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Understanding the health system utilisation and reasons for avoidable mortality after fatal injury within a Three-Delays framework in Karonga, Northern Malawi: a retrospective analysis of verbal autopsy data

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ABSTRACT

Objectives To use verbal autopsy (VA) data to understand health system utilisation and the potential avoidability associated with fatal injury. Then to categorise any evident barriers driving avoidable delays to care within a Three-Delays framework that considers delays to seeking (Delay 1), reaching (Delay 2) or receiving (Delay 3) quality injury care.

Design Retrospective analysis of existing VA data routinely collected by a demographic surveillance site.

Setting Karonga Health and Demographic Surveillance Site (HDSS) population, Northern Malawi.

Participants Fatally injured members of the HDSS.

Primary and secondary outcome measures The primary outcome was the proportion of fatal injury deaths that were potentially avoidable. Secondary outcomes were the delay stage and corresponding barriers associated with avoidable deaths and the health system utilisation for fatal injuries within the health system.

Results Of the 252 deaths due to external causes, 185 injury-related deaths were analysed. Deaths were predominantly among young males (median age 30, IQR 11–48), 71.9% (133/185). 35.1% (65/185) were assessed as potentially avoidable. Delay 1 was implicated in 30.8% (20/65) of potentially avoidable deaths, Delay 2 in 61.5% (40/65) and Delay 3 in 75.4% (49/65). Within Delay 1, 'healthcare literacy' was most commonly implicated barrier in 75% (15/20). Within Delay 2, 'communication' and 'prehospital care' were the most commonly implicated in 92.5% (37/40). Within Delay 3, 'physical resources' were most commonly implicated, 85.7% (42/49).

Conclusions VA is feasible for studying pathways to care and health system responsiveness in avoidable deaths following injury and ascertaining the delays that contribute to deaths. A large proportion of injury deaths were avoidable, and we have identified several barriers as potential targets for intervention. Refining and integrating VA with other health system assessment methods is likely necessary to holistically understand an injury care health system.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ We have demonstrated the utility of verbal autopsy (VA) for evaluating a health system's responsiveness and identifying causes of delays in accessing quality injury care.
⇒ We found that a third of deaths were potentially avoidable with access to quality healthcare and have shown the delays in access to care that contributed to that avoidable mortality.
⇒ Compared with other demographic and surveillance systems worldwide, Karonga is relatively small (over 40 000 people under surveillance), with fewer injury-related deaths per year to draw inferences from.
⇒ The health system studied cares for a much broader population than those in the Health and Demographic Surveillance Site; therefore, not all deaths occurring in the area were captured by the VA.

BACKGROUND

The global burden of injury is substantial, with fatal injuries causing 8% of all deaths worldwide.[1] Most of these (90%) occur in low-income and middle-income countries (LMICs).[2] Injuries place significant strain on health systems in LMICs, where up to 38% of the surgically treatable disease burden is due to injury.[3 4] In addition to direct effects on an individual's health, injuries have catastrophic economic impacts, with half of the injury-related mortality occurring in young adults (15–44 years) during an economically fruitful part of life.[5 6]

More empirical data are needed to better understand injury burden since many of the estimates, especially from LMIC settings, are modelled.[5] Trauma registries enable

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prospective data collection of injured patients and are advocated to optimise surveillance and quality improvement for injury care in health systems.[7] Although present in some places,[8 9] widespread registry adoption has been constrained in LMICs to date.[10] However, even when in existence, hospital facility-based trauma registries do not capture information on those injured patients who die before reaching the hospital. With a widespread lack of availability of vital registry systems, these deaths often go unrecorded. To fill this data void, non-traditional data sources such as demographic health surveillance and verbal autopsy (VA) have been advocated.[11] These methodologies also go beyond the numbers provided by vital registry data and permit an understanding of circumstances around deaths (including delays in seeking and reaching care), which can contribute vital information on the avoidability of the death and subsequent health system planning.

VA is a method of establishing the probable cause(s) of the death of an individual through interviewing a final caregiver, typically family member(s), or next of kin.[12] It has been developed to help address major gaps in the global cause of death data, responding to the lack of functioning civil registration and vital statistics systems in LMICs. It has been found to be accurate compared with a gold standard, including for injury.[13] VA data have been used in Malawi to describe causes of death at the community level.[14–16] VA analysis has shown that external causes, including injury, account for 5.4% of deaths within the rural setting of Karonga.[17] Data collected with VA also permits a distinction between avoidable and unavoidable deaths after injury.[18]

