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Adaptive Health Systems: Innovations in Crisis Management During Armed Conflicts

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Systematic Review

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Abstract

Objective: Armed conflicts cause substantial disruptions to health care systems, necessitating innovative approaches to crisis management. Systematic reviews play a critical role in evaluating adaptive health innovations implemented during such conflicts, shedding light on their impact on crisis management and health outcomes within affected communities.

Methods: Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, a systematic search in PubMed, Scopus, Cochrane Library, and Web of Science resulted in 5432 articles. The review covered studies published since 2000 that addressed crisis management innovations. A rigorous selection process based on PICO criteria was employed to include relevant high-quality studies.

Results: Following screening, 21 studies were identified, demonstrating considerable innovation in health systems in conflict-affected regions. The key innovations were decentralized management structures, community health worker programs, and mobile health units, all aimed at enhancing service delivery under difficult circumstances. In spite of this, persistent challenges like infrastructure destruction, limited resources, and security risks remain substantial obstacles to the availability of health care.

Discussion: Findings highlight the critical role played by resilient health systems in mitigating the negative effects related to armed conflicts. While some innovations are promising, problems like resource constraints, infrastructure destruction, and data collection challenges remain unresolved. The review's strengths lie in its systematic nature and extensive coverage of the literature, while potential publication bias and language restrictions should be acknowledged as limitations.

Conclusions: The present review highlights the key role of adaptive health responses in crisis management and demands more research on their long-term effects and scalability. Future research must examine comparisons across a number of nations and utilize technology, including telemedicine and digital platforms, to strengthen health care resilience in areas impacted by conflict.

In recent decades, wars and armed conflicts in various regions of the world—particularly in the Middle East and more recently in conflicts such as the Russia-Ukraine war—have posed significant challenges to health care systems.[1–4] These crises not only increase the demand for health care services but also strain existing infrastructures, often leading to their partial or complete collapse.[5–7] Consequently, health care systems increasingly require innovation and adaptation to effectively respond to the needs of affected populations during such crises.[1,8–10]

A growing body of research has highlighted the multifaceted impacts of armed conflicts on health care delivery, emphasizing both the innovative responses that arise and the persistent challenges that remain. For instance, studies have documented successful interventions, such as the deployment of mobile health units and the use of telemedicine, which have improved access to care in conflict-affected regions.[11–14]These innovations demonstrate the resilience of health care systems, showcasing how adaptability can mitigate some of the adverse effects of war. However, many studies tend to focus narrowly on specific case studies, often overlooking broader patterns and the effectiveness of various innovations across different contexts.[15,16] Additionally, while some research provides valuable insights into operational strategies, they frequently fail to quantify the impact of these innovations on health outcomes, leading to a gap in the empirical evidence needed for comprehensive policy recommendations. This review seeks to bridge these gaps by systematically analyzing both successful and unsuccessful innovations in health care systems during armed conflicts, thereby contributing to a more nuanced understanding of how to enhance crisis management and improve health outcomes in affected populations.

The significance of the research will lie in determining and exploring the innovative ideas in health systems in countries experiencing armed conflicts. In light of recent global events, further research is being called for to help hone responses to crises. Such innovations in this field could result in cost reductions, efficiency improvements, and improved health outcomes. The present

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study also investigates successful and unsuccessful experiences from different countries and tries to suggest feasible strategies for boosting health care systems in war-affected contexts.

For the purpose of assessing the results of health innovations in conflict zones, clear evaluation indicators are necessary. Mortality rates, access to health care, and operational efficiency are metrics that serve as benchmarks of success.[17,18] For instance, improvements in maternal and child health status can be used to show the success of decentralized governance or telemedicine, while outpatient visits or vaccination coverage rates can be used to show the success of mobile clinics and digital tools. These indicators are crucial in the framework of the adaptive health system approach to ensure that innovations are meaningful and replicable in other crisis contexts.[19–21]

While the literature on adaptive health systems is primarily focused on regions such as the Middle East and Eastern Europe, other regions of the world, including sub-Saharan Africa and Central Asia, face their own challenges. For instance, countries like South Sudan and Afghanistan have been through many years of conflict, which has led to the breakdown of health care.[22–24] However, mobile clinics, community health worker programs, and telemedicine have become innovations that provide lifesavers but require unique solutions due to extremely limited resources, geographic isolation, and limited aid. Thus, the review of these regions is presented in this paper to demonstrate the diversity of the approaches used to design the Adaptive Health Systems Strategies (AHSS) in different contexts.[25–28]

The objectives of this research include identifying innovations and successful approaches related to managing health care crises in the context of a war situation. The key questions this paper attempts to answer include: What types of innovations have been implemented within health care systems during a crisis? How can the experiences of countries experiencing war be applied to improving health care systems in other parts of the world? And what challenges that remain, requiring deeper study?

