



Challenges in orthopaedic data collection in Gaza Strip: observational findings and bibliometric analysis

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Abstract

Purpose The aim is to showcase the urgent need for improved data infrastructure and international collaboration by highlighting the barriers to comprehensive orthopaedic documentation and quantifying the scope and nature of scholarly research on Gaza's healthcare crisis.

Methods Data was collected through integration of observational field notes, informal interviews, patient record reviews and a bibliometric analysis of peer-reviewed articles on the 2023–2025 armed escalations in Gaza.

Results The review of patient documentation during surgical missions in Gaza revealed significant gaps in critical clinical information, including surgical history, microbiology data, and postoperative instructions, which hindered patient care. Frequent damage to records due to resource shortages and bombardments, along with issues in retrieving imaging data, further exacerbated these challenges. Bibliometric analysis showed that most studies were retrospective, focusing on trauma care and limb salvage, reflecting the difficulty of conducting prospective research in a conflict zone. Of the 114 publications reviewed, only three (2.6%) met inclusion criteria, with two of them involving Gaza-based Palestinian authors, despite barriers like power outages, limited journal access, and resource constraints. These findings highlight the resilience of Gaza's healthcare workers and the need for improved infrastructure, standardized documentation, and international partnership to enhance patient outcomes and strengthen global orthopaedic research.

Conclusion Orthopaedic documentation in Gaza is hampered by the compound impacts of recurrent conflict, infrastructural decay, and constrained academic output. Observational findings reveal the fragility of paper-based systems, while a bibliometric survey underscores the paucity of locally driven, empirical research. International efforts are needed to overcome these barriers for improved data infrastructure.

Keywords Orthopaedic Data · Gaza Healthcare Challenges · Orthopaedic Trauma · Bibliometric Analysis · War injuries · Gaza

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Introduction

Conflict zones impose immense pressures on healthcare systems, often resulting in fragmented documentation processes, overburdened facilities, and inadequate resources [1, 2]. In such environments which are characterized by high-stress and a rapidly evolving on-ground situation in terms of security, patient injuries and take, and mass-casualty events, accurate and comprehensive data is essential not only to guide immediate clinical decision-making, but also to enable meaningful long-term planning and interventions [3]. Documenting orthopaedic injuries and patient outcomes is especially critical for delivering tailored trauma care, given the large share such injuries constitute in war-zones [4]. Effective documentation also enables surgeons to make informed, evidence-based decisions, conduct detailed interdisciplinary consultations, and reduce complications, ultimately improving patient outcomes [4–6].

Since 2007, the Gaza Strip has faced a combination of political and economic blockades that severely restrict the movement of goods and personnel, including essential medical supplies and healthcare workers [7, 8]. These constraints, compounded by recurrent episodes of violence (most recently the 2023–2025 escalations) and infrastructural destruction, hamper both the delivery of medical care and the capacity of healthcare institutions to implement robust data collection systems [9, 10]. Hospitals and clinics frequently rely on outdated, paper-based records, susceptible to loss or damage during bombardments and power outages [11]. Consequently, vital information, ranging from patient demographics to detailed classifications of fractures, treatment, and follow-up care, is frequently inaccessible or incomplete [12, 13].

Orthopaedic trauma in conflict zones like Gaza often results from high-energy mechanisms such as crush, blast, and penetrating injuries [14, 15]. These injuries can lead to complex fractures and extensive soft-tissue damage that require prolonged follow-up and specialized care, including limb salvage surgeries, reconstructive procedures, and infection management [16, 17]. Standardized classification systems like AO/OTA, CPT, ICD-10 codes, or specific fracture classifications (e.g., Schatzker for tibial plateau fractures, Weber for ankle fractures) are essential tools for documenting injuries accurately [18]. They enable clinicians to monitor long-term outcomes, compare treatment strategies, and contribute to global orthopaedic research [19, 20]. However, in resource-scarce environments such as Gaza, employing these frameworks is logistically complex [21]. As a result, global awareness of the orthopaedic needs in Gaza, and proposals for effective strategies to address them, is severely limited [15]. This was evident in the experiences of international healthcare workers seeking to prepare for

missions to Gaza, due to a lack of understanding of the ever-evolving needs on the ground, which may even be different governorate to governorate, and hospital to hospital.

