty for their support and collaboration during the study.

### Funding

This study was supported through a small grant funding mechanism by the Training Programs in Epidemiology and Public Health Interventions Network (TEPHINET) Small Grants Program, awarded by the Task Force for Global Health and the U.S. Centers for Disease Control and Prevention (Grant number 2018–090).

## References

[1]. World Health Organization. Global status report on road safety 2018. https://www.who.int/publications/i/item/9789241565684 (accessed 14 September 2021).

[2]. Yannis G, Nikolaou D, Laiou A, et al. Vulnerable road users: cross-cultural perspectives on performance and attitudes. IATSS Res 2020;44(3):220–9. doi:10.1016/j.iatssr.2020.08.006.

[3]. World Health Organization. Road traffic injuries. https://www.who.int/news-room/fact-sheets/detail/road-traffic-injuries (accessed 30 June 2022).

[4]. Chang FR, Huang HL, Schwebel DC, et al. Global road traffic injury statistics: challenges, mechanisms and solutions. Chin J Traumat 2020;23(4):216–18. doi:10.1016/j.cjtee.2020.06.001.

[5]. Chen S, Kuhn M, Prettner K, et al. The global macroeconomic burden of road injuries: estimates and projections for 166 countries. Lancet Planet Health 2019;3(9):e390–8. doi:10.1016/S2542-5196(19)30170-6. [PubMed: 31538624]

[6]. Mohan D, Tiwari G, Khayesi M, et al. World Health Organization. Risk factors for road traffic injuries (unit 2) Road traffic injury prevention training manual; 2006 https://www.who.int/publications/i/item/road-traffic-injury-prevention-training-manual (accessed 14 September 2021).

[7]. World Health Organization. World report on road traffic injury prevention. https://www.who.int/publications/i/item/world-report-on-road-traffic-injury-prevention (accessed 14 September 2021).

[8]. Holder Y, Peden M, Krug E, et al. World Health Organization. Injury Surveill Guidel 2001. https://www.who.int/publications/i/item/9241591331 (accessed 16 September 2021).

[9]. Razzak JA, Shamim MS, Mehmood A, et al. A successful model of road traffic injury surveillance in a developing country: process and lessons learnt. BMC Public Health 2012;12:357. doi:10.1186/1471-2458-12-357. [PubMed: 22591600]

[10]. National Transport and Safety Authority (NTSA) Mandate. https://www.ntsa.go.ke/site/?page_id=303 (accessed 27 September 2021).

[11]. Janeway H, O'Reilly G, Schmachtenberg F, et al. Characterizing injury at a tertiary referral hospital in Kenya. PLoS ONE 2019;14(7):e0220179. doi:10.1371/journal.pone.0220179. [PubMed: 31339962]

[12]. Botchey IM, Hung YW, Bachani AM, et al. Epidemiology and outcomes of injuries in Kenya: a multisite surveillance study. Surgery 2017;162(6S):S45–53. doi:10.1016/j.surg.2017.01.030. [PubMed: 28385178]

[13]. Botchey IM, Hung YW, Bachani AM, et al. Understanding patterns of injury in Kenya: analysis of a trauma registry data from a National Referral Hospital. Surgery 2017;162(6S):S54–62. doi:10.1016/j.surg.2017.02.016. [PubMed: 28438334]

[14]. Kenya National Bureau of Statistics. 2019 Kenya population and housing census volume I: population by county and sub-county. https://www.knbs.or.ke/?wpdmpro=2019-kenya-population-and-housing-census-volume-i-population-by-county-and-sub-county (accessed 16 September 2021).

[15]. Shamim S, Razzak JA, Jooma R, et al. Initial results of Pakistan's first road traffic injury surveillance project. Int J Inj Contr Saf Promot 2011;18(3):213–17. doi:10.1080/17457300.2011.555559. [PubMed: 21491288]

[16]. McGreevy J, Stevens KA, Ekeke Monono M, et al. Road traffic injuries in Yaoundé, Cameroon: a hospital-based pilot surveillance study. Injury 2014;45(11):1687–92. doi:10.1016/j.injury.2014.05.001. [PubMed: 24998038]

