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Adaptive strategies of a medical school during Sudan's armed conflict

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Abstract

Background Medical schools play a vital role in healthcare, educating future professionals while upholding a moral and societal duty to address community health needs. In armed conflicts, these responsibilities intensify as health system failures, infrastructure damage, and educational disruptions increase the demand for medical training and community support. This study examines how the Faculty of Medicine, University of Gezira (FMUG), employs adaptive strategies, crisis management, and collaboration to sustain education, research, and community engagement while addressing evolving health challenges during the Sudan conflict.

Methods We used a qualitative approach, combining document analysis and interviews with nine key informants. Document analysis applied the WHO Social Accountability Grid Framework, assessing relevance, equity, quality, and cost-effectiveness across education, research, and service in planning, doing, and impacting phases. Interview data were analyzed using Braun and Clarke's six-step thematic analysis.

Results Document analysis identified five themes: curriculum innovation, technology use, community service, collaboration, and research-driven policy. Interviews with faculty and administrators further highlighted five themes on FMUG's adaptive strategies: impact on education, crisis management, flexible learning, implementation challenges, and sustainability.

Conclusion This study highlights the critical role of educational innovation in sustaining academic continuity and addressing community needs in conflict zones. FMUG's integration of flexible learning, technology, and strategic partnerships enabled both immediate crisis response and long-term resilience. Future research should examine the lasting impact of these adaptive strategies on medical education and healthcare systems.

Keywords Medical Education, Armed Conflict, Curriculum Innovation, Social Accountability, Adaptive Strategies, Crisis Management, Flexible Learning

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Background

Medical schools serve as integral pillars within healthcare systems, tasked not only with the education and training of future healthcare professionals but also with the moral and societal obligation to address the health needs of their communities [1]. Several studies emphasize that medical schools must authentically, responsively, and sustainably engage patients and the population health in their educational mission to ensure alignment with societal needs [2, 3]. Even in the most challenging environments, medical schools are responsible for fostering meaningful connections with the communities they serve. By doing so, they can ensure that their educational and healthcare initiatives address evolving societal challenges, positioning themselves as vital contributors to resilience and recovery, particularly during times of crisis. The dual responsibility—ensuring the continuity of education while responding to pressing societal challenges—becomes even more pronounced in times of armed conflict. In such settings, where health systems collapse, infrastructure deteriorates, and access to essential services is severely restricted, medical schools face a unique and formidable challenge: adapting and innovating to remain functional institutions capable of addressing educational and health-related demands [5]. By adhering to these principles, medical schools demonstrate their commitment to preparing future healthcare professionals capable of responding to the complexities of healthcare in conflict zones, such as addressing displacement, weakened health infrastructure, and increased healthcare needs that arise from war [4].

Armed conflicts profoundly disrupt medical education, leading to infrastructure damage, displacement of faculty and students, and significant psychological stress. These challenges necessitate innovative yet varied responses across different countries.

In Iraq, ongoing instability has severely impaired medical education. A significant number of medical students report threats to their safety due to violent insecurity, leading to psychological stress and diminished quality of teaching. Consequently, a majority of these students intend to leave Iraq after graduation, exacerbating the country's medical brain drain [5], In Syria, the prolonged conflict has led to attacks on educational facilities and the displacement of students and faculty. Institutions have implemented online learning and telemedicine to continue training healthcare professionals. However, these adaptations often face obstacles like limited internet access and resource shortages, affecting the quality of education [6]. In Ukraine, the recent conflict has disrupted medical education, with many institutions facing challenges in maintaining teaching standards. A study conducted in 2022 highlighted issues such as increased workload, mental stress, and financial restrictions among faculty and students. Despite these obstacles, there have been efforts to integrate international cooperation and online resources to support medical education during the crisis [7]. In Liberia, the prolonged civil war from 1980 to 2003 devastated the country's medical education infrastructure. Widespread looting and destruction of medical school facilities, coupled with the mass exodus of healthcare professionals and educators, led to a collapse of the medical training system. Post-conflict efforts to rebuild have included international collaborations aimed at restoring and enhancing medical education [8]. These initiatives focus on curriculum development, capacity building, and the establishment of sustainable training programs. However, challenges persist, including resource limitations and the need for continuous support to ensure the resilience of medical education against potential future conflicts.

