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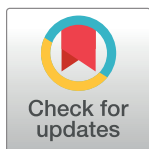
RESEARCH ARTICLE

Orthopaedic and trauma research in Tanzania: A scoping review

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Abstract

Tanzania is disproportionately burdened by musculoskeletal injuries as it faces unique challenges when dealing with trauma care. This scoping review aims to summarize and assess the current state of orthopaedic and trauma research in Tanzania. By identifying key themes, trends, and gaps in the literature, this review seeks to guide future research initiatives catered specifically to the needs of Tanzania's healthcare system. Utilizing the PRISMA-ScR protocol, OVID Medline, PubMed, and CINAHL databases were searched from inception to June 17, 2023, using keywords such as "Orthopaedics" "Trauma" and "Tanzania". One hundred and ninety-two eligible studies were included and the Arksey and O'Malley framework for scoping studies was followed. There was a notable growth of relevant publications from 2015 onward, with peaks in growth in the years 2019, 2021, and 2020. The studies employed diverse research methodologies, with cross-sectional ($n = 41$, 21%) and prospective studies ($n = 39$, 20%) being the most prevalent, and randomized-controlled trials being the least prevalent methodology, making up eight studies (4.2%). The most common study themes were trauma ($n = 101$, 52.6%), lower extremity ($n = 31$, 16%), and spine-related issues ($n = 27$, 14%). Only three studies looked at work-related injuries (1.6%). Road traffic injuries (RTIs) were the most common mechanism of trauma in 77.0% of the trauma focused studies. Fifty-three percent of the studies were conducted by a majority of Tanzanian authors. This scoping review highlights various trends in orthopaedic and trauma research in Tanzania, with a particular emphasis on road traffic-related injuries. Various gaps are explored, including a lack of research on work-related injuries and a paucity of experimental research. Our findings underline areas where future research is warranted. The future of orthopaedic and trauma care in Tanzania depends on the efforts and collaboration of both local and international stakeholders.

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Introduction

Injuries make up 9% of global deaths, with 90% occurring in low and middle-income countries (LMIC) [1]. Alongside other developing countries, Tanzania faces unique challenges when dealing with orthopaedic and trauma care [2].

With a rapidly growing population and increased economic development, orthopaedic injuries continue to rise markedly, mainly due to road traffic injuries (RTI). In a one-day survey conducted in Tanzania, nearly half of all trauma cases were attributed to RTIs [3]. While the need for orthopaedic care is on the rise, there is a lack of available orthopaedic services and an insufficient number of adequately trained healthcare professionals in the field [4]. Limited access to surgical equipment and inadequate infrastructure for the volume of required care [5] renders orthopaedic and trauma management a significant strain on the country of Tanzania.

Multiple reports have highlighted the need for local healthcare research to improve health outcomes in developing countries [6, 7]. Furthermore, local research in developing countries has been shown to be of utmost importance in contributing to infrastructural growth [8–10]. In Tanzania, the significance of generating robust local research becomes particularly pronounced due to persistent obstacles in the provision of adequate trauma care [11, 12].

By employing a scoping review approach, this study aims to comprehensively survey and synthesize the existing orthopaedic and trauma literature within the context of Tanzania. This methodology facilitates the examination of a wide spectrum of literature by date of publication, research methodologies employed, and overarching themes addressed. This thorough assessment provides a comprehensive summary of the existing literature, as well as a foundational platform for future research endeavors. Moreover, this review seeks to align its findings with the unique requirements of Tanzania's healthcare system, enhancing its capacity to contribute meaningfully to the advancement of orthopaedic and trauma care in the region.

Methods

A scoping review was chosen due to the breadth of the research topic and the expected variation in study design, and was conducted using the Arksey and O'Malley framework [13].

Identification of the research question

Our research question was, "What is the current state of orthopaedic and trauma literature in Tanzania, and where should future research be directed?"

Protocol

The preferred reporting items for systematic reviews and meta-analyses extension for scoping reviews (PRISMA-ScR) protocol was used to present the study methodology and findings (S1 Checklist) [14].

Identification of the relevant studies

The authors executed a search using the following databases: OVID Medline, PubMed, and CINAHL using controlled vocabulary (e.g. MeSH) and keywords representing the topics "Orthopaedics", "Trauma" and "Tanzania".

