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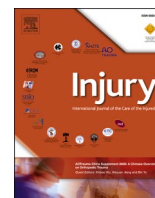
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Review

The burden of long bone fracture and health system response in Malawi: A scoping review

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ABSTRACT

Objectives: Fractures pose serious health and socioeconomic consequences for individuals, their families, and societies more broadly. In many low-resource settings, case fatality and long-term sequelae after a fracture remain high due to individual- and system-level barriers affecting timely access to care. This scoping review explored the burden of fractures in Malawi using long bone fracture (LBF) as a case study by examining the epidemiology of these injuries, their consequences, and the accessibility of quality healthcare. Our aim is to not only describe the scale of the issue but to identify specific interventions that can help address the challenges faced in settings with limited resources and healthcare budgets.

Methods: A scoping review methodology was adopted with a narrative synthesis of results. We searched five databases to identify relevant literature and applied the "Three Delays" model and the WHO's Building Blocks Framework to analyse findings on the accessibility of fracture care.

Results: Fractures most often occurred among young males, with falls being the leading cause, constituting between 5 and 35 % of the total burden of injuries. Fractures were typically managed without surgery despite consistent local evidence showing surgical treatment was superior to conservative management in terms of length of hospital stay and bone healing. Poor functional, economic, and social outcomes were noted in fracture patients, especially after conservative treatment. A lack of trust in the health system, financial barriers, poor transport, and road infrastructure, and interfacility transfers were identified as barriers to care-seeking. Factors challenging the provision of appropriate care included governance issues, poor health infrastructure, financial constraints, and shortage of supplies and human resources.

Conclusions: To the best of our knowledge, this review represents the first comprehensive examination of the state of LBF and the health system's response in Malawi. The findings underscore the pressing need for a national trauma registry to accurately determine the actual burden of injuries and support a tailored approach to fracture care in Malawi. It is further evident that the health system in Malawi must be strengthened across all six building blocks to address obstacles to equitable access to high-quality fracture care.

Introduction

Bone fractures represent a major public health burden worldwide and can lead to significant health and economic consequences for individuals, households, and societies more broadly [1,2]. Death and disability due to fractures have reduced tremendously in high-income countries, where robust health systems can provide essential medical, surgical, anaesthesia, and rehabilitative care [3]. On the other hand, in many low- and middle- income countries (LMICs), fracture care is inaccessible to much of the population, causing high case fatality rates

and long-term sequelae [4]. There have been calls to strengthen health systems worldwide to better respond to the growing burden of injuries such as fracture. For example, the Lancet Commission on Global Surgery (LCoGS) has identified surgical management of open fractures as one of the three "Bellwether" procedures which can be used to assess the health system's capacity to provide essential surgical care [4]. The commission set a target for countries to ensure 80 % of the population can access, within 2 hours, a facility that can provide treatment for open fractures and noted that many LMICs continue to face challenges in achieving this target [4].

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Malawi is a low-income country in Sub-Saharan Africa with a population of 17.56 million. Around 84 % of its population resides in rural areas and an estimated 70 % of the population lives below the international poverty line, earning \leq \$1.90 per person per day [5,6]. The country has one of the highest rates of road traffic accident mortality in the world and is facing a rising burden of injuries [7]. The public health system in Malawi is composed of district hospitals, each linked to 11-40 primary health facilities, and four central hospitals [8]. The district hospitals are mainly located in rural areas, while the central hospitals are located in the urban centres of Blantyre, Lilongwe, Zomba and Mzuzu. Fracture care in Malawi is provided in district and central hospitals through orthopaedic clinical officers (OCOs) in district hospitals, and orthopaedic surgeons and OCOs in central hospitals. As of 2020, there were an estimated 107 OCOs and 14 orthopaedic surgeons in the country [9]. The OCOs are non-physician clinicians who receive 18 months of training in the conservative management of fractures and basic surgical procedures such as external fixation and open fracture debridement before they are appointed as primary orthopaedic care providers in district and central hospitals [10]. For all complex/-extensive orthopaedic procedures, such as open reduction and internal fixation, patients are referred to central hospitals to be managed by the orthopaedic surgeons [9]. Nonetheless, almost 90 % of orthopaedic care in Malawi is provided by the OCOs [11,12]. Several studies have emerged in recent years describing the epidemiology of traumatic injuries, such as fractures, and the way in which these are managed in Malawi [9,13,14]. However, no research has consolidated this emerging body of literature to provide a comprehensive picture of what is known about the burden of fractures, their consequences, or the capacity of the health system to provide the necessary care.

In this review, long bone fracture (LBF) was selected as a case study to explore the burden and consequences of fracture. Globally, the incidence of LBFs is escalating, primarily due to the rise in road traffic accidents [15]. LBFs, which are primarily caused by such high-energy trauma, stand out as the leading cause associated with hospital admissions [16–18]. When left untreated or inadequately treated, LBFs can significantly impair mobility, thereby severely restricting an individual's ability to undertake routine activities. Moreover, considering that the younger age cohort is mostly affected by road traffic accidents, this situation inevitably leads to profound socioeconomic consequences [19]. Against this backdrop, we aim to explore the burden of fractures, their consequences for affected households, and the accessibility of appropriate care within Malawi's health system. Synthesising the literature on this topic is critical to not only demonstrate the scale of this public health issue but also identify areas for strengthening the health system to better respond to this burden and minimize the consequences of injury on individuals and their families. Further, it is hoped that the scope of this review, which brings together evidence of epidemiology, impacts and health system strengthening needs, can provide a framework for assessment that is transferable across health conditions and country settings.