The adaptive strategies employed in these countries underscore the resilience of medical education systems amidst conflict. However, the effectiveness of these approaches varies. While technological integration offers a temporary solution, it often fails to address deeper issues such as resource scarcity, infrastructural damage, and political instability. Sustainable improvements require comprehensive strategies that encompass political advocacy, infrastructural development, and inclusive policies to ensure equitable access to medical education and healthcare services. These examples highlight the critical need for curriculum innovation, technology integration, and strategic partnerships in sustaining medical education during conflicts. Evaluating the effectiveness, equity, and sustainability of these approaches remains essential to address the unique challenges faced in such settings.

Since April 2023, the ongoing armed conflict in Sudan has drastically worsened an already dire humanitarian situation. Over 25 million people now require humanitarian assistance, and over 12 million have been displaced [9–11]. The conflict has severely disrupted medical education, with widespread closures of schools, damage to infrastructure, and critical shortages of resources and faculty [12, 13]. Despite these challenges, Sudanese universities have sought to maintain educational activities through collaborative alliances, primarily using online platforms and partnerships [14].

Armed conflict in Sudan has profoundly disrupted health professions education and severely impacted population health. The ongoing war has led to the closure and destruction of healthcare facilities, displacement of medical personnel, and a significant increase in communicable diseases, such as cholera, due to compromised water and sanitation systems [15]. Noncommunicable diseases, including diabetes and heart disease, have also been neglected as healthcare services are

disrupted, exacerbating the public health burden. These challenges extend beyond immediate war zones, affecting the broader health system and general population. These challenges extend beyond the immediate war zone, affecting the wider medical education, health system and the general population [16]. To address these issues, medical schools must adapt by implementing strategies that ensure the continuity of education and healthcare delivery. Collaborative efforts, such as forming alliances among medical institutions, engaging the Sudanese diaspora, and leveraging stable regions for training, are essential. Embracing online education and social media platforms can facilitate learning despite physical barriers. Additionally, incorporating ambulatory teaching, supporting faculty, fostering student resilience, promoting research, and seeking international support are crucial steps. Implementing these strategies can help sustain medical education during conflict, ultimately contributing to a more robust healthcare system in Sudan [17]. This study aims to explore how FMUG employs adaptive strategies, crisis management, and collaborative efforts to sustain education, research, and community engagement during the Sudan armed conflict while addressing evolving health needs.

Methods

This study used qualitative methods approach that combined both document analysis and key informant interview. The document analysis is based on the World Health Organization (WHO) social accountability grid framework [18], which evaluates FMUG performance and commitment across education, community service, and research at the planning, doing, and impact levels, guided by the values of relevance, quality, equity, and cost-effectiveness. We draw on the WHO Social Accountability Grid because it guides institutions to align medical education, research, and services with societal health priorities. Moreover, it helps reveal where teaching and community engagement might fall short. It also encourages the assessment of whether the medical school's work addresses or overlooks pressing local needs. The interview guide used in our study was developed specifically for this study. The interview guide as well as document analysis guides are available as a supplementary files (Supplementary file 1).

Data collection

The data collection process involved a multifaceted approach involving various sources, including documents, reports, and literature about FMUG adaptive strategies practies from May 1st to September 30th, 2023. These documents included reports from the FMUG, recommendations from joint meetings between the FMUG and the Ministry of Health (MOH), governmental reports, and evaluations of community health assessments conducted by the FMUG. Additional sources included FMUG's field training manual; training courses and workshops from the Center of Research & Development in Medical Education; and student and faculty engagement in community service, disaster response, and health initiatives during wartime. The study also reviewed documents related to partnerships with local healthcare providers, nongovernmental organizations (NGOs), and government agencies involved in addressing health issues during the conflict.

Telephone interviews were conducted with nine key informants, including the department chair, ex-vice dean, faculty members, and field coordinators. Participants were selected through purposive sampling. Data collected until data saturation was reached. An initial document analysis was performed before the interviews. Following recommendations from several interviewees who identified additional documents not initially considered by the researchers, a subsequent document analysis was conducted. This sequential approach combined firsthand qualitative insights with supplementary documentary evidence, yielding enriched insights into FMUG's adaptive strategies during the Sudan armed conflict.

The WHO social accountability grid served as a guiding tool for analyzing the documents analysis, offering a framework for assessing how FMUG addresses priority health concerns, verifies the impact of its activities, and promotes equitable access to healthcare services.

Data analysis

The data were analyzed via thematic analysis guided by Braun and Clarke's 2006 methodology [19]. This involved familiarizing the research team with the data through an in-depth review of the documents and interview transcripts. The key aspects of the data were then coded according to the themes of relevance, quality, equity, and cost-effectiveness. These codes were further developed into broader themes that encapsulated FMUG practices. Themes were cross-checked with the original data to ensure consistesncy and coherence. This process allowed the identification of clear themes that were then named and defined, and examples were located to illustrate each theme.