Databases were searched from inception to June 17, 2023. With the goal of capturing the entirety of the relevant existing literature, no limits were applied. Results (n = 1573) were exported to Rayyan citation management system [15]. A detailed search strategy is available in S1 File.

Study selection

Two co-authors independently screened titles and abstracts of identified papers. After full-text screening by each reviewer, papers were categorized into retrospective cohort, prospective cohort, cross-sectional studies, case studies and reviews, randomized controlled trials, and

other research (for e.g., cost analysis, discussion, mixed-method). Full-text extraction was then carried out using a data extraction sheet developed for the purpose of this study. Each author verified that the papers met the inclusion criteria and focused on the topic of interest. Discrepancies in reviewers' decisions were resolved through discussion.

Inclusion and exclusion criteria

Studies met the inclusion criteria if they met the following criteria: (1) Study focused on orthopaedic conditions or injuries suffered from trauma, and (2) Study reported findings from a Tanzanian population.

Data charting

The same two co-authors independently reviewed each paper, discussed charted data, and updated a password protected Google Sheets [16] datasheet accordingly. Information extracted from the selected studies was organized and categorized as follows: authors and publication date, study type, study topic, and study context. Studies pertaining to trauma were further categorized by mechanism of injury from RTIs, falls, and violence, where the percentage of patients from each category was documented. Additionally, the country of origin pertaining to authorship was charted.

Collating and summarizing findings

A thematic data synthesis was performed to identify the state of orthopaedic literature in Tanzania. The synthesis includes useful information on past research focus, existing gaps, and suggested future initiatives.

Due to the heterogeneity of study designs and outcomes, a narrative summary of results is presented.

Results

Search results

A preliminary search of scientific databases yielded a total of 1,573 studies. After removing the duplicates ($n = 700$), titles and abstracts of 873 studies were screened. This process excluded an additional 658 studies, leaving a sample of 215 studies. Screening of full texts yielded a total sample of 192 studies eligible for this review. A complete PRISMA study flow diagram is shown in Fig 1.

Distribution of studies by year

There were no limits placed on the dates of studies included, as this scoping review aimed to capture all the relevant literature on orthopaedics and trauma in Tanzania. As a result, several decades of research were examined, dating back to 1966. Since then, the body of research grew sporadically, with the early 2000s showing a relatively steady increase. From 2015 onwards, there was a significant increase in published studies in this field. The years 2019, 2021, and 2020 marked the peaks in the literature, during which 23, 21, and 20 studies were published, respectively. In 2022, there were 16 studies, and in 2023, there have been 9 studies to date (Fig 2).

Research methodology

The scoping review examination of orthopaedic research and trauma care in Tanzania yielded diverse research methodologies that represented the multifaceted field of inquiry. The studies