[17]. Weeks SR, Stevens KA, Haider AH, et al. A modified Kampala trauma score (KTS) effectively predicts mortality in trauma patients. Injury 2016;47(1):125–9. doi:10.1016/j.injury.2015.07.004. [PubMed: 26256783]

[18]. Weeks SR, Juillard CJ, Monono ME, et al. Is the Kampala trauma score an effective predictor of mortality in low-resource settings? A comparison of multiple trauma severity scores. World J Surg 2014;38(8):1905–11. doi:10.1007/s00268-014-2496-0. [PubMed: 24715042]

[19]. Farooq U, Bhatti JA, Siddiq M, et al. Road traffic injuries in Rawalpindi city, Pakistan. East Mediterr Health J 2011;17(9):647–53. [PubMed: 22259914]

[20]. Tefft BC. Impact speed and a pedestrian's risk of severe injury or death. Accid Anal Prev 2013;50:871–8. doi:10.1016/j.aap.2012.07.022. [PubMed: 22935347]

[21]. The International Road Assessment Programme (iRAP). 3 Star or better. https://irap.org/3-star-or-better/(accessed 22 October 2021).

[22]. World Health Organization. Decade of Action for Road Safety 2021–2030. https://www.who.int/teams/social-determinants-of-health/safety-and-mobility/decade-of-action-for-road-safety-2021-2030 (accessed 22 October 2021).

[23]. Chalya PL, Mabula JB, Ngayomela IH, et al. Motorcycle injuries as an emerging public health problem in Mwanza city, Tanzania: a call for urgent intervention. Tanzan J Health Res 2010;12(4):214–21. doi:10.4314/thrb.v12i4.55500. [PubMed: 24409627]

[24]. van Hoving DJ, Hendrikse C, Gerber RJ, et al. Injury severity in relation to seatbelt use in Cape Town, South Africa: a pilot study. S Afr Med J 2014;104(7):488–92. doi:10.7196/samj.7933. [PubMed: 25214050]

[25]. Huang CY, Rau CS, Chuang JF, et al. Characteristics and outcomes of patients injured in road traffic crashes and transported by emergency medical services. Int J Environ Res Public Health 2016;13(2):236. doi:10.3390/ijerph13020236. [PubMed: 26907318]

[26]. World Health Organization. Post-crash response: supporting those affected by road traffic crashes. 2016. https://www.who.int/publications/i/item/post-crash-response-supporting-those-affected-by-road-traffic-crashes. (accessed 17 September 2021).

[27]. Suryanto Plummer V, Boyle M. EMS systems in lower-middle income countries: a literature review. Prehosp Disaster Med 2017;32(1):64–70. doi:10.1017/S1049023X1600114X. [PubMed: 27938449]

[28]. Urfi Khalique N, Ahmad A, et al. Post-crash emergency care: availability and utilization pattern of existing facilities in Aligarh, Uttar Pradesh. J Family Med Prim Care 2020;9(5):2313–18. doi:10.4103/jfmpc.jfmpc_1251_19. [PubMed: 32754494]

[29]. Lukumay GG, Outwater AH, Mkoka DA, et al. Traffic police officers' experience of post-crash care to road traffic injury victims: a qualitative study in Tanzania. BMC Emerg Med 2019;19:51. doi:10.1186/s12873-019-0274-x. [PubMed: 31601171]

[30]. Chokotho L, Mulwafu W, Singini I, et al. First responders and prehospital care for road traffic injuries in Malawi. Prehosp Disaster Med 2017;32(1):14–19. doi:10.1017/S1049023X16001175. [PubMed: 27923422]

[31]. Debenham S, Fuller M, Stewart M, et al. Where there is no EMS: lay providers in emergency medical services care - EMS as a public health priority. Prehosp Disaster Med 2017;32(6):593–5. doi:10.1017/S1049023X17006811. [PubMed: 28797317]

[32]. Balhara KS, Bustamante ND, Selvam A, et al. Bystander assistance for trauma victims in low- and middle-income countries: a systematic review of prevalence and training interventions. Prehosp Emerg Care 2019;23(3):389–410. doi:10.1080/10903127.2018.1513104. [PubMed: 30141702]

[33]. Parker EM, Ear C, Roehler DR, et al. Surveillance of road crash injuries in Cambodia: an evaluation of the Cambodia Road Crash and Victim Information System (RCVIS). Traffic Inj Prev 2014;15(5):477–82. doi:10.1080/15389588.2013.836597. [PubMed: 24215613]