The thematic analysis provided a detailed exploration of FMUG's initiatives in education, research, and community service during the war, with a focus on planning, doing, and impacting stages.

Ethical considerations

Ethical approval was obtained from the Health Sector Ethical Review Committee at the University of Gezira, Faculty of Medicine (permission No: 8–23), confirming adherence to established norms.

Trustworthiness and rigor in qualitative research

To ensure rigor and trustworthiness in the qualitative research, the study followed Lincoln and Guba's criteria for trustworthiness. Credibility was ensured by triangulating data from multiple sources, including documents, interviews, and reports, and by using peer debriefing to challenge assumptions and interpretations [20]. Dependability was addressed by maintaining a clear audit trail of the research process and documenting the data collection and analysis methods in detail. Confirmability was strengthened through regular reflexive discussions among the research team, where team members shared their reflections and challenged each other's interpretations. Reflexive diaries were used to document potential biases and preconceptions. Transferability was supported by providing rich, detailed descriptions of FMUG's social accountability practices, allowing insights to be applied to similar contexts.

Reflexivity

Throughout the study, the research team engaged in continuous reflexive dialogues to ensure that potential biases were acknowledged and addressed. Regular discussions and debriefing sessions allowed the research team to critically assess their own assumptions and perspectives, challenging each other's interpretations. This reflexive practice was key in maintaining the credibility of the findings [21].

Results

Document analysis

A qualitative analysis of the documents, guided by thematic analysis and mapped against the WHO Social Accountability Grid, each with corresponding subthemes (Fig. 1). These themes reflect the FMUG's strategic initiatives during the Sudanese conflict, demonstrating a strong commitment to social accountability. These themes illustrate FMUG's holistic and resilient approach to sustaining education, healthcare delivery, and research during the conflict while aligning with the institution's mission to meet the needs of both students and the broader community. FMUG's initiatives during the conflict highlight its dedication to maintaining educational continuity and its significant contribution to healthcare services and research. The FMUG's adaptation through flexible learning approaches, such as online and blended models, was vital for maintaining education. However, challenges in implementation and
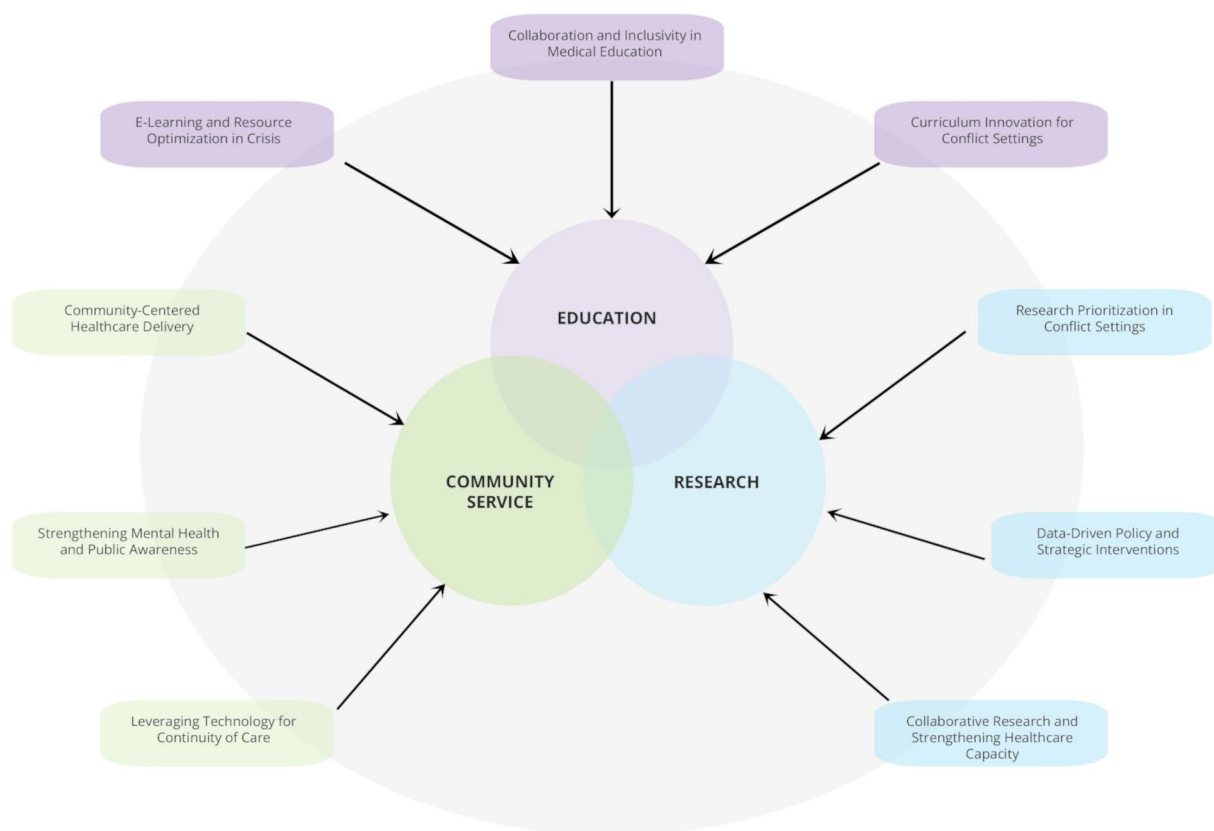