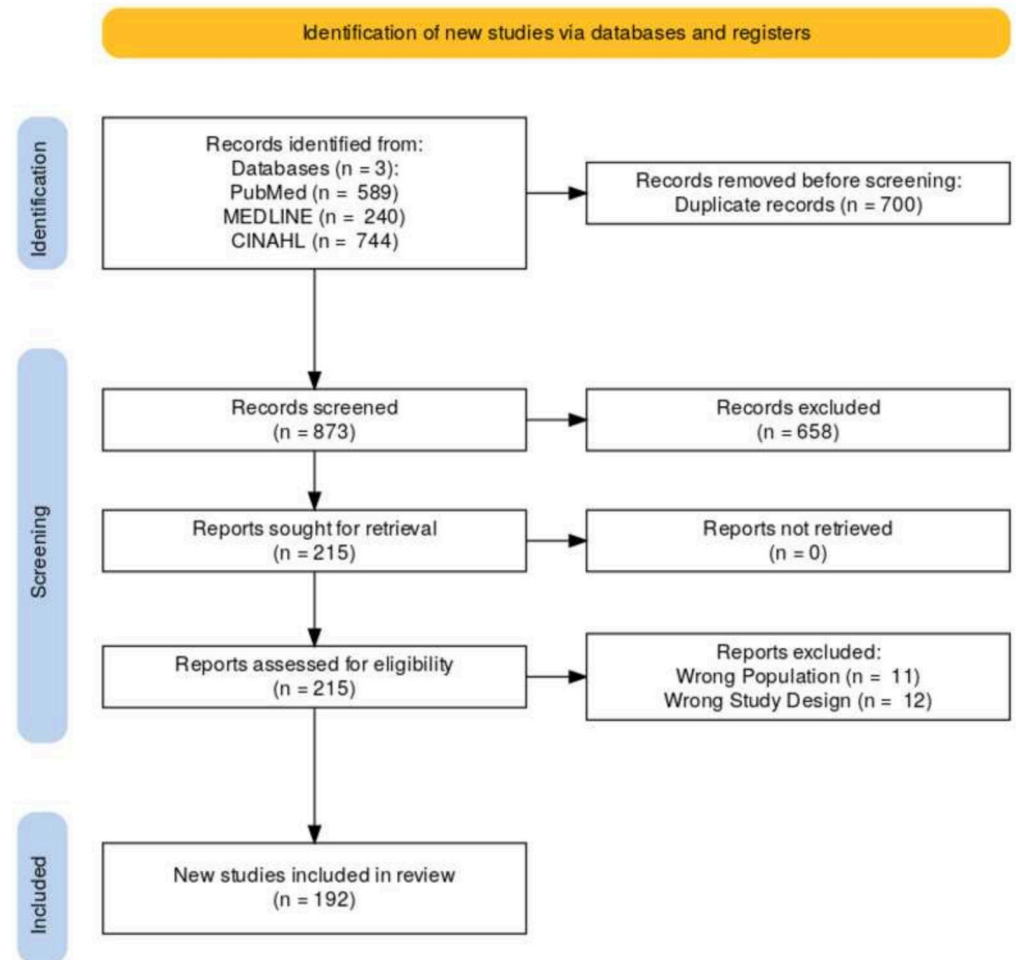


Fig 1. PRISMA flow chart.

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were primarily categorized as follows: retrospective cohort studies (14), cross-sectional studies (41), prospective studies (39), case studies (24), retrospective reviews (34), case series (9) and randomized controlled trials (8). Twenty-six studies fell in the category of other research: cost analysis (5), survey (4), qualitative (4), discussion (3), descriptive (3), mixed-method (3), modelling (1). A breakdown of study methodology is shown in [Table 1](#). This diversity in study methodologies presents opportunities and challenges when reviewing the data to guide future research in Tanzania.

Thematic analysis

Various themes were identified which highlighted the existing breadth of research in the field and identified areas where research is lacking. There were 101 trauma-specific studies, which included a focus on RTIs, falls, violence, and other trauma. Fifty-six studies focused on fractures. Overall, 31 studies looked specifically at the lower extremity and seven focused on the upper extremity. Twenty-seven studies addressed spine-related issues, and 27 studies examined a pediatric population. Fifteen studies discussed infections, eight discussed genetic

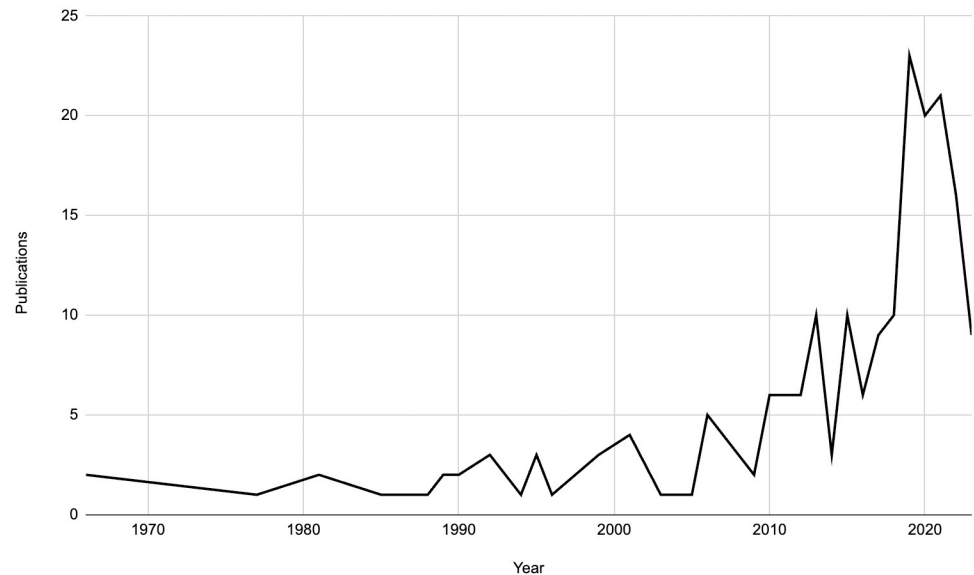


Fig 2. Publications per year.