This research continues to highlight the significance of evaluating not only the positive impact of adaptive health systems on the response to a crisis but also the limitations of such systems in the context of an armed conflict. As such, the study seeks to offer practical recommendations for policy-makers and practitioners seeking to improve the readiness of the health care system in the face of armed conflicts by identifying these challenges in more detail.

The article is organized into 4 major sections: Methods, Results, Discussion, and Conclusion. The Methods section shall outline the methodology of the research and selection criteria of studies, while the Results shall focus on the data analysis and identification of innovations. Discussion shall present interpretation of results and give policy recommendations. Finally, the Conclusion shall summarize key findings and their implications for the future of health systems in contexts of armed conflict.

Methods

Study Design

A systematic review is thus chosen for this study because it will be able to examine the literature on adaptive health systems and managerial innovations during the crises of armed conflict comprehensively and meticulously. This approach, with a predefined structured transparent protocol, offers the ability to accurately identify and compare various innovations to address complex, multilevel questions of the study. It offers a comprehensive summary of the available evidence, highlights areas where research is lacking, and facilitates an in-depth comprehension of the contemporary literature, which is essential for evaluating health systems in regions affected by conflict. Moreover, the systematic review allows for an analysis of those factors that influence health innovations; it provides a thorough investigation of their interrelations and consequences. This thus enhances the robustness and dependability of the results and provides necessary insights for decision-makers and practitioners involved in humanitarian health initiatives.

PRISMA methodology

To conduct this systematic review, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework shall serve as the main guideline. The PRISMA framework is a comprehensive and validated tool for conducting a systematic review. It guides one through the systematic identification, screening, assessment, and synthesis of the data in a way that is transparent. The steps involved will be as follows:

1. Defining Research Questions and Inclusion/Exclusion Criteria: Precisely defining research questions and establishing criteria for study selection.
2. Literature Search: Conducting an exhaustive search across scientific databases and credible sources to identify relevant studies.
3. Screening of Sources: Performing initial and secondary screening of sources to select studies pertinent to the topic.
4. Quality Assessment of Studies: Evaluating the methodological quality of the selected studies.
5. Data Extraction: Extracting the requisite data from the chosen studies.
6. Data Analysis and Synthesis: Analyzing and synthesizing the extracted data to present final results.
7. Reporting of Results: Providing a transparent and comprehensive report of the findings and research outcomes.

Following the PRISMA methodology ensures that the systematic review is conducted with the necessary thoroughness and transparency, hence making the findings reliable and generalizable. This guideline framework is particularly important in complex, multifaceted studies, one example being the management of health systems during crises caused by armed conflicts.

Research Question and PIO Framework

The research question serves as a cornerstone in guiding the scope and direction of a systematic review, ensuring transparency, focus, and relevance throughout the research process. It plays a critical role in defining objectives, establishing inclusion and exclusion criteria, and structuring analyses to comprehensively examine specific dimensions of the topic. In this study, the research question is formulated as follows:

What innovations have been implemented in adaptive health systems during armed conflicts, and how do these innovations influence crisis management outcomes in affected regions?

To address this question, the study employs the PIO framework (Population, Intervention, Outcome) to systematically investigate adaptive health systems in the context of crisis management during armed conflicts. The components of the framework are defined as follows:

Population: Health care systems operating in conflict-affected regions, including countries in the Middle East and areas impacted by the Russia-Ukraine war.

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Table 1. PIO framework for the study

Component	Description
Population	Health care systems operating in regions experiencing armed conflicts, including countries in the Middle East and areas affected by the Russia-Ukraine war.
Intervention	Adoption and implementation of adaptive health systems and managerial innovations aimed at improving crisis management during periods of armed conflict.
Outcome	Enhanced crisis management capabilities, reduced operational costs, increased efficiency of health care services, improved health outcomes for affected populations, and strengthened resilience of health care infrastructure in conflict zones.