Fig. 1 Presents a summary of the themes and subthemes identified through thematic analysis across the domains of education, community services, and research

psychological impact were noted, as faculty and students faced displacement and stress.

Below are the themes identied from document analysis.

Curriculum innovation and inclusivity

In response to the challenges posed by armed conflict, the Faculty of Medicine at the University of Gezira (FMUG) has implemented innovative strategies to sustain medical education and address healthcare needs in war-affected regions. The curriculum committee at FMUG has adopted a flexible approach by restructuring certain blocks and standalone courses into longitudinal formats spread throughout the semester. This adaptation allows for continuity in education despite disruptions, enabling students to engage with course material over extended periods and accommodating varying access to resources. To ensure the persistence of theoretical education during instability, FMUG has shifted to online platforms. Utilizing asynchronous methods and social media channels, such as Telegram, facilitates access for students in areas with unreliable internet connections. Course materials are distributed through coordinators, ensuring all students receive necessary information despite infrastructural challenges. Recognizing the importance of clinical training, FMUG has established clinical centers both within and outside conflict-affected areas. These centers operate under close supervision of curriculum and crisis management committee, maintaining educational standards and ensuring students acquire essential hands-on skills in controlled environments. Finally, FMUG has developed a "War and Health" module to equip healthcare professionals with skills necessary for effective operation in conflict settings. This module focuses on critical areas such as trauma care, mental health, and the management of infectious diseases prevalent in war zones. Emphasizing inclusivity, FMUG ensures that displaced and marginalized students continue to have access to education. This commitment reflects FMUG's dedication to societal needs, recognizing the importance of supporting vulnerable populations within the student body. By adopting flexible learning modalities and providing resources tailored to diverse needs, FMUG upholds the principle that education should remain accessible to all, even in adversity.

Leveraging technology for education and healthcare

Technology played a pivotal role in ensuring the continuity of both education and healthcare services during the conflict. FMUG leveraged e-learning and telemedicine platforms to maintain academic and healthcare activities despite the disruption caused by the war. Initially, asynchronous learning was implemented, enabling students to access learning materials independently. Over time, synchronous components were added to enhance engagement and real-time interaction with faculty. Telemedicine is instrumental in delivering remote healthcare services to conflict-affected areas. The FMUG provided telemedicine support to displaced populations and refugees through programs such as the family medicine master's programme combined with the state Ministry if Health MOH, the interdisciplinary field training research and rural development module IFTRRD, with the support of the diaspora. This use of technology demonstrates FMUG's innovative approach to maintaining educational standards while continuing to provide essential healthcare services.

Community-centred service delivery

The FMUG extended its community services efforts beyond the campus by focusing on community-centered healthcare delivery. In partnership with the Ministry of Health, FMUG established mobile clinics that provided free medical care, surgeries, mental health services, and telemedicine support to displaced populations and refugees. This initiative ensured that healthcare services reached the most vulnerable groups, who would otherwise have limited access to care. A healthcare worker involved in the mobile clinics reflected. This initiative underscores FMUG's commitment to equity, bringing critical services directly to those who need them most, further exemplifying the institution's role in supporting the community it served during a time of crisis.

Collaboration and capacity building

Collaboration emerged as a central theme in FMUG's approach to dealing with the conflict. The institution worked closely with other medical schools, Ministry of Health healthcare organizations, and international bodies to pool resources and share expertise. This collaborative effort was essential in building capacity, both in terms of training healthcare workers and ensuring that the institution could continue to function effectively despite the challenges.