This paper integrates observational data from multiple medical missions in Gaza, Palestinian healthcare workers, and a bibliometric analysis of peer-reviewed orthopaedic research on the 2023–2025 armed escalations in Gaza. Through these dual lenses, we aim to (1) illuminate the barriers that undercut comprehensive orthopaedic documentation and (2) illustrate the scope and nature of scholarly research on Gaza's orthopaedic-related health crisis. By showcasing both the observed on-the-ground realities and the shortage of output by local academics due to extreme constraints, we hope to showcase the need for improved infrastructures for data collection through international alliance. Our aim is to illustrate the existing challenges to orthopaedic research and data collection in Gaza, and foster a more robust understanding of healthcare challenges in one of the world's most protracted conflict zones.

Methods

Observational data collection

Observational field notes

The authors include local Palestinians doctors and international healthcare workers who participated in medical missions to Palestine collecting detailed field notes during surgeries and team discussions. These notes focused on identifying gaps in documentation, such as missing demographic information, incomplete injury descriptions, and inadequate follow-up documentation, and the implications for patient outcomes.

Informal interviews

On these same medical missions, qualitative insights were gathered through unstructured conversations with local healthcare providers to understand systemic barriers. These discussions captured frontline perspectives on resource shortages, paper-based record fragility, and the impact of interrupted power and internet services on documentation efforts.

Patient record reviews

Available medical records, largely paper-based, were assessed for quality, consistency, and comprehensiveness. Given the reliance on vulnerable paper files, frequent losses

and damage were noted, making long-term patient tracking extremely difficult. Ethical considerations ensured that all patient data were anonymized, and no interventions were performed solely for research.

Bibliometric analysis

Search strategy

The goal of the search was to include all aspects of orthopaedics. In order to complement these observational findings, we performed a focused bibliometric analysis by searching PubMed using the following criteria:

("orthopaedics*" OR "orthopaedics*" OR "Fixation*" OR "Cast*" OR "reduction*" OR "Compartment syndrome*" OR "Pelvis*" OR "Prosthesis*" OR "nonunion*" OR "dislocation*" OR "malunion*" OR "orthopaedic trauma*" OR "orthopaedic trauma*" OR "spine*" OR "hand*" OR "arthroplasty*" OR "fractures*" OR "fracture*" OR "pediatric orthopaedics*" OR "pediatric orthopaedics*" OR "bone tumors*" OR "Amputations*" OR "Amputation*" OR "Amputee*" OR "joint*" OR "ankle*" OR "foot*" OR "elbow*" OR "shoulder*" OR "hip*" OR "cervical*" OR "thoracic*" OR "lumbar*" OR "wrist*" OR "knee*") AND ("Gaza*") AND ("2023/10/07"[Date—Publication]: "3000"[Date—Publication]).

Timeframe: October 7, 2023 – January 12, 2025.

Language: English.

Exclusion: news articles, letters to editors, commentaries, correspondence, editorials, and opinion-based viewpoints, systematic reviews, meta-analyses.

Screening and eligibility

A total of 114 publications were retrieved. We then screened them for direct relevance to orthopaedic surgery and the Israel-Gaza conflict. Three articles met the inclusion criteria, yielding an exclusion rate of 97.4% (111/114). Studies not directly related to either conflict or orthopaedics, as well as non original research (e.g., news reports, commentaries, editorials, systematic reviews, meta-analyses) were excluded. Studies were screened using the PRISMA Guidelines as shown in Fig. 1 [22].

Data extraction and analysis

For each included study, we recorded publication date, journal name and type of journal, journal metrics (e.g. Impact Factor, CiteScore, Google Scholar h-index), country

institution affiliation(s) of the authors, population(s) studied, study type, funding sources, ethical approvals, and—when accessible—citation metrics (e.g., citation count, Altmetrics score).