[34]. Zavala DE, Bokongo S, John IA, et al. Special section: multinational injury surveillance system pilot project in Africa. J Public Health Policy 2007;28(4):432–41. doi:10.1057/palgrave.jphp.3200154. [PubMed: 17955008]

[35]. Kipsaina C, Ozanne-Smith J, Routley V. The WHO injury surveillance guidelines: a systematic review of the non-fatal guidelines' utilization, efficacy and effectiveness. Public Health 2015;129(10):1406–28. doi:10.1016/j.puhe.2015.07.007. [PubMed: 26318617]

[36]. Vissoci JRN, Shogilev DJ, Krebs E, et al. Road traffic injury in sub-Saharan African countries: a systematic review and summary of observational studies. Traffic Inj Prev 2017;18(7):767–73. doi:10.1080/15389588.2017.1314470. [PubMed: 28448753]

[37]. Staton C, Vissoci J, Gong E, et al. Road traffic injury prevention initiatives: a systematic review and metasummary of effectiveness in low and middle income countries. PLoS ONE 2016;11(1):e0144971. doi:10.1371/journal.pone.0144971. [PubMed: 26735918]

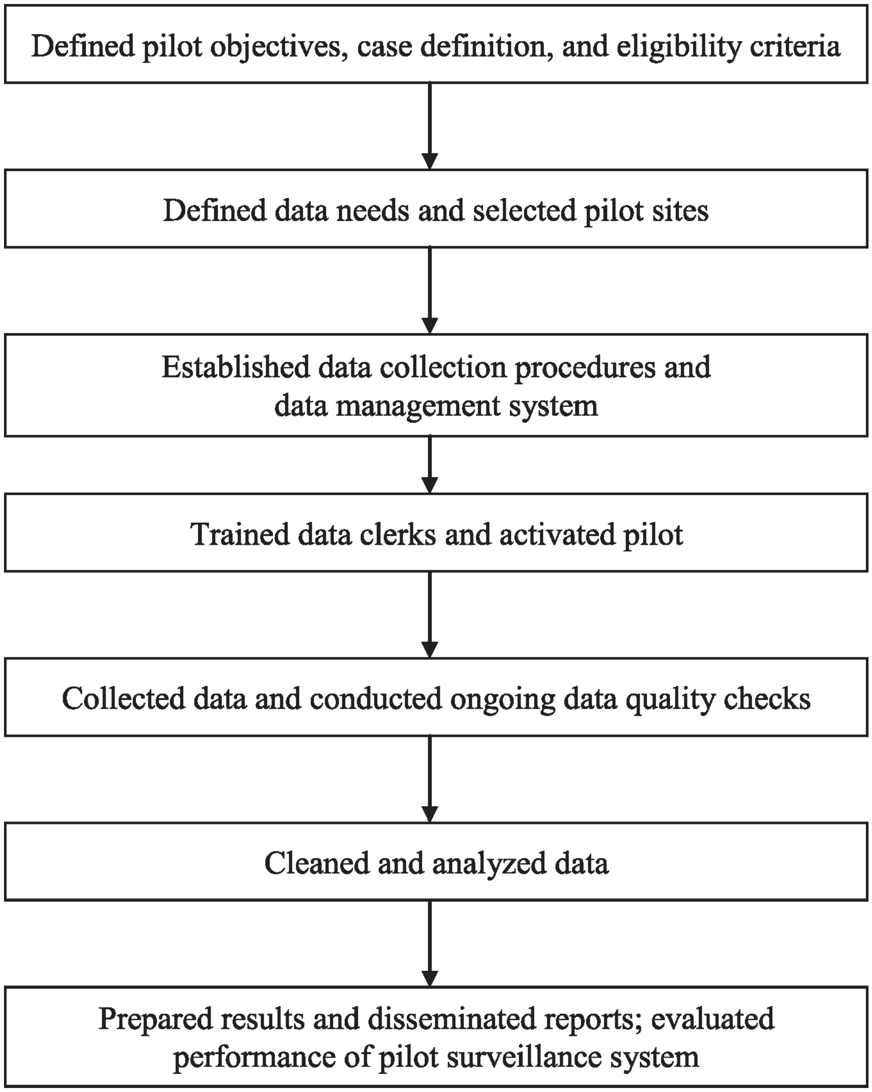


**Fig. 1.**
Flow diagram of steps used to set up and implement pilot hospital-based road traffic injury surveillance system in Nairobi County, Kenya, 2018–2019 *Note: This flow diagram was adapted and modified for this study from WHO's Injury Surveillance Guidelines Manual (2001).* [8].