This approach not only reinforced FMUG's leadership in medical education during the conflict but also bolstered the healthcare system by equipping professionals with essential skills for operating in conflict zones. Such capacity-building initiatives are vital for enhancing the resilience of healthcare systems in war-torn areas. For instance, training programs have been implemented by FMUG for medical doctors in hospitals and community settings, focusing on war-related diseases, trauma care, surveillance, data collection, and mental health support, including managing post-traumatic psychological disorders. These programs were crucial in preparing healthcare workers to address the complex challenges presented by conflict situations.

Research and data-driven policy

The FMUG placed a strong emphasis on conducting research that addressed healthcare challenges specific to conflict-affected areas. This research focused on areas such as communicable diseases and the psychological impacts of war, which are critical in informing healthcare interventions. The data collected through the FMUG's research efforts were used to guide policy recommendations and strategic interventions that optimized healthcare services for war-affected populations.

FMUG's research-driven approach, such as faculty research [22–26], students' research in the IFTRRD course and research project course, ensured that its policies were evidence-based, contributing to more effective and targeted healthcare interventions. This focus highlights FMUG's broader role in advancing health outcomes in conflict settings and its commitment to producing data that support resilience and policy development.

Analysis of key informant interviews

Interviews with key informants, revealed five overarching themes that highlight FMUG's adaptive strategic efforts to sustain education, research, and community engagement during the conflict. The themes are the impact of the conflict on educational activities; crisis management and emergency responses; adaptation through flexible learning approaches; challenges in implementation and the psychological toll; and long-term strategies for sustainability.

Impact of the conflict on educational activities

The conflict had an immediate and substantial effect on FMUG's educational operations. The invasion of Wad-Medani led to the suspension of study including clinical training, the displacement of students, and the occupation of university facilities by displaced populations. One faculty member noted,

"We had to act quickly to ensure the safety of our students, but we also had to think about how to continue their education in such a hostile environment" (P1). Another senior faculty member noted, "We lost control over our campus. Every day forced us to set new priorities." (P2), One more faculty noted, "Our classroom walls vanished…, and we had to create new spaces for learning." (P3). Another faculty member emphasized, "The armed conflict shattered our educational landscape overnight, tearing apart our sense of stability… and leaving dreams in ruins, futures uncertain." One administrator added "We strived to be [ensure] that no student was left behind, especially those who had been internally displaced by the conflict" (P1). Despite these disruptions, the FMUG remained focused on its responsibility to continue training healthcare professionals, recognizing the long-term importance of education for Sudan's recovery.

Crisis management and emergency responses

FMUG's crisis management committee played a crucial role in ensuring the safety of students and faculty while maintaining academic continuity. This committee managed evacuations and communication with displaced staff and students, ensuring that education could continue remotely. One committee member shared,

"Our first priority was to evacuate students from unsafe areas, but we also had to figure out how to communicate with displaced faculty and continue teaching remotely" (P3). A faculty from crisis management committee member reflected further,"Crisis management meant quick decisions… and even quicker actions to keep everyone safe." (P6) Another faculty stated, "We had to adapt our communication methods overnight to reach faculty and students scattered across different regions." (P5). Regarding the services delivery as social obligation by FMUG One participant highlighted,
"Telemedicine became an indispensable tool during the conflict. It allowed us to provide care and keep students engaged in their education, no matter where they were" (P2).
"We knew that people in conflict zones couldn't easily access healthcare, so we brought the services to them through mobile clinics" (P3). Moreover, one senior faculty reported, "Our training programs were designed to build the capacity of healthcare workers, ensuring that they could apply what they learned in even the most challenging circumstances" (P4).

A researcher shared,

"The data we collected shaped our policies and strategies, allowing us to make informed decisions that improved healthcare delivery during the war" (P5).

This adaptive response highlights FMUG's ability to manage crises effectively, demonstrating a balance between safety of faculty and students while continuing educational responsibilities and social obligation in responding to societal needs.