Following data extraction, we conducted a descriptive analysis to examine the proportion of locally authored research, the study designs, study focus (e.g. type of injuries, patient demographics, or healthcare system impacts), keywords, study limitations, and barriers identified in conducting research (e.g., infrastructure, logistical, political). While the small dataset limited advanced network or co-citation mapping, this bibliometric snapshot contextualizes the broader orthopaedic research landscape on Gaza's healthcare challenges.

Results

Observational findings

Patient files reviewed during surgical missions often lacked critical details essential for comprehensive care. Missing information included surgical history, injury or surgical dates, medical history, microbiology data, antibiotic treatments, fracture classifications, mechanisms of injury, post-operative instructions, allergies, and physical examination findings. Frequent physical damage to records, stemming from resource shortages for secure storage and unpredictable bombardments, further exacerbated documentation challenges. In outpatient clinics or follow-ups, patient-held copies were often the sole form of documentation. The absence of operative reports added complexity for patients requiring complex revisions, forcing reliance on patient testimony, even when health literacy was limited. This extended to imaging as well where the rigidity in the software design, coupled with power outages and damaged computers, made it nearly impossible to retrieve records efficiently, further hindering timely patient care.

Compounding these challenges, local surgeons and nurses often had limited familiarity with classification systems or protocols such as AO/OTA or ICD-10, restricting their use in clinical documentation. This issue was magnified by the reliance on volunteers, including recent graduates, students, and general practitioners, who frequently lacked specialized orthopaedic trauma training. High patient turnover and scarce continuing education opportunities further contributed to inconsistent record-keeping, complicating postoperative follow-ups. Every piece of documentation was critical, yet it often fell to the patient to retain their medical records, highlighting the fragile and fragmented state of the healthcare system.