Materials and methods

Study design

A scoping review methodology was adopted in accordance with PRISMA guidance for scoping reviews [20]. This review methodology was selected as it enables mapping of the literature that is available to describe the topic from several relevant angles and supports identification of areas for further research. In addition to charting the published evidence, we conducted a narrative synthesis of findings to allow for a deeper understanding of the information available in the body of literature on this broad topic. The review addresses the following research questions.

1) What is known about the burden of LBF in Malawi?

- a) What are the epidemiological features of LBF in Malawi?
 - b) What are the health and economic consequences of LBF?
- 2) What health system factors contribute to the burden of LBF in Malawi?
- a) What are the demand- (care-seeking) and supply- (facility capacity) side barriers influencing access to LBF care in Malawi?

The Participant, Concept, Context (PCC) framework was used to define the scope of the review, where the 'Participant' is people of all ages and genders with LBF; the 'Concept' is epidemiology, health and economic outcomes, and demand (care-seeking) and supply (facility capacity) barriers to care for LBF; and the 'Context' is the country of Malawi. The scope of our definition of epidemiological features includes demographic and social characteristics of those experiencing these injuries (such as age, gender, education), the characteristics of the fractures (such as open vs closed, type of bone involved), and the mechanisms of injury.

Search strategy

Five databases (Medline Ovid, Web of Science, Global Health, Embase, and Scopus) were searched, initially on 18th May 2022, with a repeat search conducted on 6th October 2022 to capture more recently published articles. Reference lists of the included articles were also scanned to identify additional relevant articles. Limits on publication date were set to the year 2000 to ensure that the data we analysed was current, offering a cohesive insight into the recent challenges and solutions in the field. Supplementary Table 1 provides details of the search strategy.

Eligibility criteria and screening

Duplicates were identified using EndNote before articles were imported to Covidence for screening. Studies were screened for eligibility using the selection criteria given in Supplementary Table 2. Studies were first screened based on title and abstract, followed by full text review by two authors independently. Conflicts were resolved through consensus. Studies were included if they reported on fractures involving long bones – this included studies focused on all fractures, recognising that a significant proportion of fractures involve long bones. Conversely, studies were excluded if they dealt only with fractures of non-long bones (e.g., pelvis and spine).

Data extraction and analysis

A data extraction template was developed to summarise the characteristics of the studies and extract data relevant to the research questions (Supplementary Table 3). The data extraction template was developed jointly by all authors, while data was extracted by SA and VLO with regular consultation with LC and NN. Data were extracted and synthesised using a framework of the "Three Delay Model" in conjunction with the "World Health Organizations (WHO) Health System Building Blocks". The Three Delays Model, originally designed to investigate barriers to accessing maternal care in low-resource settings [21], has also been proposed by the LCoGS as a framework to describe care-seeking for surgical conditions [4], and has been used in other studies on fractures [22,23]. According to this model, delays to receiving appropriate care can be attributed to three categories as follows: delays to the decision to seek care after a fracture (first delay): delays to reaching care once the decision is made to seek care (second delay) and delays to the provision of appropriate care once a site of care is reached. The WHO's Building Blocks, on the other hand, constitute six essential functions that serve as a foundation for an efficient and effective health system response. These building blocks encompass leadership and governance, health financing, medical products and technologies, information and research, health workforce, and health service delivery.

This Building Blocks framework was used to provide a comprehensive and structured approach to the synthesis of data relating to the third delay.

Results

Characteristics of included studies

A total of 1212 references were identified, with 510 unique references screened for eligibility, of which, 55 were included in the review (see Fig. 1 for the PRISMA flow chart and Supplementary Table 4 for a summary of study characteristics). Over half (30/55) of the studies were published in the last five years, with 12 papers (22 %) published in 2021 alone. One review article [24] and one clinical guideline [25] were included, while the remaining references were primary research papers. Many of the primary studies (27/53) were based on analysis of medical records or trauma registry data, 16 of which were based on analysis of trauma registry data from Kamuzu Central Hospital in Lilongwe. Other research designs included prospective controlled or cohort studies (11 records), qualitative studies (6 records), household surveys (5 records), facility capacity assessments (2), and economic evaluations (2). Most papers (44/55) provided quantitative evidence on the epidemiology of fractures (including the contribution of fracture to the burden of trauma), injury characteristics (location of fracture, mechanism of injury), and demographic characteristics of those with fractures. Many of the papers (30/55) described the consequences of fractures, most commonly the immediate clinical outcomes (such as rates of bone union or infection) and mortality. Most papers (41/55) discussed in some way the health system's capacity to manage fractures, mainly reporting on service delivery challenges.

Epidemiology of fractures

Demographic characteristics

In majority of the studies, the demographic characteristics of patients with traumatic injuries were not disaggregated by injury type (such as fracture or LBF). A summary of quantitative data on demographic characteristics that were reported for fractures is presented in Table 1. In

17 studies, gender distribution among fracture patients was presented and the data showed predominance in males (~54–92 %) [14,26–39]. In studies involving adult cohorts, the mean age of fracture patients was typically in the early 20s to early 40s [26,29–32,34–36,40]. A study of all patients presenting to two district and two central hospitals with fractures reported a median age of 15 years [9]. Information on the education and occupation of fracture patients was reported in only two studies. A study of 187 adults with femoral shaft fracture reported that 58 % of patients had primary education, 30 % secondary and 9 % post-secondary as their highest level of education [36]. Another study examining 23,734 fracture patients' data reported that 56 % patients had primary education while 23 % had no education. In this cohort 43 % were business owner/self-employed and 41 % were farmer/labourer [9].