In Malawi, injuries are estimated to account for 19% of non-communicable disease and injury disability-adjusted life years and 82% of injury burden affects those under 40 years.[19] One-third of road traffic collisions cause a fatality, with deaths more common in rural areas, where most Malawians live.[20 21] However, obtaining reliable data on injuries is a challenge. The quality of routinely collected medical records in Malawi is insufficient to serve this purpose.[20 22] Trauma registries exist in only a few facilities in Malawi, in Lilongwe and Blantyre and not in the northern region.[9 23] Additionally, most studies on injury care in the country have focused on facility-based care. There is limited evidence available about the total burden of injuries, including community deaths, and population barriers to seeking and reaching care following injury, in keeping with the paucity of global literature on this subject.[24]

We aimed to use VA data from a demographic surveillance site in Northern Malawi to understand the circumstances leading to death after injury. We describe the health system utilisation and potential avoidability associated with fatal injuries within the Karonga Health and Demographic Surveillance Site (HDSS) population. We identify and categorise any evident barriers driving avoidable delays in care within a Three-Delays framework that considers delays in seeking (Delay 1), reaching (Delay 2) or receiving (Delay 3) quality injury care.[18]

METHODS

Study setting

Our study was set in the Karonga HDSS population, which can be considered representative of populations in similar contexts to Northern Malawi.[25] The HDSS covers a population of over 40 000. All members of households located within the geographic area are eligible for inclusion in the demographic surveillance, with only 1% typically declining to take part, usually for religious or spiritual reasons.[25] The Karonga HDSS is managed by the Malawi Epidemiology and Intervention Research Unit.

At the time of the study, there were 10 228 households registered within the HDSS. Households are within villages, which are divided into smaller clusters (209 in total at the time of the study). Originally, each of these clusters contained 20–30 households, although, with population growth and migration, that number now varies. Groups of geographically proximal clusters, initially around 10, form the 21 reporting groups of the demographic surveillance site.[25] Each cluster has a resident who acts as a key informant and meets monthly with an HDSS staff member to report events such as births and deaths.

The setting is predominantly rural, although a minority live within semiurban settlements. The economy of Karonga district is mostly subsistence, with heavy reliance on farming and fishing in the adjacent lake Malawi.[25] The local vernacular language of Chitumbuka is spoken throughout Karonga and within the HDSS population. Progression into secondary and higher education requires certification of competence in English. The majority of secondary roads are unpaved, although a main metalled road runs north to south through the district.[25]

Primary health facilities available to the local population consist of government, military, private and Christian Health Association of Malawi (CHAM) facilities. Secondary care is provided by a government facility in the district capital, approximately 70 km to the north and a CHAM facility, approximately 40 km to the south, over difficult terrain. Tertiary care is provided in the regional capital, Mzuzu, approximately 150 km to the south, at a government central hospital. Secondary and tertiary facilities provide resuscitative surgery for severe injuries. There is no formal, established prehospital emergency care network.

Data collection

VAs are collected routinely as part of population surveillance within the Karonga HDSS.[25] Key informants for each cluster are asked to report deaths in addition to other household changes at monthly reporting sessions. All deaths are followed by a VA interview using a semi-structured questionnaire following a suitable period of mourning, typically a few weeks.[26] A clinically trained

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interviewer visits the household and completes the VA form if the family consents. The VA survey is based on the 2003 INDEPTH and WHO tools.[27 28] Since the start of the Karonga HDSS, the VA tool used has been modified to reflect changes in the WHO-standardised questionnaire. However, the questions regarding deaths from external causes remain unchanged.[17] Relatives who were present at, or leading up to, the death of the family member are asked open-ended questions to create a free-text narrative about the circumstances of death. This is accompanied by closed, symptom-specific questions. Two clinicians independently review the questionnaire to assign a cause of death, with a third acting as a tie-breaker in case of disagreement.[29] Narratives were only available as photographs in paper form. Therefore, it was not possible to keyword search the database for any other deaths that may also have been related to injury but otherwise classified. Ten circumstances of mortality (CoM) questions to assess household, community and health system determinants of death were included where available. Some had only been collected as part of VA sometime after the start of the HDSS.[30] They included questions on recognition of severity, mobilising assets to seek care, access to care and quality of care. They were originally constructed to align with the three delays and are listed in online supplemental table 1.

Data analysis

All VAs available within the Karonga HDSS database from inception in 2002 until September 2019 were searched for external causes of death. External causes of death classified as either underlying, contributory or direct within the HDSS database were extracted. All VAs were assigned an underlying cause (initiating the train of morbid events), while direct and contributory causes were only assigned when applicable. We included underlying, direct and contributory external injury-assigned deaths to ensure that we captured all VAs in which injury played a role. Within the Karonga HDSS, injury-related deaths are included within the external causes category, which is classified as unspecifiable, transport, fall, drowning/submersion, exposure to smoke/fire/flames, poisoning/exposure to noxious substances, use of weapons, contact with venomous animals and plants, hanging, choking and other specific unlisted. All the external cause cases were reviewed. Free-text narratives were reviewed for each. Those with narratives missing or not clearly describing an external cause of death were excluded from further analysis. External cause of deaths due to poisoning were also excluded. The remaining cases were considered injury related and assessed for avoidability.