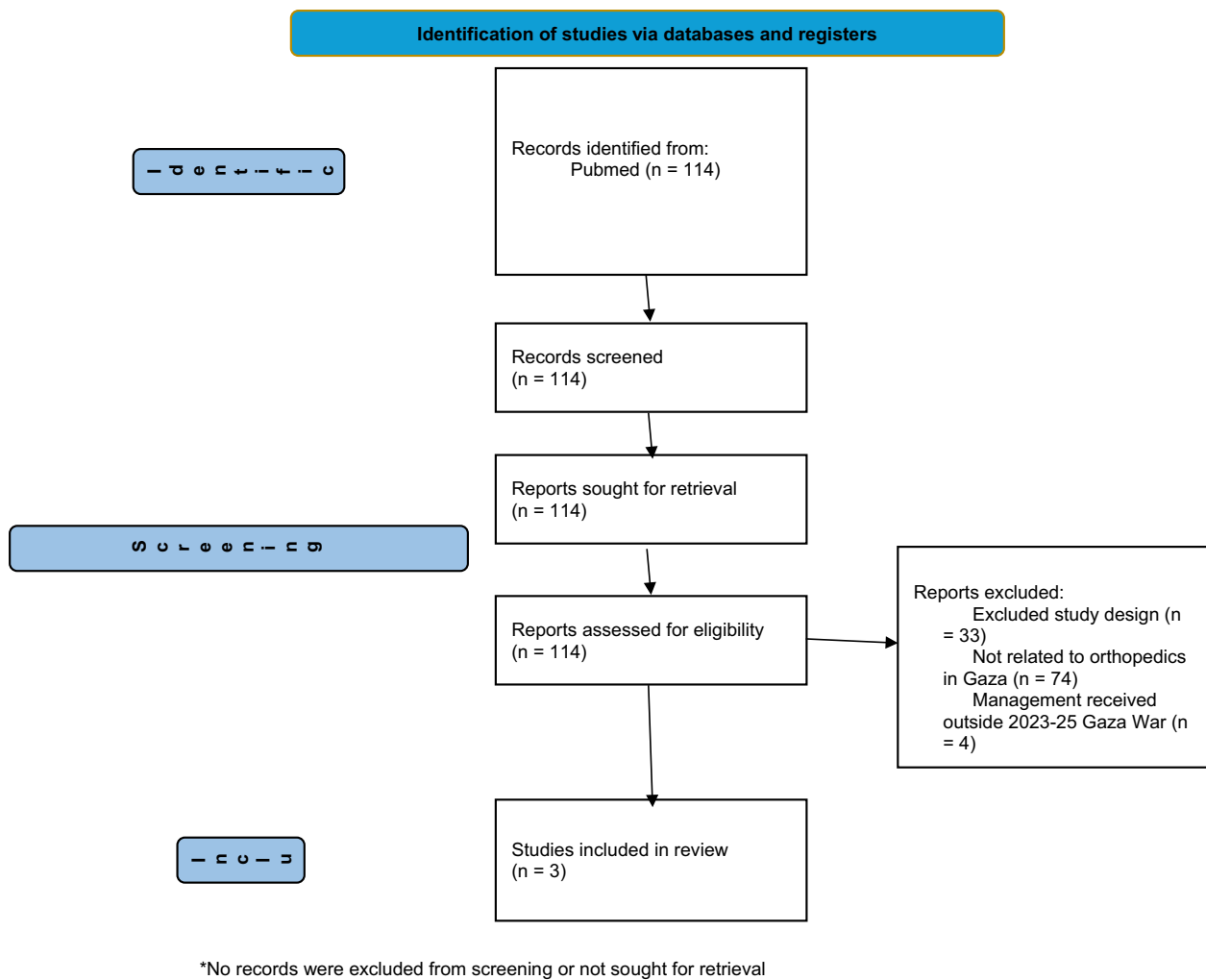


Fig. 1 Inclusion and exclusion criteria using PRISMA Guidelines regarding orthopaedic literature published in Gaza over the latest escalation

Bibliometric findings

Of the 114 publications retrieved, three were included (2.6%), while 111 (97.4%) were excluded, a summary of which can be found in Table 1. The findings presented in Tables 2 and 3 indicate both quantitative and qualitative measures of the three studies. Of the three included studies, two included authors from Gaza. The studies

addressed a range of relevant topics, including fracture-related infections, trauma care supported by telemedicine, lower-limb loss in children, and limb salvage procedures, showcasing the breadth of orthopaedic issues faced in conflict zones. Published in journals such as *The Lancet*, *Antibiotics*, and *Cureus*, with impact factors ranging from 1.2 to 98.4, these studies highlight the global recognition of Gaza's healthcare challenges despite the limited research

Table 1 Summary of included studies

Paper #	Title	Publication Date	Journal Name	Authors' affiliations country
1	Management of Fracture-Related Infection in Conflict Zones: Lessons Learned from Medical Missions to Gaza	10/30/2024	Antibiotics	USA, Palestine
2	Trauma care supported through a global telemedicine initiative during the 2023–24 military assault on the Gaza Strip, occupied Palestinian territory: a case series	8/31/2024	The Lancet	Palestine, UK, USA, Norway
3	When Simple Orthopaedic Cases Become Complex: Case Presentations From Gaza	12/12/2024	Cureus	Jordan