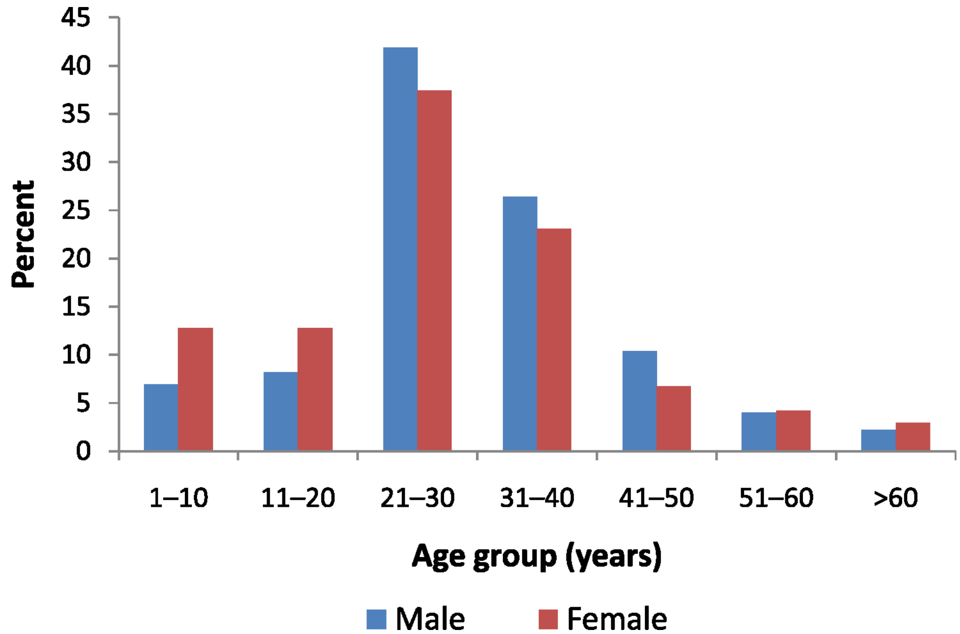


**Fig. 2.**

Road traffic injury cases by age group and by sex — Nairobi County, Kenya, October 2018–April 2019 *Note: This figure only includes cases for which age and sex were both captured (n = 1816).*

### Table 1

Road traffic injury case characteristics (*n* = 1840) — Nairobi County, Kenya, October 2018-April 2019.

| Category | n | % |
|---|---|---|
| **Sex** | | |
| Male | 1346 | 73.2 |
| Female | 477 | 25.9 |
| Unknown | 17 | 0.9 |
| **Age group (years)** | | |
| 1–10 | 156 | 8.5 |
| 11–20 | 173 | 9.4 |
| 21–30 | 744 | 40.4 |
| 31–40 | 466 | 25.3 |
| 41–50 | 173 | 9.4 |
| 51–60 | 73 | 4.0 |
| >60 | 44 | 2.4 |
| Unknown | 11 | 0.6 |
| **Road user type** | | |
| Motor vehicle occupants | 386 | 21.0 |
| Motor vehicle drivers | 86 | 4.7 |
| Motor vehicle passengers | 300 | 16.3 |
| Motorcyclists | 400 | 21.7 |
| Motorcycle drivers | 208 | 11.3 |
| Motorcycle passengers | 192 | 10.4 |
| Pedestrians | 995 | 54.1 |
| Bicyclists | 35 | 1.9 |
| Unknown | 24 | 1.3 |
| **Injured body area categories** * | | |
| Bony pelvis and extremities | 745 | 40.5 |
| Head, neck, and face | 526 | 28.6 |
| Chest | 83 | 4.5 |
| Abdomen | 67 | 3.6 |
| Polytrauma | 50 | 2.7 |
| Spinal cord | 20 | 1.1 |
| No major injuries | 349 | 19.0 |
| **Injury severity** | | |
| Severe (KTS <11) | 199 | 10.8 |
| Less severe (KTS ≥11) | 1641 | 89.2 |
| **Hospital transport mode** | | |
| Bystanders | 740 | 40.2 |
| Ambulance | 479 | 26.0 |
| Family members | 466 | 25.3 |
| Self | 102 | 5.5 |