Outcome variables

The primary outcome of this study was the proportion of fatal injury deaths that were potentially avoidable. Secondary outcomes were the delay stage and corresponding barriers contributing to those delays associated with avoidable deaths, the health system utilisation for fatal injuries within the health system and the exploration of the utility of CoM questions in determining avoidability.

The method for evaluating avoidability from VA data has been described before.[18] Each free-text narrative was reviewed for descriptions of the geographical location of the event, acuity or chronicity of the injury, clinical signs and symptoms from the injury, care-seeking behaviour, factors facilitating or inhibiting access to care, the provision of medical care, descriptions of care delivered and understanding of the effects of care on the patient's outcome. Answers to the CoM questions were also reviewed to understand care-seeking behaviour. This information was reviewed by a clinician to evaluate whether the death could have been avoidable if quality healthcare had been accessed in a timely manner. Factors indicating potentially avoidable deaths include being alive at the scene of injury, being able to seek help and low-severity injuries affecting a single-body system.[18] Deaths were categorised by avoidability and, if deemed potentially avoidable, by which delay or delays were implicated in the death. Delays were not mutually exclusive and more than one could be implicated in an avoidable death. Barriers derived from an earlier Delphi study[31] were noted if evidenced, as was any novel barrier believed to be evidenced as driving delays in care. Where multiple delays contributed to avoidable mortality, those found to be the most important in leading to death were considered the primary contributing delay.

The categorisations of avoidability and the delays and barriers implicated, including their relative importance, were performed first in a subsample of 10% of injury cases by one author (JW). These results were then validated by another author (IE) with experience as an injury care provider and researcher experienced with VA analysis. Discrepancies were discussed until consensus was achieved to improve the classification of subsequent data. Once agreement was reached on avoidable deaths, delays and barrier classification, one author (JW) analysed the remaining cases. Whether or not CoM questions helped form the judgement of avoidability or barrier assignment was recorded.

The mechanism of injuries was categorised using the external cause classification and free-text narratives as fall, struck/hit by person or object, road traffic accident, animal bite, fire/flames or heat, stab, drowning or near-drowning, other and unknown. Facilities attended were classified in the household survey as 'government primary', 'government secondary', 'government tertiary', 'faith-based primary', 'faith-based secondary', 'military primary', 'private primary' and 'unknown'. They were then summarised as primary, secondary, tertiary and quaternary. Whether or not a fatal injury clearly occurred outside the Karonga HDSS health system was recorded. This excluded those fatally injured who did not access the health system facilities and were geographically remote from the Karonga HDSS location (eg, deaths occurring when visiting another region).

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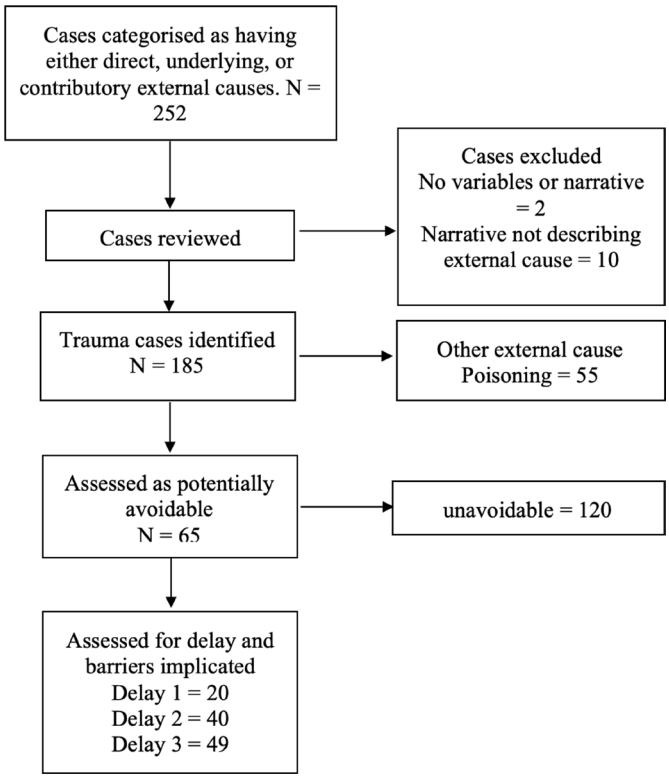


Figure 1 Flow diagram of verbal autopsy case analysis.

Avoidable deaths and the delays and barriers evidenced are described as counts and percentages. For those who accessed a care facility, including multiple facilities, the order and choice of facilities were described.

