Original article

Epidemiology of prehospital trauma deaths in Malawi: A retrospective cohort study

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ABSTRACT

Introduction: Trauma is among the leading causes of death and disability in both adults and children worldwide. In Malawi, trauma patients are commonly brought in dead (BID). We aimed to describe the prevalence, socio-demographic, and injury-related characteristics of patients BID to Kamuzu Central Hospital (KCH), a referral hospital in Lilongwe, Malawi.
Methods: We retrospectively reviewed records of all patients BID in the trauma surveillance registry at KCH from February 2008 to September 2019. We excluded patients BID that did not present to the emergency centre, and were instead taken to the mortuary directly. We used descriptive statistics to evaluate the epidemiology of patients BID.
Results: We reviewed 106,198 trauma records and 1889 (1.8%) were BID patients. Most patients BID were male, in both adult ($n = 1337/1528$, 88.4%) and children ($n = 231/360$, 64.9%) cohorts. The mean age was 34.7 (SD 11.9) years in adults and 7.8 (SD 5.4) years in children. Among the adult BID patients, 33.2% were unemployed, 25.6% were construction workers, and 10.1% were small business owners or managers. The common injury mechanisms in adults were road traffic-related injuries (RTIs) (47.1%) and assaults (23.6%). In children, injuries resulted from RTIs (39.7%), with 74.4% of those were pedestrians hit by cars, drowning (22.9%), and burns (12.4%). In both groups, most injuries occurred on roads (60.2%) or at home (22.1%). Reported alcohol use at the time of trauma was present in 6.3%. The police (57.9%) and privately-owned vehicles (26.6%) transported most BID patients to KCH.
Conclusion: Efforts to reduce prehospital trauma mortality must focus on improving prehospital care, including training the police and community in basic life support and improving resources towards prehospital trauma care. Further efforts to reduce prehospital mortality must aim to decrease injuries on the roads and at home.

African relevance

- One of the settings where mortality due to trauma is very high.
- There is need to develop and improve prehospital trauma care.
- Police and community should be involved in trauma care efforts.

Introduction

More than five million people die each year as a result of injuries [1]. Injuries account for 9% of the world's deaths, nearly 1.7 times the number of deaths that result from HIV/AIDS, tuberculosis, and malaria combined [2]. More than 90% of the world's injury-related deaths occur in low- and middle-income countries (LMICs), where preventive efforts are often non-existent, and healthcare systems are least prepared to meet this challenge [2].

The majority of trauma deaths in LMICs occur in the prehospital setting. This is unsurprising, as formal prehospital care systems are lacking, and most of the population do not have access to basic forms of prehospital care [3,4]. One study found that 81% of trauma deaths occurred in the prehospital setting in the low-income country of Ghana compared with 72% in the middle-income country Mexico and 59% in the high-income country of The United States [5].

In Sub-Saharan Africa, road traffic injuries (RTIs), gunshots, and assaults are significant causes of prehospital deaths [6–8]. In Malawi, a low-income country, a national trauma registry is not currently available [9,10]. Traumatic injury trends reported from Malawi's hospital-based registries and studies show that the common mechanisms of injury are RTIs(43.4%) and assaults (24.0%) in the urban setting, with falls (53.2%) and animal bites (16.6%) being common in the rural setting [11,12].

Kamuzu Central Hospital (KCH) is the only public tertiary and referral hospital in Malawi's central region and has a catchment population of about 7.5 million people [13]. Trauma victims, alive or dead, are brought from trauma scenes directly, or via primary and secondary care centres, to KCH. A previous study at KCH reported trauma-related mortality at 43.7% in-hospital and 56.3% in the prehospital setting [14]. While previous studies at this institution have focused primarily on in-hospital morbidity and mortality [12,15], we have focused on prehospital mortality in our study. We aimed to describe the prevalence, sociodemographic, and injury-related characteristics of patients brought in dead (BID) to KCH.

Methods

We performed a retrospective review of the prospectively collected KCH Trauma Surveillance Registry of patients BID from February 2008 to September 2019. We included all patients in the registry who presented to KCH's emergency centre (EC). Data routinely collected in the registry includes sociodemographic (age, sex, district of origin, occupation), injury information (alcohol use, mode of transport to hospital, date and time of hospital arrival (daytime: 6 am–5.59 pm, night-time: 6 pm–5.59 am)), mechanism of injury, injury setting, injury location on the body and BID. Trained data clerks are responsible for gathering injury and demographic information from patients, guardians, police, ambulance, and other providers who transport patients to the hospital. The data clerks are located in the EC and work 24 h a day, seven days a week, to collect this data. EC physician assessments are also captured in the data collection. Data is initially collected on standard collection forms and then subsequently entered into REDCap, an encrypted and secure web-based database system [16–18].