Characteristics of LBF

Seven out of 55 studies reported on the mechanism of injury specifically for fractures (Table 1). A study conducted in four hospitals reported falls (66.6 %), followed by road traffic accidents (17.6 %) as the most common causes of fracture cases [9]. In two other studies, similar results were seen in paediatric populations where falls were noted as the most common mechanism of humeral and femoral fractures in patients <15 years old (83 % and 69.7 % respectively) [37,38]. Other studies have found road traffic accidents to be the major cause of LBF, accounting for between 52–72 % of femoral shaft fractures [33,36,41], and 63.3 % of tibia fractures [39]. Only one study gave further detail on the type of road traffic accident (e.g. vehicle(s) involved) [33], and no studies provided detail on the location or circumstances of falls.

Four studies focused exclusively on open fractures, while seven were focussed on closed fractures and the remainder included both or did not specify. Open fractures were reported to make up a minority of fractures (5 %) [9]. Seven studies reported exclusively on femoral fractures [11, 13,31,33,36,38,42], three on tibia fractures [18,27,39], two studies on humeral fractures [28,37], while the remaining studies included multiple bones or did not specify. A study on 23,734 fractures reported that over three-quarters of cases were fractures of long bones, where the most common bones involved were radius/ulna (36.6 %), followed by tibia/fibula (17.0 %), humerus (14.9 %) and finally femur (9.9 %) [9].

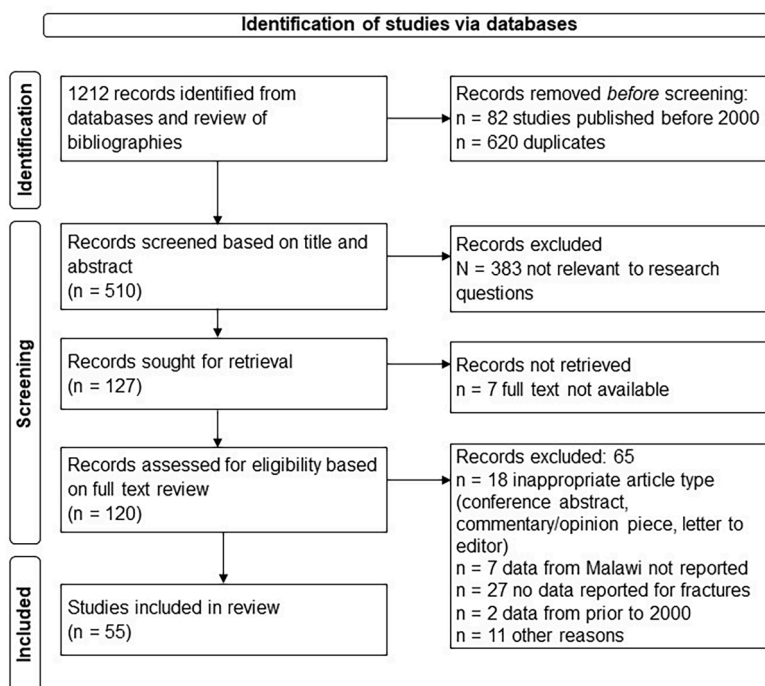


Fig. 1. PRISMA flowchart.

Table 1
Summary of reported demographic characteristics and common mechanism(s) of injury among fracture patients.