The primary outcome of this study was the proportion of all fatal injury deaths that were potentially avoidable. Secondary outcomes were the delay stage and corresponding barriers associated with avoidable deaths, the health system utilisation for fatal injuries within the health system and the exploration of the utility of CoM questions in determining avoidability.

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

RESULTS

There were 252 deaths categorised in the Karonga HDSS database as having either direct, underlying or contributory external causes (figure 1). Twelve deaths were excluded as there was no narrative available (n=2) or the narrative did not describe an external cause of death (n=10). Of the 240 external cause deaths analysed, 55 were due to poisoning, including through alcohol, and were excluded. The remaining 185 injury-related deaths were analysed.

Deaths due to injury were predominantly in young males (median age 30, IQR 11–48), 72.4% (134/185) (figure 2). Road traffic collision was the most common mechanism for fatal injury, 29.7% (55/185) (table 1), although, for those aged under 16 years, drowning was the most common cause, 28.3% (15/53).

Of the injury deaths, 35.1% (65/185) were assessed as potentially avoidable. Delay 1 was judged the most important contributor to avoidable death in 16.9% (11/65) of cases, compared with 23.1% (15/65) and 60% (39/65) for Delays 2 and 3, respectively (table 2). Delay 1 was implicated in 30.8% (20/65) of potentially avoidable deaths, Delay 2 in 61.5% (40/65) and Delay 3 in 75.4% (49/65). All three delays were implicated in 7.7% (5/65) of deaths, but the most commonly co-implicated delays were Delays 2 and 3 in 38.5% (25/65).

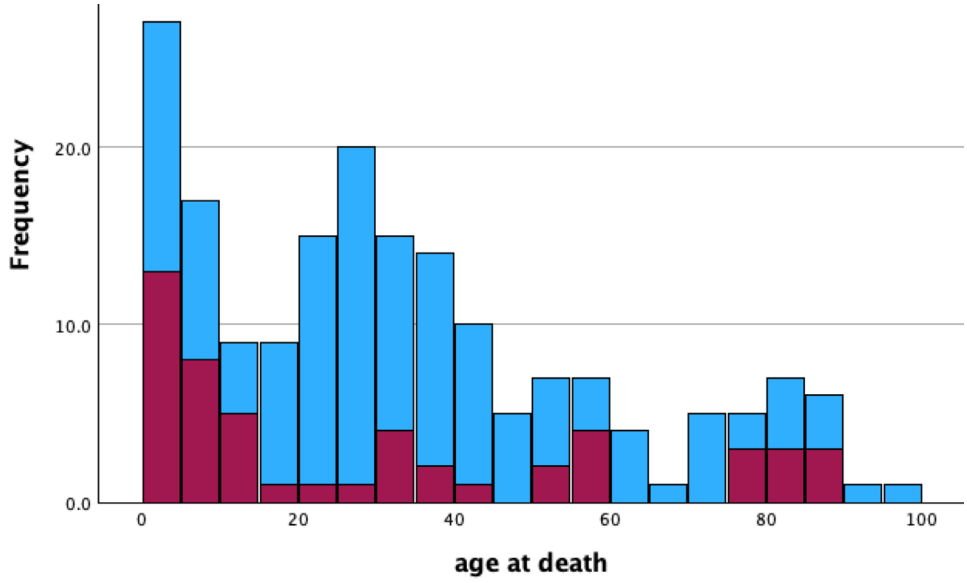


Figure 2 Verbal autopsy injury deaths according to age and sex. Bars represent 5-year intervals; male sex in blue and female sex in red.

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Table 1 Demonstrating mechanisms of injury according to sex and age (classified as aged under 16 years or 16 years and over)

Mechanism of injury	Male aged 16 years and over, % (n) (N=107)	Males aged under 16 years, % (n) (N=27)	Females aged 16 years and over, % (n) (N=25)	Females aged under 16 years, % (n) (N=26)	Total % (n) (N=185)
Road traffic accident	35.5% (38)	7.4% (2)	40.0% (10)	19.2% (5)	29.7% (55)
Drowning or near-drowning	19.6% (21)	55.6% (15)	8.0% (2)	38.5% (10)	25.9% (48)
Other—hanging	22.4% (24)	0	8.0% (2)	0	14.1% (26)
Fall	4.6% (5)	11.1% (3)	36.0% (9)	11.5% (3)	10.8% (20)
Struck/hit by person or object	8.4% (9)	0	8.0% (2)	7.7% (2)	7.0% (13)
Stab	5.6% (6)	0	0	0	3.2% (6)
Animal bite or sting	0.9% (1)	3.7% (1)	0	7.7% (2)	2.2% (4)
Fire, flames or heat	0	7.4% (2)	0	7.7% (2)	2.2% (4)
Other—choking or aspiration	0	3.7% (1)	0	7.7% (2)	1.6% (3)
Other— accidental strangulation	0.9% (1)	3.7% (1)	0	0	1.1% (2)
Electricity shock (lightening)	0.9% (1)	3.7% (1)	0	0	1.1% (2)
Gunshot	0.9% (1)	0	0	0	0.5% (1)
Unknown	0	3.7% (1)	0	0	0.5% (1)