We included all BID patients with traumatic injury mechanisms captured in the registry during the pre-defined study period. We excluded BID patients who were taken directly to the mortuary, therefore bypassing the EC, as the registry did not capture these patients. We defined adults as ≥18 years old and children <18 years. Young adults are defined as adults ≤45 years old. We used descriptive statistics in the analysis to evaluate the prevalence, sociodemographic and injury-related characteristics of trauma patients BID. The central tendency was described with means and standard deviations (SD) and medians and interquartile ranges (IQR) for normally and non-normally distributed variables, respectively. Pearson Chi-square for categorical covariates and Student's T-Test for continuous covariates were utilised for bivariate analysis to compare the differences between adult and paediatric patients who were BID. Alpha was set at 0.05 for this study.

Stata/IC 14.0 (StataCorp, College Station, Texas, USA) was used to analyse this data. The Malawi National Health Science Research Committee (NHRSC #813) and the University of North Carolina Institutional Review Board (17-1210) approved this study. Both institutions waived consent.

Results

We reviewed 106,198 trauma cases recorded in the trauma registry from February 2008 to September 2019, of which 1889 (1.8%) were BID. Children accounted for 19% of the BID patients (Fig. 1). The mean ages were 34.7 (SD 11.9) and 7.8 (SD 5.4) years in adults and children, respectively. The majority of the adults were unemployed, working as construction workers, business owners, or salespeople. Among the
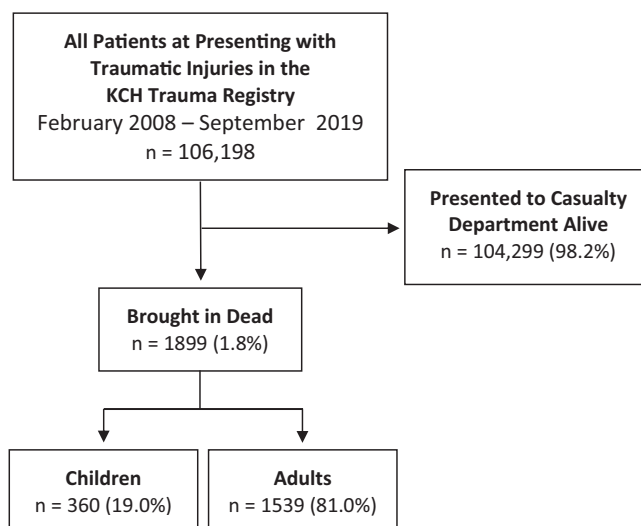

Fig. 1. Inclusion and exclusion flow diagram.

children, 49.9% ($n = 177$) were students or pupils. The median age of the children who had an employment was 15 (IQR 11–17) years. Suspected or actual alcohol use by the victim was reported in 6.3% ($n = 107$) cases (Table 1).

Most injuries occurred on the roads and in homes. Among adults, common mechanisms of injury were RTIs and assault with RTIs, drowning, and burns being the common mechanisms of injury among children. In both groups, head injury was the most common type of injury. Overall, the majority of the injuries were unintentional (Table 2). The yearly number of BID cases remained relatively constant among children but increased among adults (Fig. 2). The injury mechanism trend has remained relatively constant for assault, drowning, and burns but grew for RTIs (Fig. 3). There was no significant seasonal variation in the occurrence of BID cases, $p = 0.09$.

Discussion

In this study, we report a 1.8% prevalence of prehospital trauma patients BID to KCH. Higher rates of prehospital deaths have been

Table 1
Demographics.