Reference	Study location(s)	Study population and size	Proportion of study cohort that are male	Age distribution	Most common mechanisms of injury
Harrison, 2002 [1]	Queen Elizabeth Central Hospital (QECH), Blantyre	Adults with a fracture. 39 HIV-positive patients; 141 HIV-negative patients	Not reported	Mean age HIV-positive group: 37 years (21 to 54) Mean age HIV-negative group 36 years (15 to 76)	Not reported
Harrison, 2004a [2]	QECH, Blantyre	27 patients with open tibia fractures.	88.9 %	Not reported	Not reported
Harrison, 2004b [3]	Two hospitals in Blantyre	36 HIV positive patients requiring orthopaedic implant surgery	91.7 %	Mean age: 37 years	Not reported
Igbigbi, 2004 [4]	QECH Blantyre, Beit Cure, Mwaiwathu, Blantyre Adventist Hospital	258 patients aged 3-81 years with humeral diaphyseal fracture	60.5 %	Mean or median not reported	Not reported
Norrish, 2007 [5]	Beit CURE Hospital, Blantyre	47 adult patients with a severe open fracture	85.1 %	Mean age: 35 years (19 to 60)	Not reported
Bates, 2012 [6]	QECH and Beit CURE International Hospital, Blantyre	609 adult patients admitted for internal fixation	81.9 %	Mean age: 37 years (18-80)	Not reported
Doorgakant, 2012 [7]	Ntcheu district hospital	20 adults (>14 years) with unilateral isolated closed femoral shaft fracture	65.0 %	Mean age: 34.5 years	Not reported
Gardner, 2013 [8]	QECH, Blantyre	89 patients undergoing surgical fixation.	82.0 %	Mean age: 37.8 years	Not reported
Young, 2013 [9]	Kamuzu Central Hospital (KCH), Lilongwe	137 patients with femoral fractures	83 %	Median age: 30 years (12-78)	Road traffic accidents (71 %) followed by fall (29 %)
Graham, 2015 [10]	QECH, Blantyre	99 HIV-positive patients admitted for internal fixation	71.7 %	Mean age: 42 years (20-70)	Not reported
Young, 2016 [11]	KCH, Lilongwe	992 patients aged ≥ 16 years with femoral fractures	72 %	Median age (men): 36 years (16-96) Median age (women): 60 years (16-93)	Not reported
Chagomerana, 2017 [12]	KCH, Lilongwe	586 patients admitted with femur or tibia/fibula fracture	70.5 %	Not reported	Not reported
Diab, 2019 [13]	QECH, Blantyre	65 adult patients (≥ 18 years) with an isolated closed femur shaft fracture	81.5 %	Mean age (IMN): 38 years (19-94) Mean age (traction): 41 years (22-86)	Road traffic accidents (72.3 %) followed by falls (20 %)
Chokotho, 2020 [14]	QECH, Beit Cure, KCH; and 3 district hospitals (Chiradzulu, Thyolo, and Chikwawa)	185 adult patients (>18 years) with isolated femoral shaft fracture	80.5 %	Mean age (IMN): 38 years Mean age (traction): 40 years	Road traffic accidents (52 %), followed by falls (34 %)
Mlinda, 2021 [15]	Nkhotakota District Hospital	182 patients aged 3-15 years old with closed supracondylar humeral fractures	53.9 %	Mean age: 7 years	Falls (83 %) followed by sports injury (15.35 %)
Mlinda, 2021 [16]	Nkhotakota District Hospital	149 children aged 14 years or younger with femoral shaft fractures	66.0 %	Mean age (Gallows traction): 10 months. Mean age (Bucks skin traction): 5.2 years	Falls (69.7 %) followed by road traffic accidents (9.4 %)
Schade, 2021 [17]	QECH, Blantyre and KCH, Lilongwe; Mangochi district hospital and Nkhata Bay district hospital	23,734 patients with a fracture	69.4 %	Median age: 15 years (IQR = 10-35 years)	Falls (66.6 %) followed by road traffic accidents (17.6 %)
Mwafulirwa, 2022 [18]	QECH, Blantyre	60 patients with open tibia fractures	81.2 %	The median age: 36 years.	Road traffic accidents (63.3 %) followed by assault (18.3 %)

Only four studies reported a measure of injury severity for fractures, three of which used the Gustilo and Anderson scoring system for open fractures [29,33,39], and one used the Orthopaedic Trauma Association scoring system for open fractures [36]. Heterogeneity in the sampling methodology across these studies limits narrative summary of findings. Only one study reported on whether fracture patients were single or poly-trauma: in a population of 137 femoral fracture patients treated with intramedullary nailing (IMN), 25 % were poly-trauma patients [33].

Burden of LBF

Five studies provided evidence to understand the prevalence and/or incidence of fresh fractures and fracture malunions in Malawi [13, 43-46]. A 2016 nationwide household survey estimated that 0.5 % of the population are living with a fracture malunion or non-union [43].

Among children, 2.7 % of the surveyed population were living with a limb fracture [45], with an estimated 17,000 children in the country living with a fracture malunion or non-union [44]. A 2018 survey estimated the prevalence of adult femoral shaft fractures presenting to public hospitals to be 1.38 per 100,000 people, with an estimated incidence of 0.51 per 100,000 persons-week [13]. Authors of this study suggested that 2,400 new patients with femoral shaft fractures could be receiving inpatient care at any given time in Malawi with as many as 70 new patients each week [13].

Seventeen out of 55 studies analysed trauma registry data to describe the contribution of fracture to the burden of trauma cases presenting to hospitals in Malawi [35,47-62]. These studies revealed that fractures were generally the second most common type of traumatic injuries, after soft tissue trauma, representing anywhere between 5 % and 35 % of injuries, depending on the study population (Table 2).

Table 2

Summary of evidence describing the contribution of fracture to the burden of trauma in Malawi.

Study	Health facility	Time period	Patient population	Proportion of cases with fracture
Nga' mbi 2005 [19]	Queen Elizabeth Central Hospital (QECH), Blantyre	1 st to 30 th September, 2003	Children (age 0 to 14) with trauma admitted to QECH	The most common injury was limb fractures (44.9 %).
Samuel 2009 [20]	Kamuzu Central Hospital (KCH), Lilongwe	February to June 2008	Injured individuals admitted to KCH from casualty, and those who died or were brought in dead to casualty	Fractures were the third most common form of injury (14.3 %) after abrasions and lacerations
Kiser 2012 [21]	KCH, Lilongwe	July 2008 to December 2010	Children (0–16 years) with an injury and presented to the emergency department	21.7 % of all paediatric trauma cases involved a fracture, second most common type after contusion
Chokocho 2014 [22]	Dedza, Mangochi, Nkhata Bay, and Thyolo district hospitals	1 st January to 31 st December 2012	All patients with a trauma presented to the four district hospitals	Fractures were the second most common form of trauma (23.1 %) after soft tissue injuries.
Gallaher 2016a [23]	KCH, Lilongwe	January 2009 to December 2013	Adults (>18 years) with an injury presenting to KCH	Fractures were the second most common form of trauma after soft tissue injuries and were more common in the elderly population than in younger age groups (35.2 % of cases were fractures in patients 65 years and over compared to 10.6 % in 18–44 year olds and 21.3 % in 45–64 year olds).
Gallaher 2016b [24]	KCH, Lilongwe	January 2009 to December 2013	All paediatric patients (<18 years) who presented to the emergency department with traumatic physical injuries	Fractures were the second most common primary injury (after soft tissue injury) in both intentional and unintentional trauma cases, accounting for 5.5 % and 23.7 % of injuries respectively.
Jaffry 2017 [25]	Mulanje District Hospital	14 th April 2013 to 30 th	All patients presenting to the hospital	Fractures were the second most common