Barriers believed to contribute to delays in avoidable death are tabulated in table 3. Within Delay 1, 'healthcare literacy' was most commonly implicated in 75% (15/20), followed by 'cultural norms' in 50% (10/20). Within Delay 2, 'communication' and 'prehospital care' were most commonly implicated in 92.5% (37/40) each, followed by 'distance' and 'coordination' in 42.5% (17/40). Within Delay 3, 'physical resources' were most commonly implicated in 85.7% (42/49), followed by 'quality processes' in 71.4% (35/49).

During validation discussions, in addition to the barriers identified by the Delphi study,[31] a separate Delay 3 barrier of 'interfacility transfer' was agreed to differentiate the delay associated with moving between facilities from the Delay 2 barrier 'coordination', which incorporates bypassing primary facilities. 'Police processes', related to attending a police station before care following injury, were also identified as a barrier for one case in Delay 1. We did not find evidence for the Delphi[31] derived Delay 1 barriers 'perceived physical access' or 'perceived care quality' or Delay 3 barriers 'patient cooperation' or 'capacity'.

Table 2 Demonstrating how each of the three delays contributed to avoidable fatal injury (65 injury deaths were assessed as being potentially avoidable)

Intersection of delays implicated in avoidable fatal injury	
Delay 1 alone	9.2% (6/65)
Delay 2 alone	13.8% (9/65)
Delay 3 alone	16.9% (11/65)
Both delays 1 and 2	1.5% (1/65)
Both delay 2 and 3	38.5% (25/65)
Both delay 1 and 3	12.3% (8/65)
All of delays 1, 2 and 3	7.7% (5/65)
Delay considered the most important for avoidable fatal injury	
Delay 1	16.9% (11/65)
Delay 2	23.1% (15/65)
Delay 3	60.0% (39/65)

Considering healthcare access, of the 185 injury deaths, 5.9% (11/185) clearly took place outside the catchment area for the HDSS health services (geographically remote from the Karonga HDSS location). Of the 174 injury deaths within the HDSS health system, most (64.4%, 112/174) died without accessing care (prehospital deaths). Of the 35.6% (62/174) who interacted with the health system, almost all (91.9%, 57/62) were deemed potentially avoidable. A government primary facility was initially accessed by 71% (44/62), and for 41.9% (26/62), this was the only facility they accessed. The pattern of facility types accessed following injury is shown in figure 3. The figure shows all deaths accessing care since a few (8.1%, 5/62) were deemed unavoidable.

Considering the avoidable deaths, none of the CoM questions (online supplemental table 1) were answered in 9.2% (6/65) of cases, and only some of the CoM questions were answered in 70.8% (46/65) (usually traditional medicine and attended a hospital), and all CoM questions were answered in 20% (13/65). In 21.5% (14/65) of avoidable deaths, the CoM questions (whether partially or fully answered) were useful in judging either avoidability or barriers implicated. However, the narrative was the primary means for determining evidence of avoidability and the corresponding delay and barriers implicated.

DISCUSSION

Our study analysed VA data and found one-third of injury-related deaths in this setting to be potentially avoidable.

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Table 3 Verbal autopsy barriers evidenced in avoidable deaths according to delay