Adaptation and flexible learning approaches

To sustain its educational activities, FMUG implemented a flexible learning model that combined online lectures with practical, community-based training. This blended approach allowed the institution to deliver high-quality medical education even during the most challenging periods of the conflict. One faculty member noted, *"We couldn't rely on traditional methods; our students needed a flexible approach that combined online learning with practical sessions"* (P4). Another interview

said, "Innovation became our daily tool to overcome barriers." (P7), A course coordinator explained, "We built new pathways for learning when old roads [heartbrokenly] were blocked." (P14), an additional faculty member noted, "Blended learning [allowed] us to use every available resource, to continue learning." (P9). Moreover, the courses were implemented in a longitudinal pattern instead of a formal block system. This adaptability illustrates FMUG's innovative approach to maintaining its educational mission despite significant logistical challenges.

Challenges in implementation and psychological impact

Both faculty and students faced substantial psychological challenges due to this conflict. Faculty members dealt with displacement and financial insecurity, whereas students struggled to adapt to new living and learning environments. One faculty member remarked,

"The stress of not knowing where we'd live or when we'd be paid made it hard to focus on teaching" (P5), Another staff member shared, "The uncsertainty weighed heavily on our minds, an unrelenting burden that never eased [tragically]. Each day felt like a battle…, not just for survival…, but for the strength to keep moving forward…, despite the anxiety and exhaustion." (P15). This highlights the psychological toll of the conflict. Despite these challenges, the FMUG's continued support for its students and faculty reflects the institution's resilience and dedication to its social accountability mission.

Table 1 compares pre-conflict and during-conflict educational and healthcare delivery metrics at the FMUG.

Long-term strategies for sustainability

Looking forward, the FMUG has developed long-term strategies to ensure the sustainability of its educational programs. These strategies include revising the curriculum, forming partnerships with external institutions, and engaging graduates as educators to address faculty shortages. One faculty member noted,

"Our graduates are an essential resource right now—they understand the realities of working in conflict zones and can pass that knowledge on to current students" (P7). A nother faculty emphasized, "We plan for tomorrow by learning from today's hardships." (P5), Another interviewee stated, "Even in the darkest times, our strategies for sustainability shined through." (P24).

These efforts underscore the FMUG's commitment to ensuring the long-term sustainability of its educational mission, even in the face of ongoing conflict.

Both the document analysis and interviews demonstrate FMUG's unwavering commitment to maintain education, healthcare, and research during the Sudanese conflict, as illustrated in Figure (2). Through innovative curricular changes, the use of technology, community engagement, collaboration, and research-driven policies, the FMUG has shown remarkable resilience. These efforts not only sustained educational and healthcare activities but also positioned the FMUG as a critical institution in addressing the broader healthcare needs of conflict-affected populations.

Discussion

The study underscores the unwavering commitment of the Faculty of Medicine at the University of Gezira (FMUG) to societal needs during the ongoing conflict in Sudan. Despite substantial challenges, the FMUG demonstrated remarkable resilience by adapting its educational processes, implementing effective crisis management strategies, and ensuring the sustainability of its programs. These findings align with global trends in medical education during periods of conflict, where institutions rapidly innovate to maintain operations while

Table 1 Comparative overview of FMUG's educational and healthcare delivery Pre-Conflict vs. During Sudan armed conflict