	Overall ($n = 1899$)	Adult ($n = 1529$, 81.0%)	Children ($n = 360$, 19.0%)	p-Value
Male sex: n (%)	1568 (83.9)	1337 (88.4)	231 (64.9)	<0.001
Age (years): mean (SD)	28.9 (15.5)	34.7 (11.9)	7.8 (5.4)	<0.001
Occupation: n (%)				<0.001
Unemployed	509 (27.9)	488 (33.2)	21 (5.9)	
Business owner	154 (8.4)	149 (10.1)	4 (1.1)	
Student	223 (12.2)	46 (3.1)	177 (49.9)	
Child	128 (6.8)	0 (0.0)	136 (37.8)	
Peasant farmer	122 (6.7)	120 (8.2)	2 (0.6)	
Construction worker	392 (21.5)	376 (25.6)	9 (2.5)	
Office worker	70 (3.8)	69 (4.7)	1 (0.3)	
Manual labour	99 (5.4)	98 (6.7)	1 (0.3)	
Driver	57 (3.1)	53 (3.6)	4 (1.1)	
Police/soldier	28 (1.5)	28 (1.9)	0 (0.0)	
Other	43 (2.4)	43 (2.9)	0 (0.0)	
Alcohol use: n (%)				<0.001
No	1633 (93.7)	1302 (92.7)	331 (97.9)	
Yes	97 (5.6)	90 (6.4)	7 (2.1)	
Suspected	12 (0.7)	12 (0.9)	0 (0.0)	

Table 2
Injury characteristics.

	Overall (n = 1899)	Adult (n = 1539, 81.0%)	Children (n = 360, 19.0%)	p-Value
Season of injury: n (%)				0.09
Rainy (December–February)	412 (21.8)	317 (20.7)	95 (26.5)	
Lush/green (March–May)	507 (26.8)	411 (26.8)	96 (26.7)	
Cold/dry (June–August)	519 (27.4)	432 (28.2)	87 (24.2)	
Hot/dry (September–October)	455 (24.0)	374 (24.4)	81 (22.6)	
Injury setting: n (%)				<0.001
Home	401 (22.1)	277 (18.9)	124 (36.2)	
Work	39 (2.2)	38 (2.6)	1 (0.3)	
Road	1091 (60.2)	931 (63.4)	160 (46.7)	
Public space	124 (6.8)	106 (7.2)	18 (5.3)	
Other	157 (8.7)	117 (8.0)	40 (11.7)	
Mode of transport: n (%)				<0.001
Minibus	78 (4.2)	43 (2.9)	35 (10.0)	
Private vehicle	491 (26.6)	338 (22.6)	153 (43.6)	
Ambulance	136 (7.4)	112 (7.5)	24 (6.8)	
Police	1070 (57.9)	942 (62.9)	128 (36.5)	
Other	73 (4.0)	62 (4.1)	11 (3.1)	
Injury mechanism: n (%)				<0.001
Pedestrian vs. motor vehicle	338 (19.7)	245 (17.5)	93 (29.5)	
Motor vehicle collision	322 (18.8)	294 (21.1)	28 (8.9)	
Bike injury	123 (7.2)	119 (8.5)	4 (1.3)	
Gunshot wound	88 (5.1)	85 (6.1)	3 (1.0)	
Fall	37 (2.2)	28 (2.0)	9 (2.9)	
Burn	115 (6.7)	76 (5.4)	39 (12.4)	
Assault	351 (20.5)	329 (23.6)	22 (7.0)	
Hanging	103 (6.0)	93 (6.7)	10 (3.2)	
Drowning	124 (7.2)	52 (3.7)	72 (22.9)	
Collapsed structure	61 (3.6)	38 (2.7)	23 (7.3)	
Other	50 (2.9)	38 (2.7)	12 (3.8)	
Injury intent: n (%)				<0.001
Unintentional	1354 (73.1)	1031 (68.8)	323 (91.2)	
Assault	418 (22.6)	396 (26.4)	22 (6.2)	
Self-inflicted	80 (4.3)	71 (4.7)	9 (2.5)	
Injury type: n (%)				<0.001
Contusion	85 (4.6)	71 (4.8)	14 (4.0)	
Laceration	116 (6.3)	104 (7.0)	12 (3.4)	
Fracture	150 (8.0)	135 (9.1)	15 (4.3)	
Burn	72 (3.9)	45 (3.0)	27 (7.7)	
Penetrating wound	150 (8.1)	140 (9.4)	10 (2.8)	
Injury to internal injury	76 (4.1)	65 (4.4)	11 (3.1)	
Head injury	914 (49.6)	747 (50.1)	167 (47.4)	
Other	281 (15.2)	185 (12.4)	96 (27.3)	
Injury location: n (%)				<0.001
Head/C-spine	1272 (70.9)	1057 (71.5)	215 (68.0)	
Chest	105 (5.9)	96 (6.5)	9 (2.9)	
Abdomen/pelvis	149 (8.3)	117 (7.9)	32 (10.1)	
Extremity	166 (9.3)	141 (9.6)	25 (7.9)	
Other	101 (5.6)	66 (4.5)	35 (11.1)	
Time of presentation: n (%)				<0.001
Day (6 am–6 pm)	973 (51.7)	734 (48.2)	239 (66.8)	
Night (6 pm–6 am)	907 (48.3)	788 (51.8)	119 (33.2)	