Table 2 (continued)

Study	Health facility	Time period	Patient population	Proportion of cases with fracture
		December 2014	with trauma (physical injury for the first time)	form of trauma (27.9 %) after soft tissue injuries.
Chagomerana 2017 [12]	KCH, Lilongwe	October 2010 to September 2011	All patients admitted with lower extremity trauma	Femur fractures were the most common lower extremity injury (46.1 %) followed by tibia/fibula fracture (18.7 %)
Chokocho 2019 [26]	QECH, Blantyre	May 2013 to May 2015.	All patients reporting to QECH with trauma	Fractures/dislocations were the second most common form of trauma after soft tissue injuries, accounting for 13.6 % of all trauma cases.
Gallaher 2019 [27]	KCH, Lilongwe	January 2011 to December 2014	All patients who presented to the emergency department with traumatic injuries	Fractures were the second most common form of trauma after soft tissue injuries, accounting for 16 % of all trauma cases.
Maine 2020 [28]	KCH, Lilongwe	January 2012 to July 2017	Trauma patients referred to KCH from another facility	Fractures were the second most common form of trauma in patients transferred from another facility (35.7 %) after soft tissue injuries.
Gallaher 2020 [29]	KCH, Lilongwe	January 2012 to December 2016	All patients who presented to the emergency department with traumatic injuries	Fracture was the second most common injury type after soft tissue injury (16 %). 17.5 % of trauma cases presenting during the day time had fracture as the primary injury compared to 13.3 % of those presenting during the night time.
An 2021 [30]	KCH, Lilongwe	February 2008 to May 2018	All patients presenting to KCH involved in vehicular road injuries.	Fracture/dislocations/traumatic amputation was the most severe injury in 18.5 % of cases (the second most common after contusions/abrasions).

(continued on next page)

Table 2 (continued)

Study	Health facility	Time period	Patient population	Proportion of cases with fracture
				Fracture/dislocations/traumatic amputation was the most severe injury in 16.1 % of patients involved in a motorised vehicle accident compared to 23.7 % for non-motorised vehicle accidents.
Purcell 2021 [31]	KCH, Lilongwe	January 2011 to May 2018	All patients with road traffic injuries who presented directly from the scene of the injury	Fracture was the most common type of primary injury, accounting for 34.9 % of cases.
Williams 2021 [32]	KCH, Lilongwe	January 2011 to December 2017	All patients over 18 years old who presented to the emergency department with traumatic injuries	Fracture/dislocation were the second most common type of injury (15.6 %) after soft tissue injury. 42 % of elderly patients (>65 years) had fracture as the most severe injury compared to 14.8 % among the non-elderly population.
Chokotho 2022 [33]	2 central, 7 district, 1 community hospital	September 2018 to March 2020	Adults (over 15 years old) presenting to facilities with trauma	Fractures made up 27 % of all trauma patients (second most common type of injury of those presenting). The most common type of injury for hospitalised patients was fracture (35 %)
Gallaher 2022 [34]	KCH, Lilongwe	January 2011 to July 2021. (No data were collected in April or May 2020)	All patients with a trauma presented to KCH (excluding burns)	Fractures were the second most common form of trauma after soft tissue injuries, accounting for 17.4 % of all trauma cases. A statistically significant increase in the proportion of injuries due to fractures was seen during the

Table 2 (continued)

Study	Health facility	Time period	Patient population	Proportion of cases with fracture
				COVID-19 pandemic (17.1 % pre-pandemic compared to 20.4 % during the pandemic)

Consequences of LBF

Twenty-five studies reported on immediate treatment outcomes such as rates of union, infection, and length of hospital stay (LOS) [9,11,14,18,26,27,29–42,54,63–66]. Surgical treatment of LBF with IMN was consistently found to be superior to conservative management in terms of lower infection rate, lower risk of mal/non-union, and lower probability of re-operation [11,33,35,36,42,64,66]. The LOS following fracture treatment varied between 4.8–74 days depending on the type of bone involved, mode of treatment, and complications involved [9,31,33,35,37–39,42,67]. One study noted a significantly shorter LOS (from procedure to discharge) for femur shaft fractures treated surgically compared to treatment with skeletal traction (mean 17.38 vs. 45 days) [67]. HIV infection was not identified as a risk factor for infection, and delayed/ non-union [26,27,30,32,34,40] except in one small study [29].

In 9/55 studies, functional and social outcomes were examined [11,18,31,36–38,63,65,66]. One study stated that there were better functional outcomes (as measured through Short Musculoskeletal Function Assessment’s Dysfunction and Bothersome Indices) for patients receiving surgical compared to conservative management [36]. However, all studies noted fracture patients, even those managed surgically, experience limited return to everyday activities, reduced employment opportunities, high dependency on others for daily chores, and persistent pain.