	How deduced	No. of deaths
Delay 1: seeking care		
Cost: the financial costs associated with seeking care are too great	CoM Q6 in conjunction with evidence of Delay 1 from narrative.	2
Perceived physical access: people perceive that care is too difficult to physically access	Evidence from narrative.	0
Perceived care quality: people perceive that available facility care is poor quality	Evidence from narrative.	0
Delayed discovery: there are delays in discovering injured people, including because of intoxication	Evidence from narrative.	5
Traditional healers: people prefer traditional healers	CoM Q2 along with Delay 1 evidence from narrative.	1
Healthcare literacy: people don't understand about health and available healthcare	Evidence from narrative.	15
Cultural norms: normal cultural behaviours delay seeking care such as gender roles, family responsibilities and requiring someone else's permission to seek care	Evidence from narrative.	10
Other: police processes—perceived or actual police functions affect care access	Evidence from narrative.	1
Delay 2: reaching care		
Communication: there is a lack of accessible emergency assistance communication mechanism (eg, emergency call centre)	Evidence from narrative.	37
Transport: there is a lack of timely affordable emergency transport (formal or informal)	Evidence from narrative and CoM Q4 and 5.	13
Prehospital care: there is a lack of timely available prehospital emergency care (formal or informal/bystander)	Evidence from narrative.	37
Distance: there is a large physical distance from place of injury to an appropriate healthcare facility	Evidence from narrative and CoM Q5.	17
Coordination: there is a lack of emergency care service coordination, including bypassing unsuitable facilities or transferring between facilities	Evidence from the narrative of being referred through facilities when bypassing smaller facilities would have avoided delay.	17
Roads: there is a lack of reliable uncongested roads with priority for emergency vehicles	Evidence from the narrative of a journey undertaken away from tarmac roads.	11
Delay 3: receiving care		
Staff: In regard to staffing, there is a lack of reliably available, suitably trained and motivated clinical staff	Evidence from narrative and CoM Q8 and Q9, but neither applied.	34
Specialists: there is a lack of reliable timely access to specialist injury care services	Evidence from narrative.	19
Physical resources: there is a lack of reliably available necessary physical resources (eg, infrastructure, equipment and consumable material)	Evidence from narrative and CoM Q10.	42
Patient cooperation: there is a lack of patient and family cooperation with care processes	Evidence from narrative.	0
Quality processes: there is a lack of good quality, consistent, structured, clinical priority driven injury care processes	Evidence from narrative and CoM Q8, 9 and 10.	35
Payment: difficulties with timely payment for care	Evidence from narrative and CoM Q6.	1
Capacity: In regard to patient demand, there is insufficient facility capacity to meet patient demand (eg, overcrowding)	Any evidence from narrative and CoM Q8.	0
Other: interfacility transfer—lack of available means to safely and quickly transfer injured patients on to a more specialist facility.	Evidence from narrative.	18

CoM, circumstances of mortality.

Each of the three delays was implicated in avoidable injury-related mortality in our study, with a noteworthy number characterised by Delays 2 and 3. We identified several common barriers driving those delays. Almost two-thirds of deaths occurred in the community. Most of the deaths that did interact with the health system were deemed to be potentially avoidable.

The number of avoidable injury-related deaths we found is comparable to those estimated by Mock *et al*.[32] They extrapolated survival rates following injury in LMICs and proposed that if these improved to the rates seen in high-income countries, one-third of annual global injury deaths could be avoided.[32] Studies using a case mortality peer review methodology for determining avoidable

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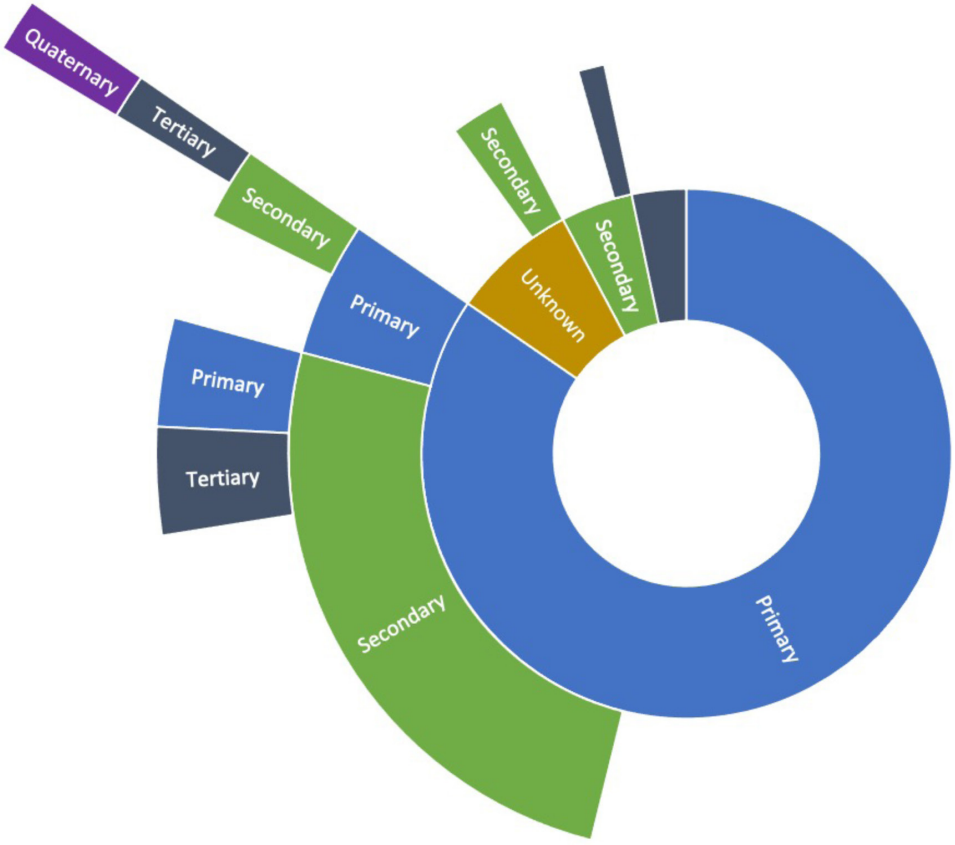