reported in similar settings such as Iraq (6.3%), Tanzania (13%), and in Ghana (51%) [8,19,20]. Our lower prevalence may be attributed to excluding traumatic deaths being confirmed and/or certified by referring clinics or hospitals closer to the site of injury. While our data did not capture whether the victims died at the scene or in transit to the hospital, they strongly support the need for an organised trauma care system beyond hospital premises in our setting to reduce deaths from injury [10,20,21].

It is not surprising that there were more males than females included in our study's cohorts as, generally, the incidence of traumatic injuries is disproportionately high in males [22]. Young adults comprised the majority of BID cases in our study. This demographic finding aligns with the fact that trauma remains a leading cause of mortality among young people globally [23]. The pattern of injury mechanism, RTIs, and assaults in adults, and RTIs, drowning, and burns in children, are similar to other studies [24–27]. We found a high proportion of children (19.1%) among the BID patients. Yokobori et al. reported, from verbal autopsies at a third-level hospital in Zambia, children made up between 26.5% and 34.9% of those BID due to trauma [28]. Children around the world have a right to a safe environment and protection from injury and violence [29]. Several measures at national and local levels in Malawi could help protect children from injury, including strict enforcement of laws to safeguard child protection, policies on road safety, improved road infrastructure, enhanced vehicle safety, barriers around bodies of water, and covers on wells around homes [25,30–32]. Also, programs to educate children and guardians about water safety, drowning prevention, and first aid could be implemented [33,34].

The high proportion of assault cases seen in this study, i.e. interpersonal violence (IPV), highlights a rising public health and security concern. In Malawi, 12.4% and 24.5% of males and females respectively are reported victims of domestic violence [35]. In the same setting, Maine et al. have reported an IPV prevalence of 34.5% in the injured population [36]. In an effort to curb this problem, a deliberate collaboration between the health care service and law enforcement agencies in injury surveillance and prevention should be promoted [37]. Further, public health interventions should be designed to identify at-risk populations and key contributing factors for a tailor-made solution in dealing with IPV, especially in this setting [36].

Globally alcohol causes 3.2% of all deaths equating to approximately 1.8 million deaths annually. Approximately half of the deaths attributable to alcohol result from injuries [38]. In Malawi, 30.1% of males and 4.1% of females between the ages of 24 and 64 years consume alcohol [39]. Sundet et al. reported a 24.9% prevalence of alcohol use among RTIs victims brought to KCH alive [40]. A 6.1% alcohol prevalence in our study may be an underestimation since no toxicology data was available. The high proportion of unemployed individuals among our cohort is a reflection of the unemployment rate in Malawi which is approximately 5.7%. Only Zambia has a higher unemployment rate (11.4%) when compared to Malawi's immediate neighbouring countries (Tanzania: 2.0%, and Mozambique: 3.2%) [41]. Our data shows that 5.8% of the children, median age of 15 (IQR 11–17) years were employed. The legal framework for child labour in Malawi contained in the Employment Act of 2000 (CAP 55:01) sets the minimum age for admission of a child to employment at 14 years. The Act further prohibits children between the ages of 14 and 18 to work in hazardous work [42].