Intervention: The adoption and implementation of adaptive health systems and managerial innovations aimed at enhancing crisis management during periods of armed conflict.

Outcome: Improved crisis management capabilities, reduced operational costs, increased efficiency of health care services, better health outcomes for affected populations, and strengthened resilience of health care infrastructure in conflict zones.

This structured approach, detailed in Table 1, facilitates the analysis of how interventions impact health care delivery in conflict-affected regions and supports the development of robust health management strategies. The keywords and their equivalents are presented in Table 2.

Search Protocol

A systematic search strategy will be designed to systematically search for articles and materials on adaptive health systems and managerial innovations related to armed conflicts. The proposed databases that will lead the basis of the search include: PubMed, Scopus, Cochrane Library, and Web of Science. The search period will cover from the inception of these databases to October 1, 2024, with no specific time restrictions. This approach ensures that all work relevant to the subject published from the most ancient record to the most recent is considered and summarized. In addition, for relevance and quality, only publications in the English and French languages will be considered, as they form the major proportion of scientific inputs relevant to the topic under research.

The search strategy will involve a list of identified keywords that include "Adaptive health systems," "Crisis management," "Armed conflicts," "Health innovations," "Health systems in war," "Humanitarian health responses," and "Wartime health systems." The keywords, along with their common synonyms retrieved from PubMed, are outlined in Table 1-1. Combinations of these terms will be utilized, together with Boolean operators such as AND or OR, in view of maximizing both comprehensiveness and precision of the results that will be obtained. This protocol will try to cover the most extensive range of research that may be conducted on the complex dimensions of health system management in conflict situations by utilizing various combinations of keywords and their synonyms. This systematic approach is wide in focus to ensure the capture of all relevant studies that contribute to an advanced understanding of adaptive health systems and their innovative coping strategies during armed conflicts.

The following inclusion and exclusion criteria have been established to select appropriate articles:

Inclusion Criteria:

- Studies that examine health systems during periods of armed conflict.
- Studies that investigate managerial innovations in health crises during wars and conflicts.
- Articles published in reputable, peer-reviewed scientific journals.
- Studies that provide empirical data or conduct analytical reviews.
- Studies focusing on post-2000 periods that address health crisis situations in conflict-affected regions.

Exclusion Criteria:

- Studies that focus on health systems outside the context of armed conflicts.
- Articles that discuss health innovations in non-conflict-related crises.
- Literature reviews that lack systematic analysis or empirical evidence.
- Articles published before 2000, unless they specifically address revolutionary innovations in health systems during conflicts.

Search Strategies for PubMed, Scopus, Cochrane Library, and Web of Science:

To systematically identify relevant articles and resources related to adaptive health systems and managerial innovations during armed conflicts, a comprehensive search strategy was developed for each of the selected databases: PubMed, Scopus, Cochrane Library, and Web of Science. The search strategies utilize the predefined keywords and their common equivalents as outlined in Table 1-1. Additionally, the search queries incorporate Boolean operators (AND, OR) to ensure comprehensive and precise retrieval of relevant studies.

Table 2. Keywords and their common equivalents

Keyword	Equivalent 1	Equivalent 2	Equivalent 3	Equivalent 4
Adaptive health systems	Dynamic health systems	Resilient health systems	Flexible health systems	crisis Adapted health systems
Crisis management	Disaster Management	Crisis Response Systems	Emergency Crisis Handling	
Armed conflicts	Military Conflicts	War		
Health innovations	Health care Innovation	Innovative Health Solutions	Novel Health Technologies	
Health systems in war	Wartime Health Systems	Conflict Zone Health Systems	Health Systems in Armed Conflicts	
Wartime health systems	Conflict Zone Health care	Wartime Medical Systems	Emergency Health Systems in War	Health Services in Armed Conflicts

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Synthesis of Results

The data extracted from the selected articles for in-depth review consisted of many key elements: reference details, description of the health program, age and other characteristics of the study population (including sample size), research design, geographical location, the primary objectives of the study, and any challenges or limitations identified. After that, the above pieces of information were collected with due care and were then analyzed with great detail to notice the knowledge gaps, as reflected in Table 3. The reference organization for the study was done using the EndNote referencing software. The information extracted was then archived using Microsoft Excel. This systematic way of organization ensured a comprehensive synthesis of the findings, thereby enhancing the reliability and clarity of the analysis.