In 8/55 studies, the economic consequences of LBF were reported [11,18,31,42,63,65,66,67]. Medical services in public facilities in Malawi are free at the point of care, however, prolonged hospitalisation often left patients cut off from income generating opportunities and pushed poor families further into poverty [11,18,31,65,66]. Job losses and reduced earning was reported to extend to family members, who were often required to stay in hospital providing care for the patient [65,66]. These consequences were described as particularly significant for patients receiving conservative treatment, which required long periods of immobilisation, and in some cases, hospital readmission for surgical management of bones that had not united after conservative management [11,65]. Economic evaluations found conservative treatment for femoral fractures to be more costly compared to surgery for both the health system (US\$678.02 to manage a case with skeletal traction vs. US\$596.97 for IMN) and households (US\$640 in expenses and lost earnings for patients undergoing skeletal traction vs. US\$480 for those managed with IMN) [42,67]. Other studies highlighted how long-term disability following LBF left patients and their families unable to generate income, enforcing dependency on others and impacting affordability of necessities such as food and school fees [18,63,66].

Impact of LBF on quality of life was less well studied, with only two papers reporting on quantitative quality of life metrics following these injuries. These studies demonstrated that femoral shaft fracture patients who received surgery had significantly better quality of life (as measured by the EQ-5D index) in the 12 months after the injury compared to those who were treated with skeletal traction [36,42].

Mortality associated with fracture was reported in 10 studies. In a large scale study a mortality rate of 0.2 % was reported [9], while mortality rates between 1–7 % were reported in other studies [14,30,33,35,50]. However, heterogeneity in the populations and interventions

explored in these studies would limit meta-analysis of these findings. Likewise, data on the pre-hospital or in-hospital trauma deaths associated with fractures were varied – ranging from 4.9 % to 21.1 % of trauma deaths involving a fracture [48,68–70].

Barriers to accessing healthcare

The three delays model was applied as a framework to analyse the evidence on the barriers to accessing healthcare for fractures in Malawi, where delays one and two represent care-seeking related (demand) barriers and delay three represents health system related (supply) barriers (Fig. 2).

Care seeking for LBF

Eighteen studies reported on the time between injury and the patient reaching a healthcare facility. i.e., the first and second delays [11,18,33,37,38,45,48,51,54–56,58,59,62,63,68,71]. Almost all the studies reported significant delay to patients reaching a health facility after their injury, ranging from a few hours to several days [11,37,38,51,54–56,58,59,62,68,71]. In studies by Mlinde and colleagues, there was a slightly higher rate of delayed presentation (>2 days) among children with lower limb fractures (femoral shaft fractures) compared to upper limb fractures (supracondylar humeral fractures): 14.8 % compared to 9 % [37,38]. However, these studies were not appropriately designed to draw conclusions about the relationship between fracture type and delayed presentation to care.

None of the studies clearly demonstrated whether delayed presentation to hospital was attributable to a delay in the decision to seek care (first delay) or the delay in reaching care after that decision has been made (second delay). The authors of two studies argued that a delay in recognising the need for immediate care after a fracture is rare due to visible deformity, acute pain, or critical condition of the patient [18,48]. The cost of transport was the most commonly reported barrier to seeking care (reported in three of the seven studies where reasons for delayed presentation were reported) [33,63,72]. Other factors reported to contribute to delayed presentation to hospital included fear or lack of trust in the health system [45], lack of time to seek care [45], the pain of trips to the hospital on foot [63], limited transportation options (particularly for injuries occurring over the weekend) [51,71], non-availability of a health facility [45], and interfacility transfers [18,32,71]. Only one study quantified the reasons for not seeking care – a nation-wide household survey of paediatric surgical conditions reported the most common reasons to be unavailability of facility/personnel and no time to seek care (17 and 12 respectively out of 50 children with a surgical condition for whom care was not sought) [45].

Health system capacity to manage LBF

The third delay represents a delay in patients receiving care after

they arrived at a health facility. The WHO’s health systems building blocks framework was used to assess this delay. Two studies, both from Kamuzu Central Hospital, point towards leadership and governance gaps contributing to suboptimal patient care [11,52]. The studies noted dissatisfaction among patients including allegations of favouritism and corruption in health service delivery. These studies identified lack of trauma care protocols, absence of interhospital communication and transfer guidelines as key governance issues resulting in over-triage and unnecessary referral of patients to central hospitals. In other studies, including a qualitative study and a health facility capacity assessment, issues with healthcare financing were highlighted, as most equipment used in fracture management relied on donation and two of the four central hospitals were entirely dependent on foreign funding for the supply of implants [66,73].

Limited supplies of medical products and technologies were noted in 11/55 studies [11,14,31,33,37,50,63,65,66,73,72]. In a survey conducted in all 25 district and four central hospitals, it was found that no hospital had all essential material supplies available to manage diaphyseal femoral fractures [73]. Central hospitals often faced shortages of traction pins, hand drills, anaesthesia equipment, Plaster-of-Paris, X-rays facility, antiseptic solution, bandages, linen, prosthetic material, anti-thrombotic and pain relief medication, in addition to intermittent water supply, and limited blood bank services [11,14,33,50,63,65,66,72]. Two studies from district hospitals also reported similar supply gaps such as non-availability of traction pins, tapes, fluoroscope, and plaster for splinting and casting [31,37].

Twelve studies highlighted the lack of and the need for up-to-date information and research to improve fracture care [24,31,33,37,38,56–59,65,66,74]. Studies identified gaps such as the lack of a national trauma registry, incomplete patient files, non-existent systems to retrieve patient records and X-rays, and lack of staff and institutional buy-in to facilitate data maintenance as barriers to understanding the true burden of injuries (including LBF). Similarly, the absence of protocols for post-treatment follow-up was reported as a barrier to understanding the extent of recovery or long-term disability among patients after discharge from the hospital [65,66]. Despite these gaps Malawi was identified as the only LMIC for which national guidelines on management of open extremity fractures was available [24,25].