Figure 3 Sunburst diagram demonstrating the pattern of health facility access for all fatally injured individuals according to facility type (primary, secondary, tertiary and quaternary). The innermost ring represents the initial facility type attended; the subsequent outer layers represent the subsequent facility types attended by each fatally injured individual (where applicable).

injury deaths (preventable or potentially preventable) have found the proportion ranging from approaching two-thirds in Ghana,[33] India[34] and Pakistan[35] to a fifth in Colombia[36] and a quarter in Tehran.[37] Our previous study analysing VA for avoidable mortality found a similar rate of avoidable injury deaths (41% of injury deaths).[18] Higher rates in studies using data only from facilities in comparable LMIC contexts fit with our finding that the third delay was the most commonly found contributing to avoidable deaths.

The predominance of road injury, drowning and suicide as leading causes of death from external causes in the Karonga HDSS has been described and discussed before, but is worth further comment here.[17] Globally, road traffic collisions are a major cause of death. particularly among younger males.[38] Much more progress is needed in low-resource settings to achieve the same major success in reducing mortality and morbidity from such incidents as seen in high-income settings.[39] Interventions such as installing road modifications at sites at higher risk of road traffic collisions have been shown to be effective, as too can traffic police presence,[38] as well as enforcement of seat belt use.[39] The close proximity to Lake Malawi accounts for some of the observed drowning burden, given its importance for essential activities such as washing, bathing and fishing. While limited adult supervision plays an important role in these deaths, undertreated epilepsy is also likely implicated.[17] Educational strategies to improve swimming and water safety in children have been found effective in other low-resource settings[40] and have been advocated for adoption in Malawi.[41] The difficulties and vulnerabilities associated with relative poverty and subsistence living have been proposed as drivers for observed levels of suicide within Malawi.[42 43] Malawi has higher rates of suicide compared with neighbouring countries and the COVID-19 pandemic may have made this burden worse.[42] Decriminalising self-harm (illegal in Malawi), improving community-based mental health support and challenging existing gender norms to encourage help-seeking, especially among males, have all been proposed as steps that Malawi could take to tackle this issue.[42]

Another commonly adopted method for evaluating avoidable injury deaths is a retrospective peer review of fatal injuries, usually using facility-derived data, often from registries and often guided by the WHO trauma quality improvement standards.[33–35 44] In the absence of other accessible databases, such as a trauma registry, a VA database represents a valuable longitudinal population data source. A strength of our approach using VA is that it captures deaths that would not have featured in hospital records and been available for facility-based mortality review exercises.

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Within Delay 1, 'healthcare literacy' and 'cultural norms' were most commonly evidenced as barriers. Health literacy is defined (by), as 'the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health'.[45] One important dimension evidenced in this assessment is related to the perception of injury severity, which has been noted as an important barrier in Rwanda.[46] Similarly, in Cameroon and Sudan, close to half of community survey respondents did not seek injury care due to perceived low severity.[47 48] A lack of individual and community understanding of how best to respond following injuries is another dimension of 'healthcare literacy' found to delay injury care in comparable sub-Saharan settings in South Africa, Zambia and Uganda.[18 49 50]

While linked to 'healthcare literacy', we defined 'cultural norms' specifically as normal cultural behaviours delaying seeking care such as gender roles, family responsibilities and requiring someone else's permission to seek care. We previously found cultural factors to play a role in delaying seeking injury care in South Africa.[18] Needing the permission of another to seek injury care was seen in neighbouring Tanzania.[51] This suggests the importance of family decision-making processes governed by cultural customs, and the status of women, in particular, is well described by Thaddeus and Maine in their seminal paper on delays in obstetric emergencies[52] and is well established within the maternal health literature.[53]

Within Delay 2, 'communication' and 'prehospital care' were most commonly classified as barriers. In nearby Zambia and Kenya, a formal prehospital emergency care system with a functioning emergency call system was strongly desired by community members.[50 54] Community awareness, in addition to helping drive demand, is important for service utilisation. In settings with a local ambulance service and universal emergency numbers, this may not be well known or used by injured patients, linked to the barrier of 'healthcare literacy'.[55] This is important since there is some evidence from Lilongwe that direct transfer of patients to tertiary facilities following injury in Malawi is associated with survival benefits.[56]