For the purposes of transparency and clarity in the systematic review process, data synthesis necessitated a detailed integration of both qualitative and quantitative research to facilitate an exhaustive grasp of adaptive health systems in the situation of armed conflicts. Qualitative methods, including interviews and case studies, have revealed contextual obstacles and innovative solutions adopted in conflict-affected areas, whereas quantitative analysis has yielded quantifiable results, including mortality rate reductions and efficiency improvements in service delivery. Synthesis of these various sources of information was enabled through the use of thematic analysis that facilitated recognition of emerging patterns and innovations across various regions and settings.[29] Papers were excluded categorically on the basis of predetermined criteria that involved a failure to be applicable to armed conflict contexts, insufficient empirical evidence, or publication in a language other than English. As an example, 487 studies were excluded due to a lack of evidence or because they did not meet the predetermined inclusion criteria. Such rigorous methodology ensured that only relevant and high-quality studies were considered, thus enhancing the reliability and generalizability of the findings. With an in-depth exploration of these factors, this review provides a strong foundation for understanding the complex nature of health system adaptations during crises.

Results

Overview of Selected Studies

The systematic review identified a total of 5432 articles across four databases (PubMed, Scopus, Cochrane Library, and Web of Science) based on the initial search strategy. After removing duplicates and performing primary and secondary screenings, 92 studies were deemed eligible for full-text review. Following a thorough evaluation against the inclusion and exclusion criteria, 21 articles were ultimately included in the final synthesis. These articles provided valuable insights into various innovations and adaptive strategies implemented in health care systems during armed conflicts across diverse geographical contexts including the Middle East, Africa, Eastern Europe, and South Asia.

The article selection process is illustrated in Figure 1, which outlines the systematic PRISMA flow diagram for identifying relevant literature from January 2000 to February 2024. The diagram includes details on the number of records identified through database searches, the removal of duplicates, and the screening process. Additionally, it highlights that some articles were excluded for meeting more than 1 exclusion criterion, such as being unrelated to conflict-affected health systems, lacking empirical evidence, or being published in languages other than English.

This systematic review examines the diverse populations affected by armed conflicts, focusing on vulnerable groups such as civilians in Ukraine, women and children in countries like Angola, Eritrea, Ethiopia, Mozambique, and Rwanda, as well as internally displaced individuals in Colombia and Yemen. The findings indicate that millions of people, including Ukrainian civilians and women and children in several African countries and various regions of the Middle East, are significantly impacted by these conflicts. This review employs a range of methodologies, including observational studies, qualitative interviews, and literature reviews, to gather comprehensive information about the health challenges faced by these populations.

Geographically, the research encompasses regions such as Ukraine, Colombia, Yemen, Palestine, Syria, South Sudan, and various areas across Africa and the Middle East. These studies emphasize the critical health challenges arising from armed conflicts and explore the innovations within health systems designed to address the needs of affected communities amid ongoing violence. Innovations include the deployment of community health workers, the establishment of mobile health units, and the integration of digital technologies, all aimed at ensuring continuity of care and improving health outcomes for individuals living in conflict-affected areas. Overall, this review highlights the resilience and creativity of health systems striving to provide essential services in the face of significant challenges.

Main Concepts and Analysis of Health System Innovations for Adaptation in Conflict-Affected Areas

In regions affected by conflict, health systems face unprecedented challenges that demand rapid and effective adaptations. The following key concepts emerge from a systematic review of 21 articles focused on innovations that enhance the adaptability of health systems in these contexts:

1. Decentralization of Health Governance: Empowering local decision-making is crucial for improving governance and responsiveness to community needs. Decentralization allows health systems to tailor their strategies to the unique circumstances of affected populations, fostering a more effective and locally relevant health response.
2. Training and Deployment of Community Health Workers (CHWs): CHWs are instrumental in maintaining essential maternal and child health services, particularly in conflict-affected areas where traditional health care infrastructure may be compromised. Their presence not only fills critical gaps in service delivery but also builds trust within communities, which is essential during times of instability.
3. Health Financing Reforms: Adequate resource allocation is vital for sustaining health services amid disruptions caused by conflict. Reforms aimed at increasing financial resources and reallocating budgets can enhance the resilience of health systems, ensuring they can continue to operate effectively even in challenging environments.
4. Adaptation of Health Services in Wartime: Strategies to protect and enhance health care delivery during conflict are crucial. This includes exploring mechanisms that safeguard health services and improve access to care, ensuring that essential health services remain available despite the challenges posed by violence.