Health workforce shortage and skills gaps in both district and central hospitals were discussed in 15/55 studies [9,11,14,18,31,36,37,43,52,58,65,66,72–74]. According to a 2021 study, there were only 14 orthopaedic surgeons (all based in urban central hospitals) and 107 Orthopaedic Clinical Officers (OCO) in Malawi [9]. OCOs based in district hospitals were mandated to provide conservative treatment for fractures but had fewer training opportunities, which often led to either unnecessary or delayed referral of patients to central hospitals [9,52,73]. Similar human resource constraints were observed in central hospitals, where there was a chronic shortage of trained surgeons, nurses, and

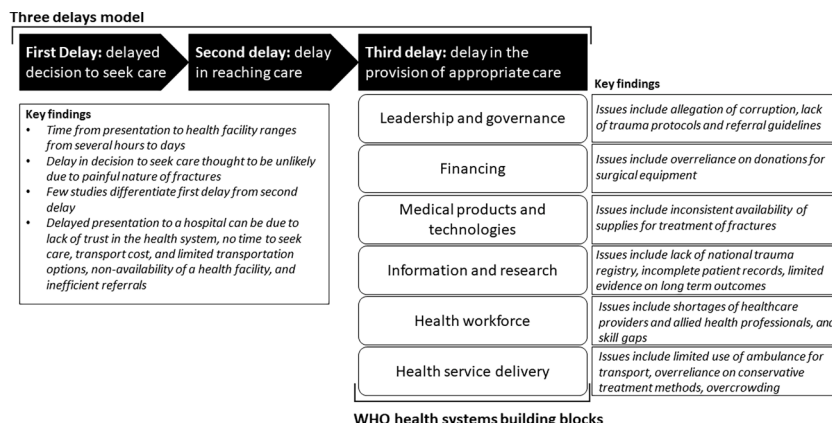


Fig. 2. Analytical framework and key findings on barriers to care for fractures.

anaesthetists [9,11,36,65,66,73]. Given the critical shortage of nurses (the nurse-to-patient ratio in two central hospitals was 1:70), most of the day-to-day nursing care was provided by family members [18,65]. In at least one central hospital there was an on-going training program for orthopaedic surgeons to better deliver orthopaedic services [14].

Gaps in service delivery leading to a sub-optimal health system response to fracture care were discussed in 37/55 papers [9,11,13,14,18,25,31–39,48,50–56,58–63,65–74]. These service delivery gaps begin with pre-hospital trauma systems, which were noted in several studies to be deficient. Out of the 15 studies reporting on mode of transport used by patients presenting to hospital, 13 noted that it was rare for trauma patients to arrive at hospital in an ambulance, with the majority of the patients using private or public transport, such as bicycle or minibus [48,50,51,53–56,58–61,68–70]. Ambulances transferring patients between district and central hospitals reportedly waited until they had an adequate number of patients to transport, resulting in delays to the provision of care and high morbidity and mortality among critically injured patients [18]. In both district and central hospitals, fractures were typically managed conservatively while surgical treatment was reserved for complicated cases or where conservative management had failed already. As noted in one study conducted in two central and two district hospitals, only 15 % of the proximal femoral fractures received surgery as initial management, compared to 85 % treated surgically in high income countries [9]. Other service delivery gaps included non-existent prehospital trauma care system, non-availability of orthopaedic outpatient services over the weekends, ineffective communication between healthcare facilities, limited role of rehabilitative services in fracture care, and overcrowding and unhygienic conditions of inpatient wards [52,65,66,68,70,71,74]. Delays in receiving either conservative or surgical care were also noted. In a study conducted in three central and three district hospitals, the mean waiting time from injury to receiving IMN was 13 days whereas it was 4.4 days for skeletal traction [36]. Factors contributing to a delay in receiving surgical care also included limited availability of implants, surgical personnel, and theatre space [14,50,67].

Discussion

Fractures in general, and LBF in particular, comprise a significant proportion of the burden of traumatic injuries in Malawi. These injuries most often occur in younger age groups and in males – an epidemiologic profile with significant implications for the economic stability of the households affected and of the country, given the heavy reliance of Malawi's economy on agriculture and manual labour [6]. There is no national trauma registry in Malawi. Hence, the evidence presented in this paper on the burden of fracture is predominantly drawn from reviews of donor-funded trauma registries at central (tertiary) hospitals, with the exception of some district hospital registries. These tertiary hospitals are located in urban areas, while a substantial population of Malawi lives in rural areas. The location of these central hospitals, coupled with considerable financial and geographic barriers for rural populations, may hinder many from accessing care, leaving them uncounted in hospital registries. All these challenges make it difficult to gauge the actual burden of LBF in Malawi accurately. There is also a paucity of evidence to enable a full understanding, particularly of the longer-term impacts of poorly healed fractures on individuals, households or on the national economy.

Beyond understanding the epidemiology of LBF, this review also explored the barriers patients face in seeking, reaching and receiving appropriate care using the three delays model. The first delay related to decision-making to seek care after an injury was the least studied topic in the literature reviewed. Several studies, on the other hand, examined barriers leading to the second delay i.e., the delay in reaching a health facility capable of providing the necessary treatment. The noted barriers, such as the non-availability of a health facility, not having enough finances to travel, limited transportation options, including limited

ambulance service, and poor road infrastructure, have also been identified in literature from other LMICs [4,23].