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conditions, and four discussed cancer. Finally, seven studies addressed health economics, and seven addressed public health. These results are depicted in [Table 2](#).

Trauma specific studies

Of the 101 trauma related studies, 61 (60.3%) further explored injury mechanisms in cohorts involving multiple admission causes (RTI, falls, violence, etc.). Of these studies, the most common cause of trauma were RTIs (77.0%), followed by falls (18.0%) and violence (4.92%). Almost 97% of trauma-focused studies included patients injured in RTI, 74.2% included patients injured from falls, and 50% included patients injured because of violence ([Table 3](#)).

Randomized controlled trials analysis

Of the eight studies classified in the category of RCT, there were four unique trials, one of which is in progress. There were five studies that reported results from RCTs [[17](#), [18](#), [22–24](#)], two RCT protocols [[19](#), [20](#)], and one pilot study [[21](#)]. Four of the eight studies focused on infection prevention [[17–20](#)]. In 1989, Museru, Kumar, and Ickler compared isotonic saline,

Table 1. Study types.

Study Type	Count (%)
Cross-Sectional	41 (21.4%)
Prospective	39 (20.3%)
Retrospective Reviews	34 (17.7%)
Case Studies	24 (12.5%)
Retrospective Cohort	14 (7.3%)
Case Series	9 (4.7%)
RCTs	8 (4.2%)
Other	23 (12.0%)

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Table 2. Study themes.

Themes	Count (%)
Trauma	101 (52.6%)
Fractures	56 (29.1%)
Lower Extremity	31 (16.1%)
Pediatrics	27 (14%)
Spine	27 (14%)
Infection	15 (7.8%)
Genetic	8 (4.2%)
Upper Extremity	7 (3.6%)
Health Econ	7 (3.6%)
Public Health	7 (3.6%)
Cancer	4 (2.1%)
Work-Related Injuries	3 (1.6%)

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Table 3. Trauma-focused studies' most common cause of injury.

Mechanism of Trauma	Most Common Cause (%)
Road Traffic Injuries	47 (77%)
Falls	11 (18%)
Violence	3 (4.92%)

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distilled water, and boiled water in irrigation of open fractures, and found no difference in outcomes [17]. In 2015, Marwa et al. examined the use of cefepime versus ceftriaxone prophylaxis in elective orthopaedic procedures and found no significant difference [18]. Two protocols were published with reference to the Go-Tibia trial, which aims to be completed by 2028 [19, 20]. This trial is a masked randomized control trial assessing the rate of infection after gentamicin or saline administration in patients with open tibia fractures. The other four included RCTs related to a prospective trial comparing intramedullary nailing versus external fixation in the treatment of open tibial fractures [21–24]. The pilot study was published in 2018 [21], which was followed by a cost effectiveness analysis in 2019 [22], which revealed that intramedullary nailing was more cost effective and had better union rates at three months follow-up. The following publication at a one-year follow-up showed no difference in primary events, however found that intramedullary nailing yielded better coronal alignment [23]. A three to five year follow up of this cohort revealed that 25% of patients suffered chronic fracture-related infection and non-union, regardless of reintervention [24].

Work related injuries

There were three studies focusing specifically on work-related injuries. In 2010, Kishashu et al. surveyed 1385 patients with injuries from 2007 to 2008 and found that 638 (46%) were work related [25]. In 2013, Boniface et al. examined 248 miners suffering WRI from 2009 to 2012 and found that 98.7% of workers did not use protective gear and worked over 12 hours daily. Falling rocks were the leading cause of injury, and in total 41.3% of these patients died [26]. In 2021, Shewiyo et al. performed a retrospective review of 4578 claims to the Workers Compensatory Fund in Tanzania from 2016 to 2019. They concluded that motor accidents, machine faults, and falls were the most common causes of WRI. They also reported the odds of a work-related fatalities increased greater than 6-fold in injuries occurring during conveyance [27].