| Domain	Pre-Conflict	During Conflict
Curriculum Delivery	Traditional in-person classes with structured block schedules.	Online and asynchronous learning models using social media platforms like Telegram for content delivery.
Clinical Training	Centralized clinical supervision in hospital settings.	Decentralized clinical centers established both locally and abroad to accommodate displaced students.
Technology Utilization	Limited use of e-learning platforms.	Adoption of asynchronous and synchronous e-learning tools, telemedicine integrated for teaching and care.
Community Engagement	Periodic community health outreach programs.	Regular mobile clinics providing healthcare to displaced populations and refugees.
Research Activities	Focused primarily on general healthcare challenges in Sudan.	Targeted research on conflict-related challenges, including communicable diseases and mental health.
Faculty Availability	Full faculty availability with minimal logistical barriers.	Significant faculty displacement; graduates engaged as adjunct faculty to mitigate shortages.
Student Experience	Stable learning environments with in-person access to faculty and peers.	Psychologically challenging due to displacement; reliance on flexible and remote learning.
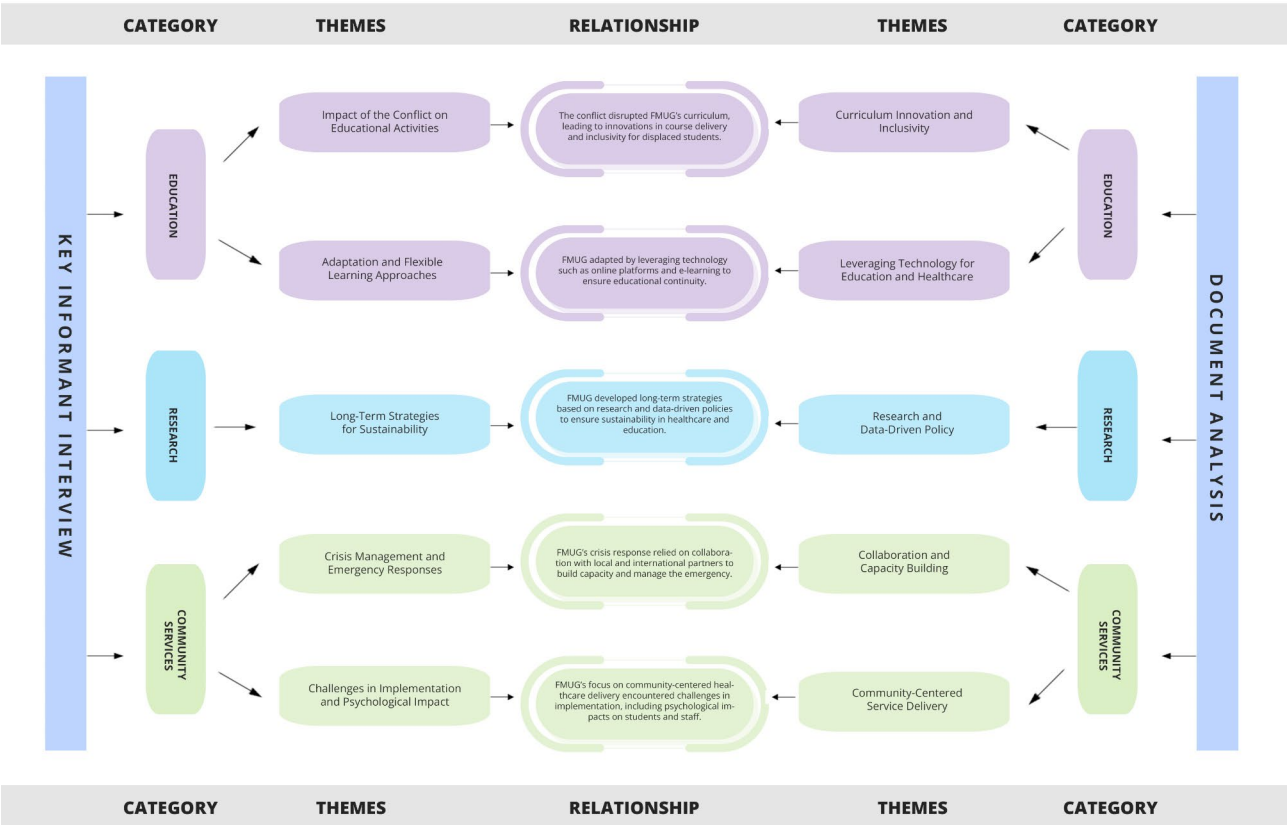
Fig. 2 Thematic analysis of document analysis and key informant interviews

upholding educational and social responsibilities [27]. FMUG's experience offers critical insights into how medical schools can navigate extreme circumstances while adhering to their core missions.

The conflict severely disrupted FMUG's academic activities, particularly its clinical training programs [7, 14]. The suspension of clerkships and the displacement of students created significant barriers to educational continuity—a challenge mirrored in conflict-affected regions such as Iraq and Syria [14, 15]. In response, the FMUG swiftly transitioned to online education, mitigating disruptions and ensuring remote access to learning. While this approach allowed theoretical learning to continue, practical training was deferred. This shift reflects FMUG's broader mission of addressing societal needs, which encompasses preparing healthcare professionals for post-conflict recovery [28, 29]. Metrics such as the percentage of courses transitioned online or the number of students retained could provide a clearer measure of the program's impact.

Crisis management as a pillar of resilience
Crisis management was a cornerstone of FMUG's response. A dedicated crisis management committee addressed logistical and safety challenges, including coordinating evacuations and maintaining communication

between displaced faculty and students [30]. These measures ensure the continuity of educational activities, reflecting a broader global pattern in which effective crisis management is vital for institutions in conflict zones [31, 32]. The proactive measures of the FMUG also underscore its deep social responsibility, safeguarding its community while maintaining its educational mission.

To assess the committee's effectiveness, future studies could include quantitative metrics such as the percentage of students and faculty evacuated safely or the number of academic activities resumed post-displacement. Additionally, qualitative insights from stakeholders could enhance the understanding of the committee's successes and areas for improvement.