| Category | n | % |
|---|---|---|
| Police | 1 | 0.1 |
| Unknown | 52 | 2.8 |
| **Outcome after 30 days** | | |
| Discharged from hospital | 1439 | 78.2 |
| Still admitted | 181 | 9.8 |
| Dead | 220 | 12.0 |

*Categories are mutually exclusive. Cases that experienced two or more injured body areas were classified as polytrauma. The most common polytrauma combination was injuries to the bony pelvis and extremities combined with head, neck, and face injuries, occurring in 33 polytrauma cases.

## Table 2

Road traffic injury cases experiencing severe injury and death, by road user type — Nairobi County, Kenya, October 2018-April 2019.

| Road user type | Number of injury cases | Severe injury[*] n (%) | Deathn (%) | Death among severe injury cases n (%) |
|---|---|---|---|---|
| Overall | 1,816[ɫ] | 199 (11.0) | 220 (12.1) | 142 (71.4) |
| Motor vehicle occupants | 386 | 46 (11.9) | 48 (12.4) | 33 (71.7) |
| Drivers | 86 | 19 (22.1) | 25 (29.1) | 14 (73.7) |
| Passengers | 300 | 27 (9.0) | 23 (7.7) | 19 (70.4) |
| Motorcyclists | 400 | 46 (11.5) | 54 (13.5) | 32 (69.6) |
| Drivers | 208 | 30 (14.4) | 30 (14.4) | 21 (70.0) |
| Passengers | 192 | 16 (8.3) | 24 (12.5) | 11 (68.8) |
| Pedestrians | 995 | 102 (10.3) | 114 (11.5) | 75 (73.5) |
| Bicyclists | 35 | 5 (14.3) | 4 (11.4) | 2 (40.0) |

[*] KTS <11.

[ɫ] A total of 24 cases had missing information for road user type and therefore are not included in this table.

Author Manuscript

Author Manuscript

Author Manuscript

**Table 3**

Factors potentially contributing to road traffic crashes (*n* = 1840) — Nairobi County, Kenya, October 2018-April 2019.

| **Potential risk factor** | **Contribution (n,%)** | | |
|---|---|---|---|
| | **Yes** | **No** | **Unknown** |
| Mobile phone use | 161 (8.8) | 580 (31.5) | 1099 (59.7) |
| Speeding | 159 (8.6) | 894 (48.6) | 787 (42.8) |
| Alcohol use | 129 (7.0) | 810 (44.0) | 901 (49.0) |
| Other | 54 (2.9) | 782 (42.5) | 1004 (54.6) |
| drug/substance use Bad weather | 25 (1.4) | 1340 (72.8) | 475 (25.8) |

## Table 4

Use of safety equipment among road traffic injury cases by road user type — Nairobi County, Kenya, October 2018-April 2019.

| Safety equipment by road user type | Number of RTI cases | Safety equipment use | | |
|---|---|---|---|---|
| | | Yes | No | Unknown |
| | | n (%) | n (%) | n (%) |
| Seat belt use among motor vehicle occupants | | | | |
| Overall | 386 | 79 (20.5) | 230 (59.6) | 77 (19.9) |
| Drivers | 86 | 39 (45.3) | 37 (43.0) | 10 (11.6) |
| Passengers | 300 | 40 (13.3) | 193 (64.3) | 67 (22.3) |
| Helmet use among motorcyclists | | | | |
| Overall | 400 | 96 (24.0) | 192 (48.0) | 112 (28.0) |
| Drivers | 208 | 70 (33.7) | 74 (35.6) | 64 (30.8) |
| Passengers | 192 | 26 (13.5) | 118 (61.5) | 48 (25.0) |
| Helmet use among bicyclists | 35 | 2 (5.7) | 23 (65.7) | 10 (28.6) |