A formal and well-established prehospital trauma care system is currently not available in Malawi [10]. Recent studies in LMICs cite the effective use of diverse prehospital transport methods, including public, private, commercial, police, and non-motorised transport, as well as formal Emergency Medical Services [43]. Our study shows that police and private vehicles form a crucial transportation mechanism in prehospital trauma care in Malawi. It is unknown if the victim was alive at the time of contact with the police or private vehicle owner from our data. However, the role of police and private vehicles in trauma care underscores the need for basic life support skills among the police and
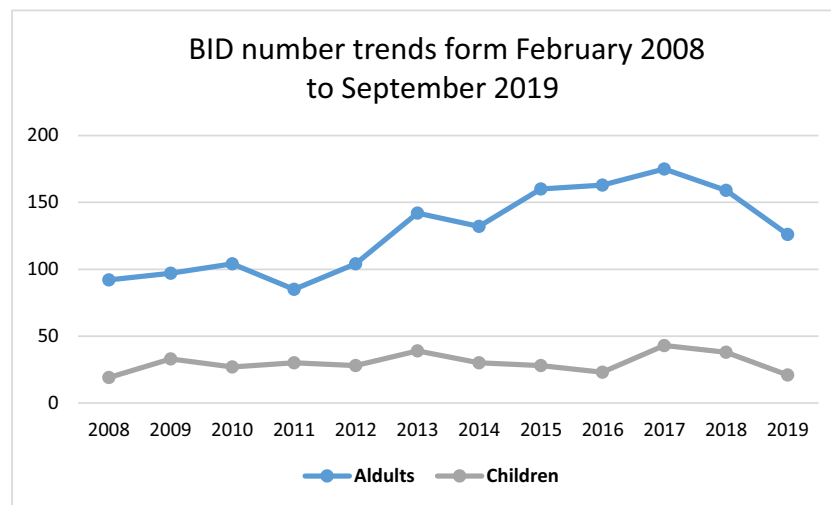
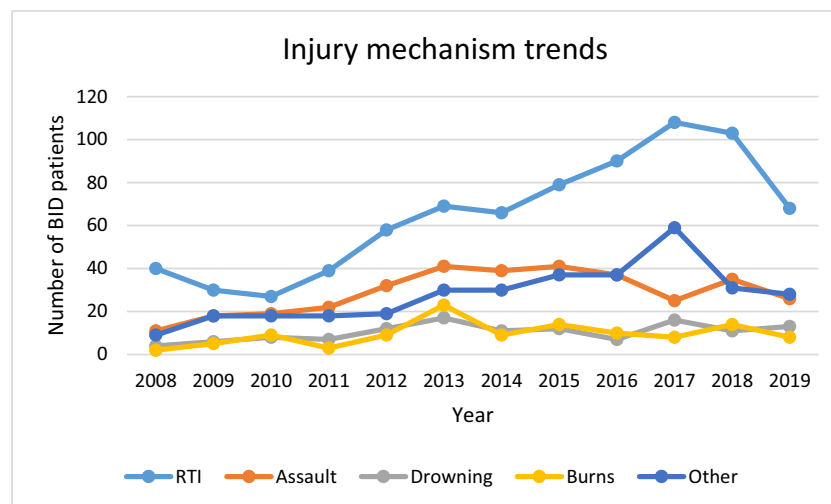**Fig. 2.** BID number trends form February 2008 to September 2019.

Fig. 3. Injury mechanism trends.

community to support life at the point of contact and in transit to the hospital. In Uganda, programs training police officers, taxi and truck drivers, and the general community members to provide first aid have been successfully implemented [44,45]. A cheaper, and perhaps more sustainable alternative, is establishing a community-based emergency first aid responder (EFAR) system. The role of EFARs would be to arrive on the scene and provide basic life support until ambulance services arrive or to transport the patient themselves to the nearest hospital [46].

The limitations of this study are those common with any study with a retrospective methodology. Data such as time of death, death at the scene or during transportation to the hospital, and prehospital interventions were not available in our registry. Also, patients BID that bypassed the EC were not captured in our database, which may exclude a proportion of subjects not captured in our analysis. Furthermore, autopsies are not routinely performed in Malawi, so confirmation of the injury patterns resulting in death could not be done. Lastly, this is a single-centre study so generalisation is limited. However, KCH is a tertiary hospital with a broad catchment region which covers over one third of Malawi's population.

Conclusions

Prehospital trauma mortality is prevalent in Malawi. Young people

who are unemployed and children are common victims. Efforts to reduce prehospital trauma mortality must focus on improving prehospital care, including training the police and community in basic life support and directing resources towards prehospital trauma care. Further, a multi-faceted approach by multiple stakeholders needs to be devised to curb interpersonal violence, prevent drowning accidents, improve road infrastructure and sensitise the community on road safety measures.

Authors' contribution

Authors contributed as follow 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: GM 35%; AC 20%; and LNP, RM and ECB 15% each. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

Dissemination of results

Results from this study were shared with staff members at the data collection site through an informal presentation.

Declaration of competing interest

The authors declare no conflicts of interest.

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