Compared to the first and second delay, a higher number of studies have investigated factors related to the third delay, which refers to the gaps in the health system response to fractures. We applied the WHO's health systems building blocks framework to methodically analyse the third delay. The findings showed that while several good practices exist, such as free health services at the point of care and the availability of surgical treatment in central hospitals, there remain gaps and potential for improvement across all six building blocks.

Gaps in leadership and governance have resulted in various challenges, including allegations of corruption and the lack of standard operating procedures, among others. Such deficiencies have not only undermined public trust but also adversely impact the other five building blocks. Persistent local financial constraints, coupled with heavy reliance on donor funding that prioritises central hospitals, have limited the surgical capacity of lower tiers of the health system. Similarly, robust health management and information systems are yet to be established in the country. The limitations in these three upstream building blocks are likely to contribute to the reported shortages and maldistribution of medical products and health workforce and associated inconsistencies in health service delivery such as shortages and maldistribution of skilled healthcare workers, overreliance on conservative management of LBF even when not indicated, and unwarranted referral to higher level health facilities.

The ultimate price paid for these health system weaknesses was by the patients themselves, who often lacked timely access to surgical care – the 'gold standard' for managing many LBFs and a Bellwether procedure representing the performance of a country's ability to provide essential surgical services. These gaps have far-reaching implications for individuals and communities, encompassing physical, social, economic, and functional consequences and call for the urgent attention of health system leadership in Malawi.

To optimise health system response, it is crucial for the country to first understand the full scope of the burden of LBF. Hospital registries offer valuable insights, yet they are limited to facility-level data and challenges. In contrast, structured systems such as national trauma registries, when functioning properly, have a broader reach. They can be instrumental in assessing the national burden of injuries such as LBF, thereby paving ways for targeted and strategic planning related to trauma prevention, treatment, and rehabilitation. Our findings also revealed that the literature available on the first delay is limited. While the severe pain and debilitating effects of a fracture may make recognition of the need for medical care obvious, it is important to conduct further research to gain insights into factors that influence decision-making around care-seeking for traumatic injuries in Malawi. This research is necessary to enhance our understanding of the local context surrounding seeking medical care for fractures and inform strategies designed to reduce delayed access to care. Similarly, the barriers related to accessing a health facility call for an interconnected economic and social development agenda to support equitable access to healthcare services [75].

Fractures in Malawi are primarily caused by falls and road traffic accidents. However, data on the mechanisms of injury, such as the causes of falls or the locations (rural or urban areas), are limited. There is a need for more studies to understand the epidemiology of falls in Malawi to inform preventative interventions that are likely to reduce the incidence of falls and the burden of fall-related fractures. The government of Malawi has acknowledged the significant burden of road traffic injuries in the country and reaffirmed its commitment to addressing the issue as they draft the new National Action Plan for safer roads by 2030 [76]. This will require a well-resourced, multi-sectoral approach, with close collaboration between the Ministries of Transport, Health and Finance towards the prevention and treatment of road traffic injuries. Given the significant resource constraints, the support of development partners will continue to be critical to help finance action on road safety.

Nonetheless, heavy reliance on external funding poses a risk to the long-term sustainability of any intervention [77]. To mitigate this risk, enhancing local ownership is crucial, and this can be achieved by involving local stakeholders in decision-making processes at every level of the health system. There is also a need to generate local resources to support the health system's response (to fracture care), which would pave the way for a more self-reliant and resilient system. Establishing financial and non-financial incentives for trained healthcare providers is also important to ensure that skills and knowledge remain within the country even when external funding diminishes [78,79]. Another key consideration for the government of Malawi's existing plans for the construction of trauma centres along the country's major highway should be to involve establishing robust data collection mechanisms and integrating hospital registries into these routine data collection processes across all healthcare institutions [80].

Finally, it is imperative to realise that LBF management is only one component of patient care under the umbrella of the overall health system. Addressing and investing solely in LBF care while ignoring the systematic challenges of the broader health system may prove to be an inefficient approach. Instead, a holistic approach that aims to strengthen the entirety of the health system should be the ultimate goal for any country.

To the best of our knowledge, this is the first review to encompass both the burden of fractures and a health system's capacity to manage these injuries within a single country setting. This review provides a comprehensive depiction of the need to strengthen surgical care capacity in Malawi, building upon the aims of the Lancet Commission on Global Surgery to bring attention to the importance of surgical care. A limitation to note is the absence of a quality appraisal for the studies included in this review. The heterogeneity in the populations and interventions explored in the studies included limit the potential for a meta-analysis of the findings. Furthermore, we did not explore the grey literature on this subject. The insights from this review may not be directly transferable. However, the health system gaps highlighted in this review are likely to broadly apply to other health conditions in Malawi as well as to other LMICs with similar health system contexts.

Conclusion

This narrative review highlights the significant burden of fractures in Malawi. These injuries mainly affect young age groups and males and are, therefore, likely to have significant consequences for household income security and national economic growth. The limited availability of accurate data on the burden of fracture poses a major obstacle to the design and evaluation of an effective health system response. Prioritising the integration of registries into routine data collection processes across all healthcare institutions is therefore crucial. Likewise, strengthening the health system to better respond to the burden of fractures and other traumatic injuries is important for Malawi. There is also a pressing need to prioritise research efforts to understand the factors influencing care-seeking behaviours in the local context.

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Declaration of Competing Interest

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Supplementary materials

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