Table 2 Quantitative Metrics

	Paper #	1	2	3	Averages	Aggregates
Journal Metrics	Journal name	Antibiotics	The Lancet	Cureus	N/A	N/A
	Journal country of origin	Switzerland	UK	USA	N/A	N/A
	Journal type	Clinical Pharmacology	Variable	Multispecialty medical	N/A	N/A
	Journal impact factor	4.3	98.4	1.2 (2022)	21.98	N/A
	Journal CiteScore	7.3	148.1	N/A	77.7	N/A
	Journal SJR Hindex	77	895	N/A	486	N/A
	Journal Google Scholar h5index	95	368	96	186.33	N/A
Author Metrics	First author affiliation	UT Southwestern Medical Center, Dallas, TX, USA	Department of Surgery, Nasser Hospital, Gaza Strip, occupied Palestinian territory	Department of Orthopaedics, Jordanian Royal Medical Services, Amman, JOR	N/A	N/A
	Corresponding author affiliation	School of Medicine, Wayne State University, Detroit, MI, USA	Faculty of Medicine, Islamic University of Gaza, Gaza Strip, occupied Palestinian territory	Department of Anesthesiology, Jordanian Royal Medical Services, Amman, JOR	N/A	N/A
	Countries of origin for all authors' affiliations	USA, Palestine	Palestine, UK, USA, Norway	Jordan	N/A	N/A
	Number of authors per paper	7	9	3	6.33	N/A
	International research collaboration?	Yes	Yes	No	N/A	66% (2/3) Yes
Article Metrics	Population(s) studied	Palestinian civilians presenting with conflict-related orthopaedic trauma in Gaza			N/A	N/A
	Data source(s)	Primary	Primary	Primary	N/A	100% (3/3) Primary
	Funding?	No	No	No	N/A	0% (0/3) Funded
	Ethical approval (s)	Palestinian Ministry of Health in Gaza, FAJR Scientific Ethics Committee	Helsinki Committee of Gaza	Jordanian Royal Medical Services Human Research Ethics Committee	N/A	N/A

output. Predominantly retrospective in design, the research reflects the reliance on observational methodologies due to the logistical difficulties of conducting prospective or randomized trials in volatile environments. Across the studies, recurring limitations include the lack of reliable electronic health systems and standardized documentation protocols, which hinder systematic data collection and long-term patient follow-up. Addressing these gaps through robust infrastructure, standardized practices, and international efforts is essential for advancing patient outcomes and strengthening Gaza's contributions to global orthopaedic research.

Discussion

Our findings reveal the existing barriers to comprehensive orthopaedic documentation in Gaza, reflecting some of the broader healthcare challenges in conflict zones. Two main issues emerged: the lack of essential patient details, ranging from surgical history, fracture classifications, and injury mechanisms in medical records, and the heavy reliance on physical files and imaging for documentation. These gaps are exacerbated by the overwhelming number of injuries, limited healthcare providers due to attacks

Table 3 Qualitative Metrics

Paper #	1	2	3	Aggregates
Locally (Palestinian) authored research?	Yes	Yes	No	66% (2/3) Yes
Study design	Retrospective review	Case series	Case series	66% (2/3) Case Series
Study focus	Type of injuries	Healthcare system impacts	Healthcare system impacts	66% (2/3) Healthcare system impacts
Keywords	fracture-related infection; orthopaedic trauma; conflict zones; medical mission	N/A	orthopaedic injuries, delayed treatment, external fixation, physiotherapy access, conflict zones, humanitarian crisis, medical infrastructure	"conflict zones" repeated twice
Study limitations	1. Resource constraints 2. Low injury volume 3. Incomplete data 4. Limited data extrapolation 5. Lack of reliable EMRs	1. Resource constraints 2. Limited case selection and documentation 3. Ethical and regulatory hurdles 4. High-risk environment	1. Resource constraints 2. Transient nature of medical personnel 3. Ethical and logistical challenges 4. Limited diagnostic tools	Resource constraints, small sample size, ethical/logistical challenges repeated twice

on facilities, and insufficient ongoing medical education [23–29]. Additionally, the destruction of hospital infrastructure and constant evacuation orders often leads to the loss of physical records, forcing providers to rely on patient-held copies and testimony, which can be unreliable especially in a region where health literacy is low [30–32]. Digital solutions like mobile health (mHealth) apps and offline-compatible electronic health records (EHR) have been proposed to address these challenges. However, Gaza's frequent power outages and internet disruptions amid constant aerial bombardment make these technologies unreliable unless specifically adapted for offline use, and there needs to be somewhat of a pause in the military assault to train and enable systems and individuals to gradually shift. Training local staff to navigate digital systems under the pressure of daily clinical demands remains an additional limitation.