Currently, access to professional prehospital care in Malawi is 'almost non-existent'.[57] Ambulances, where available, tend to be used for interhospital rather than prehospital transport.[57] This finding is common across most of sub-Saharan Africa, where most of Africa's population lacks access to emergency medical services.[58] Interventions to improve prehospital injury care in LMICs have been found to save lives, reducing injury-related mortality.[59] However, it should be noted that in settings where formal ambulance prehospital transport is available but nascent, informal means of transport can still lead to prompter care access than achieved through scarcely available ambulances.[55 60] With other means also associated with better outcomes in some situations.[61]

Within Delay 3, 'physical resources' and 'quality processes' were most commonly classified as barriers. A lack of good quality, consistent, structured, clinical priority-driven injury care processes summarises 'quality processes'.[60 62] The need to ensure patients were seen in order of clinical priority was highlighted by community members in Kenya and Zambia, who have raised similar concerns related to waiting time taking precedent over the clinical urgency of a critically injured person as well as the need for care protocols.[50 63] Implementation of facility-based interventions such as the WHO Trauma Care Checklist can lead to improvements in care processes for injured patients across some comparable settings.[64]

Both within Malawi, across sub-Saharan Africa and LMICs, facility capacity assessments reveal systemic resource deficiencies.[24 33 65–67] Other studies also support a lack of infrastructure and physical resources hampering timely quality care delivery to injured patients, particularly at peripheral facilities.[49 50 68] This is usually particularly the case for primary facilities across LMICs,[65] which, while not necessarily expected to provide specialist, definitive curative care, are nevertheless routinely the first port of call for initial management of the injured. While such studies are useful, VA-derived data provide additional insight into the health system's responsiveness.

Most fatally injured patients who accessed care did so initially at a primary facility. This demonstrated a lack of bypassing primary facilities in the Karonga HDSS health system and therefore a strong need for transferring those with serious injuries to referral facilities. This experience is common for those injured in Malawi and similar to other LMICs where injured people often seek care at the nearest healthcare facility, which may not have the capacity to manage them.[56 68] Implementing emergency medical systems that include the ability to bypass severely injured patients to more suitable facilities can save lives.[59] However, implementing such bypass procedures can potentially overburden central facilities with patients who could be adequately served in more peripheral facilities.[69]

We did not find evidence of some barriers previously identified by the Delphi study,[31] which may be primarily a methodological phenomenon rather than a true absence of the barrier. We used VA data to assess a health system as a secondary use for which it was not designed. This methodological limitation may be particularly the case for barriers from the Delphi study[31] related to individual perceptions such as 'perceived physical access' or 'perceived care quality' which we found no evidence for in VA analysis. Perceptions of a deceased person may not be readily identifiable through VA narratives or CoM data, which would require specific adjustments to CoM questions and may still not be readily known by a relative providing the VA information.

Our study has some limitations. Compared with other demographic and surveillance systems, Karonga is relatively small. The numbers were too small to allow meaningful comparisons by age group or sex. Our earlier work

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using VA in Agincourt, South Africa, benefited from a much larger population under surveillance and therefore a larger number of injury-related deaths per year from which to draw inferences about the health system.[18] For the analysis in Karonga, the whole database time frame was used. Limiting the analysis to the most recent few years, as was done with the Agincourt study, could enable a more contemporary evaluation of the health system that could have evolved over time.

Additionally, HDSS household members can and did die while physically away from the area, such as visiting family elsewhere in Malawi. This meant their deaths were not informative of the HDSS health system's response to injury. Similarly, the health system studied, particularly referral facilities, care for a much broader population than just the HDSS. Such patients and others treated within the health system while visiting or transiting through (such as a road traffic collision on the main metalled road) would not be captured through this method. We could not search narratives for injury-related keywords, as done in a previous study,[18] which may have identified any miscoded deaths. Although all death coding is verified by at least two clinicians, incorrectly coded injury deaths are likely to be few.[29]

Nevertheless, we have further demonstrated the utility of VA as an efficient use of secondary analysis for evaluating a health system's responsiveness and identifying sources of delay in accessing quality injury care. We have illuminated potential barriers that should be considered when evaluating parallel populations and systems. While secondary data analysis depends on the collaboration of a pre-existing, established HDSS, such an approach is pragmatic and can meaningfully provide important health system insights.

CONCLUSION

We have again shown VA to be a feasible method for studying pathways to care and health systems responsiveness in avoidable deaths in injury and ascertaining the delays that contribute to deaths. In this setting, a large proportion of injury deaths were avoidable, with the third delay followed by the second delay as the most prominent contributor to avoidable deaths. We have identified several barriers as potential targets for intervention, although refining and integrating VA with other health system assessment methods is likely necessary to holistically understand an injury care health system.

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