Country of origin

Of the 192 studies included, 91% had Tanzanian authors and 53% had a majority of Tanzanian authors. Of the studies with a majority of out-of-country authors, 55% of these studies had a majority of authors from the United States. Further, the USA was the most represented country after Tanzania, with 40% of all included studies including an American author. Africa was the most represented continent (54%), followed by North America (26%) and Europe (10.4%).

Discussion

This scoping review outlines the evolution of orthopaedic trauma care in Tanzania, as reflected in the distribution of studies spanning several decades. The growth in orthopaedic and trauma research in Tanzania since 1966 is noteworthy as it represents shifts in scientific, societal, and health policy interests. The early years of research were marked by subtle and inconsistent growth, indicating the lower priority of trauma care in Tanzania. This is likely because infectious diseases such as HIV/AIDS, malaria, and tuberculosis had posed a more imminent threat to public health [28]. In particular, the last decade marked a significant period of growth for orthopaedic and trauma research. This may be attributed to increased awareness and international collaboration among world experts [29, 30].

Road traffic injuries

The predominant focus on RTIs among trauma cases reveals the substantial burden created by these injuries. The increased incidence of RTIs is likely a result of the exponential proliferation of roads, which led to underdeveloped and unsafe driving conditions [31, 32]. Roughly 10% of the roads in Tanzania are paved [33]. The increase in RTIs is multi-factorial and has increased due to more motorized vehicle use (e.g., cheaper foreign motorcycles from China and India) in conjunction with a lack of proper infrastructure (e.g., lack of sidewalks, lights on roads, road quality) and inadequate safety measures (e.g., seatbelt and helmet laws, traffic lights, stop signs) [34–36]. In 2011, the World Health Organization (WHO) and the World Bank launched a Decade of Action for Road Safety with the goal of cutting RTIs and deaths in half [37]. However, minimal progress has been made in LMICs [38], underscoring the need for further preventative initiatives.

Addressing road safety remains of utmost importance for the Tanzanian population. Ahmed et al. (2013) report that raising awareness of RTIs is integral in low-income countries [39]. They recommend increasing public awareness, road safety infrastructure, and traffic rules as the most effective means for reducing traffic accidents [39]. Thus, further research on the outcomes of these initiatives, and the formulation of health policy specific to the Tanzanian population, will be vital in minimizing the burden of RTIs.

In addition to raising awareness, future research should focus on rehabilitation and post-operative management of trauma patients, as this theme was seldom examined in the literature. By optimizing rehabilitation, patients will be better able to return to their livelihood, support their families, and contribute to the country's economic growth, benefiting all shareholders [40].

Economic impact of injury

The financial implications of injuries remain a prevalent concern in Tanzania. On average, 52% of a citizen's total health expenditure is out-of-pocket [41]. Over a one-month period, 75% of Tanzanians surveyed in the Kilimanjaro Christian Medical Center orthopaedic ward reported that their healthcare expenditure cost more than their monthly income, and roughly

40% of these patients reported losing their job due to their disability after their injury [42]. With nearly 26 million people in Tanzania living in extreme poverty (below 1.90 U.S. dollars a day) [43], the cost of health care augments the economic strain on trauma victims.

In addition to improving infrastructure and raising awareness, addressing work-related injuries (WRI) will help alleviate the overall trauma burden. When appropriate measures are put into place, WRIs are often preventable [44]. Such measures include safe working environments, appropriate protective equipment, appropriate training, and rehabilitation initiatives [45]. Poor workplace conditions place an economic and health burden on society [45, 46]. The International Labour Organization (ILO) estimates that approximately 4% of the world's gross domestic product is lost due to WRIs, and low-income countries are particularly affected [47, 48]. In 2015, it was estimated that, in the Southern Africa region alone, 18,000 workers died from work-related accidents [49]. In Tanzania, WRI remains an unaddressed epidemic. This scoping review found a scarcity of research specifically related to WRI, with only three studies focusing on this topic. Although many of the trauma studies included patients who were injured at work, there is little research on interventions and initiatives focused on reducing injuries in the workplace.

Sustainability

Under conservative assumptions, over 90% of the Northern Tanzania population cannot access orthopaedic surgical services [50]. Tanzania has an estimated 118 orthopaedic surgeons for a population of over 60 million [51], which equates to one orthopaedic surgeon for every 508,000 citizens. In stark contrast, this ratio in America is one orthopaedic surgeon for every 10.8 thousand citizens [52].