Our bibliometric analysis reveals a high exclusion rate (97.4%), indicating that most published papers on Gaza amid the 2023–2025 escalations are commentary-driven rather than empirical findings, as seen in Fig. 1. While two (66.7%) of these included manuscripts had Palestinian authors from Gaza, seen in Table 3, demonstrating local research potential, it also highlights the lack, and potential barriers to, international collaboration [33]. This reflects the determination of Palestinian healthcare professionals to document their experiences despite immense challenges such as frequent power outages, limited access to international journals, and resource constraints.

There are also barriers to maintaining certain ethical standards for research conducted in Gaza, as written approval from patients may be difficult due to paper limitations, and the scaling down of certain operations of ethics oversight committees in Gaza through the Ministry of Health, local hospitals, groups, or universities. The underrepresentation, which may reflect a lack of overall documentation, of orthopaedic trauma research in Gaza is concerning, especially considering the high prevalence of such injuries in conflict which impedes resource allocation and underscores the need for international collaboration to build a research infrastructure, train local researchers, and fund relevant studies.

The gaps in orthopaedic research in Gaza are not just academic but also reflect the real challenges faced by healthcare providers in Gaza. Issues like poor paper records, lack of standardized injury classifications, fear of speaking out due to safety concerns, and staffing shortages hinder efforts to collect, analyze data and publish articles on orthopaedic injuries. Reliable data on patient outcomes is crucial for humanitarian advocacy, helping organizations assess the crisis and allocate resources effectively including allocating funds, deploying specialized teams, and providing targeted orthopaedic implants [34–36]. Improving documentation practices in Gaza can improve patient care and strengthen the broader humanitarian response [37].

Limitations of our bibliometric analysis included being confined to a short period window (October 2023–January 2025) and a single database (PubMed). Relevant articles appearing in regional or non-indexed journals, particularly

those in Arabic, may not be captured. Additionally, publication output in conflict zones often lags due to extended peer-review times and resource constraints, potentially underrepresenting current on-the-ground research efforts. Moreover, our analysis primarily relies on retrospective studies due to the near absence of prospective research in conflict-affected regions. The challenges of standardized data collection in conflict settings present a significant limitation for in-depth analysis of prospective studies. Instability, resource constraints, and safety concerns hinder the ability to implement robust studies. The lack of a stable research infrastructure hinders our ability to conduct a more in-depth quantitative analysis.

Implications For Overcoming Orthopaedic Documentation Challenges

The political and economic blockade imposed on Gaza since 2007, and recent since October 2023, has severely hampered the development and maintenance of robust medical data collection systems by restricting the entry of essential equipment, technological infrastructure, and specialized personnel [7]. As of March 2025, Israel has imposed a total blockade of the entry of goods and medical supplies into Gaza despite the recent ceasefire agreement. Hospitals and clinics often lack access to reliable power sources, with destruction of fuel, water, and energy supply and death of healthcare personnel [6]. Modern computer hardware and software solutions required to create, store, and retrieve electronic health records are also limited, and have been destroyed in attacks upon Palestinian hospitals. This scarcity forces a continued reliance on fragile paper-based documentation systems that are easily damaged or lost in such volatile settings. Additionally, the limitations on the free movement of healthcare providers and technical experts within Gaza, such as north to south, governorate to governorate, or from one street to another, as well into and out of the Strip, perpetuate gaps in training, leaving localized Palestinian teams at times with insufficient knowledge of standardized classification systems and digital data management [38]. Experts are routinely imprisoned or killed, and those with certain skill sets may be trapped in a specific part of the Strip and unable to reach another facility [27]. The blockade also contributes to an overall inconsistent delivery of medical supplies that are essential for both patient care and data collection, such as imaging tools and consumables needed to digitize and preserve patient records. All of these factors, taken together, create an environment where systematic data collection is exceedingly difficult, depriving clinicians of comprehensive information that is vital for evidence-based treatment decisions.