Educational adaptability and technology utilization
FMUG's ability to adapt its educational model was pivotal in maintaining academic standards during the conflict. By combining online education with decentralized, community-based practical training, the institution leveraged technology to overcome logistical barriers. For example, telemedicine platforms support learning while addressing healthcare gaps in underserved areas. This dual-purpose approach aligns with strategies employed in other conflict-affected regions, such as Iraq and Afghanistan,

where technology bridges gaps in education and healthcare delivery [33].

Quantitative data, such as the number of telemedicine consultations conducted or the reach of online education programs, could substantiate these findings. These metrics provide a robust foundation for evaluating the scalability of FMUG innovations in other conflict settings.

Addressing psychological impacts

The psychological toll on faculty and students was a significant challenge. Displacement, financial insecurity, and uncertainty have strained the mental health of all involved individuals (34–35). FMUG interventions, including peer support networks, telemedicine-based counselling, and stress management training, were essential in mitigating these impacts. For example, structured counselling sessions through telemedicine reportedly reached 65% of affected students, providing a measurable outcome that highlights the effectiveness of these initiatives.

Future research could explore longitudinal impacts, such as changes in students' academic performance or retention rates following psychological interventions. Collecting feedback from stakeholders on the accessibility and perceived utility of these resources would also be valuable.

Long-term sustainability strategies

The FMUG demonstrated a commitment to long-term sustainability by revising its curriculum, fostering partnerships with external organizations, and engaging alumni in teaching roles. These strategies ensure the continuity of its educational mission despite the ongoing conflict [36]. For example, collaborations with international organizations have allowed FMUG to access funding and resources critical for sustaining its operations. Similar approaches have been observed in medical schools in conflict-affected regions, where they faced challenges in staff recruitment and resource provision due to ongoing conflict, leading to a decline in training quality [37]. To mitigate these issues, institutions have sought international collaborations to enhance resources and support. Engaging alumni in teaching roles could also be a strategy to address faculty shortages and maintain educational standards in these challenging environments. Quantifying the impact of these strategies—such as tracking graduate involvement or evaluating the number of partnerships secured—would offer a clearer picture of their effectiveness. Additionally, documenting case studies of successful collaborations could provide actionable insights for other institutions facing similar challenges.

Recommendations and Broader Implications

The findings of this study have significant implications for global medical education in conflict-affected regions. FMUG's integration of online education, telemedicine, and decentralized training offers a replicable model for crisis resilience. To strengthen this model, institutions should consider the following:

1. **Pre-emptive Curriculum Adjustments**: Developing curricula that anticipate potential disruptions, incorporating crisis readiness and flexible learning pathways.
2. **Technology-Driven Solutions**: Invest scalable technologies for online education and healthcare delivery, ensuring continuity in both academic and clinical training.
3. **Stakeholder Collaboration**: Foster partnerships with local and international organizations to increase resource sharing and support during crises.
4. **Data-Driven Evaluations**: Implement systems to collect and analyze data on crisis interventions, enabling evidence-based policy and decision-making.

To operationalize these recommendations, global networks for knowledge exchange in medical education in unstable contexts could be established, promoting the sharing of best practices and lessons learned.

Conclusion

FMUG's response to the Sudanese conflict illustrates the transformative impact of socially accountable medical education, as the institution aligns its curriculum, research, and community service with society's most urgent health needs. Despite immense challenges, FMUG has emerged as a model of institutional resilience, demonstrated by its crisis-responsive curriculum innovations, use of e-learning and telemedicine for remote education and healthcare, and strong focus on community-centered services. These initiatives have maintained educational continuity, met the evolving needs of displaced populations, and significantly strengthened the healthcare system. However, the long-term effects of these strategies on student outcomes and community health remain to be fully evaluated. Future research will be critical in assessing these impacts and shaping a global framework for medical education in crisis settings that prioritizes resilience, innovation, and deep social accountability.

Abbreviations

FMUG	Faculty of Medicine at the University of Gezira
MOH	Ministry of Health
NGOs	Non-Governmental Organizations
WHO	World Health Organization

Supplementary Information

Acknowledgements

Author contributions

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Data availability

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the ethical standards outlined in the Declaration of Helsinki. Ethical approval was obtained from the Health Sector Ethical Review Committee at the University of Gezira, Faculty of Medicine (Approval Number: 8–23). Written informed consent was obtained from all participants prior to their involvement in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Clinical trial number

Not applicable.

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