In recent years, there has been increased enthusiasm for medical missions to developing countries as initiatives such as Doctors without Borders continue to expand [53–55]. As international orthopaedic surgeons volunteer in Africa on medical missions, addressing the long-term sequelae of their work is vital. These mission trips often involve completing many surgeries quickly, introducing new equipment and thus, potentially new complications, which further increase the burden on the local healthcare system [30, 56]. For a more sustainable future of care, global collaboration is critical to develop adequate infrastructure for continuous orthopaedic management in Tanzania [30, 57, 58].

Future research

Given that developing countries constitute the majority of the global population [59], conducting research tailored to these populations is imperative. As delineated by the 10/90 phenomenon, only 10% of worldwide resources are devoted to the population which suffers 90% of the burden [60]. This scoping review found eight studies pertaining to randomized controlled trials, with four being unique trials. This scarcity highlights the need for further research into the population-specific determinants of health in Tanzania. In their systematic review of orthopaedic global outreach efforts, Nolte et al. concluded that orthopaedic outreach initiatives in LMICs are cost-effective and direct funding is needed to ameliorate global orthopaedic health [61]. Of the ten studies on surgical mission trips to Africa included in their review [61], none were in Tanzania, further highlighting the need for research in this specific population.

It is well-accepted that randomized clinical trials are the gold standard for assessing causal relationships in research [62]. However, this research methodology is often expensive and time-consuming [63]. In developing countries, various barriers exist to conducting high-quality research [64], such as lack of suitable research infrastructure, deficiency in policymakers understanding of the importance of research, and absence of research materials [65–67].

Historically, research in Tanzania has not been focused on the context-specific structural determinants of health and inequities, which warrants wider implementation of local investigator-initiated trials [64, 67]. Further initiatives should focus on interdisciplinary collaboration in creating appropriate research infrastructure to better suit randomized controlled trials. As more experimental research is done in Tanzania, the management of orthopaedic conditions will be better understood to ultimately improve patient outcomes.

Most of the studies included were conducted by Tanzanian authors. Nevertheless, addressing orthopaedic and trauma care in other LMICs remains a global health priority. In LMICs, RTIs remains a significant health burden, due to similar factors discussed in this review [1]. Longitudinal partnerships and research that reflect the interests and goals of local populations in other LMICs are needed to further explore this topic, and ultimately improve global health outcomes [6–10].

Strengths and limitations

The major strength of this scoping review is its comprehensive overview of the literature. By including studies dating back to 1966, this review encapsulates the wide range of methodologies, focuses, and themes in orthopaedic and trauma research in Tanzania. This breadth of included studies allowed for a thorough review of trends and gaps in the literature, highlighting areas where future research is warranted. The main limitations are the lack of ability to perform a meta-analysis and lack of study quality (risk of bias) assessment.

Conclusion

The escalating orthopaedic and trauma crisis in Tanzania demands immediate attention and international intervention to mitigate the country's massive health and economic burden. This scoping review offers a comprehensive analysis of orthopaedic and trauma research conducted in Tanzania from 1966 to 2023. Our findings highlight the prevalence of RTIs as a significant cause of injuries, emphasizing the pressing need for more effective interventions and health policies to reduce this burden. The notable scarcity of research on WRIs and randomized controlled trials indicates a significant gap in the existing literature, highlighting the need for high-quality research in these areas in Tanzania. A commitment to implementing sustainable orthopaedic and trauma care should be a local and global priority. This scoping review aims to catalyze further research endeavors and outreach initiatives in Tanzania's orthopaedic and trauma sectors.

Supporting information

S1 Checklist. PRISMA-ScR checklist.

(PDF)

S1 File. Search strategy.

(PDF)

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Conceptualization: Benjamin Blackman, Neil P. Sheth.

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Formal analysis: Benjamin Blackman, Sarah Barnett, Ajay Premkumar.

Investigation: Benjamin Blackman, Sarah Barnett.

Methodology: Benjamin Blackman, Sarah Barnett, Neil P. Sheth.

Project administration: Ajay Premkumar, Neil P. Sheth.

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Validation: Ajay Premkumar, Neil P. Sheth.

Visualization: Benjamin Blackman, Neil P. Sheth.

Writing – original draft: Benjamin Blackman.

Writing – review & editing: Benjamin Blackman, Sarah Barnett, Ajay Premkumar, Neil P. Sheth.

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