These local realities echo challenges documented in broader conflict and disaster literature, which consistently makes note of the role of political instability and economic deprivation in undermining healthcare infrastructure. Yet the situation in Gaza is uniquely exacerbated by the sustained and multifaceted nature of the blockade that effectively cuts off external support and impedes the possibility of long-term planning. Healthcare facilities operating in conflict zones elsewhere may encounter supply disruptions and security challenges, but they often retain at least partial avenues for international assistance, research collaboration, and specialized staff mobility. In Gaza, such avenues are largely obstructed, preventing meaningful upgrades to data management and limiting the integration of new research methods or technologies. The resulting gaps in documentation undermine both clinical care and scientific inquiry, as fragmented data weakens the capacity to track patient outcomes, identify emerging trends, and advocate for targeted interventions. The Israeli blockade's restrictions on technology, human resources, and regular supply lines create a near-constant state of crisis for local healthcare providers, even under 'ceasefire' conditions, posing an insurmountable barrier to establishing the kind of reliable orthopaedic data systems that underpin sustained improvements in patient care and scholarly output.

The challenges faced in orthopaedic data collection in warzones heavily impact patients' healthcare. By having such limited data about one's injuries and the limited infrastructure for appropriate healthcare, patients are offered suboptimal management for current injuries and future complications. Orthopaedic trauma care requires a multi-faceted approach where any suboptimal management increases risks for both morbidity and mortality. Furthermore, the lack of proper documentation forces caregivers to rely on patient history for surgical history, infection cultures, treatment plans and so forth. This poses various challenges, where pediatric patients without guardians, patients with poor health literacy or even those who experienced high energy trauma may be unable to provide these crucial details. These challenges were evident in our prior missions, for example, in the setting of temporizing uniplanar external fixators that were lost to follow up and resulted in nonunions and malunions or following up positive infection cultures [8, 39].

Orthopaedic associations can do much for war settings, ranging from training medical teams and non-orthopaedic providers, to the provision and delivery of crucial supplies such as external fixators. It is vital to provide free downloadable concise resources, courses and training for future orthopaedic teams for adapted orthopaedic documentation and management, improvising effective time management, teamwork and creating conflict scenarios stimulation to help educate trainees. A specialized disaster orthopaedic association with experiences learned from other warzones may

aid to provide expertise and adaptations to mitigate such challenges through collaborating in conferences, courses and academic publications. In broader context, the bigger responsibility falls on the international community by raising awareness about the infrastructure destruction in Gaza and the need to fundraise its reconstruction, current medical staff and researchers in order to provide better healthcare, patients health data and scholarly output. Inability to bring in medical supply and personnel in the face of conflict is unacceptable. Furthermore, a significant portion of Gaza's orthopaedic care is reliant on international aid teams since the start of the recent escalation [14]. There are gaps in ability to follow up and provide proper handoffs given the constantly changing environment. The utilization of telehealth frameworks such as GXZA Health is vital however limited given lack of access to proper internet or cell reception. The development of a secure and cloud based electronic medical record in conjugation with the ministry of health is a viable solution that would require coordination amongst the various governmental and nongovernmental agencies. Humanitarian and medical missions, along with clinical, academic, and educational collaborations, are essential first steps to support this critical period.

Conclusion

Orthopaedic documentation in Gaza is hampered by the compound impacts of recurrent conflict, infrastructural decay, and constrained academic output. Observational findings reveal the fragility of paper-based systems, while a bibliometric survey underscores the paucity of locally driven, empirical research. Addressing these challenges demands a comprehensive strategy: incorporating standardized classification protocols, investing in resilient digital solutions, fostering global-local partnerships, and ensuring that clinicians receive the training and resources necessary for rigorous data collection. Strengthening orthopaedic documentation is not merely a technical fix—it is an urgent imperative that underpins effective patient care, accurate resource allocation, and equitable humanitarian intervention in one of the world's most protracted conflict zones.

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Data Availability No datasets were generated or analysed during the current study.

Declarations

Competing Interests The authors declare no competing interests.

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