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Table 3. Key elements of selected studies on adaptive health systems and innovations during armed conflicts

Reference	Title	Adaptive health system innovation	Population	Study design	Geographical region	Outcomes	Challenges/limitations
	Title of the article	(Describe the adaptive health intervention or innovation)	(Details of the health care systems and populations studied in conflict zones)	(Methodology used, e.g., RCT, observational study, etc.)	(Country/region affected by armed conflict)	(Key outcomes such as improved health care delivery, cost reduction, increased efficiency, etc.)	(Challenges faced in implementing the innovation, such as infrastructure limitations, resource availability, etc.)
(34)	The human toll and humanitarian crisis of the Russia-Ukraine war: the first 162 days	The study provides an analysis of the impact of the Russia-Ukraine war on health care systems and civilian safety, highlighting the destruction of health care infrastructure and its effects on health service delivery. It emphasizes the need for public health preparedness and potential adaptations in health care delivery amidst conflict.	The population includes civilians in Ukraine, with a focus on vulnerable groups like children and those with chronic conditions. The health care system was already under strain prior to the war, facing issues like under-funding and inequitable resource distribution.	Observational study analyzing data from multiple sources including media reports, government statistics, and health organizations.	Ukraine, specifically affected areas like Mariupol, Kyiv, and other conflict zones.	Key outcomes include increased awareness of the humanitarian crisis, documentation of civilian casualties, and the impact on health care delivery. The study suggests the need for prioritizing health care delivery amidst ongoing conflict.	Challenges include significant destruction of health care facilities, disruption of essential services, lack of access to medications, and the ongoing threat to safety for health care workers and patients. Additionally, the accuracy of data collection was hampered by the chaos of war.
(35)	Health system reforms in five sub-Saharan African countries that experienced major armed conflicts (wars) during 1990–2015	The study identified three main adaptive health interventions: 1) Health systems decentralization to improve governance and local decision-making; 2) Training and deployment of community health care workers (CHWs) to enhance maternal health service delivery; 3) Health financing reforms to increase funding and resource allocation for health services.	The populations studied include women and children in Angola, Eritrea, Ethiopia, Mozambique, and Rwanda, focusing on maternal health services in the context of conflict-affected health care systems.	Selective literature review	Angola, Eritrea, Ethiopia, Mozambique, Rwanda	The key outcomes include a significant reduction in maternal mortality ratios (MMR) by ≥ 50% during the study period, improved access to maternal health care, and increased utilization of health services.	Challenges include ongoing infrastructure issues, resource limitations, and the need for further research to validate findings and inform policy effectively
(36)	Impact of the armed conflict in Colombia: consequences in the health system, response and challenges	The study assesses the effects of armed conflict on the health system, focusing on mechanisms developed to protect medical missions and improve health care delivery in conflict zones.	The population includes civilians affected by armed conflict, health professionals, and displaced individuals within Colombia; health care systems impacted by violence and governance issues.	Qualitative study using semi-structured interviews and focus groups; Ground Theory methodology.	Colombia, particularly conflict-affected regions like Chocó, Antioquia, Nariño, and Putumayo.	Improved understanding of barriers to health care access, development of protocols for health service delivery in conflict areas, and enhanced coordination among health actors.	Significant challenges included insecurity affecting health care delivery, inadequate medical supplies, limited state presence in conflict zones, and political instability impacting health policy implementation.
(37)	Health system functionality in a low-income country in the	The article reviews the functionality of Yemen's health system before and during the conflict,	The population includes approximately 26 million Yemenis, with a focus on vulnerable groups such as	Review of literature and secondary data analysis from 2005 to	Yemen	Key outcomes include reduced child and maternal mortality rates prior to conflict, but	Major challenges include destruction of health infrastructure, funding crises, shortages of

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Table 3. (*Continued*)

Reference	Title	Adaptive health system innovation	Population	Study design	Geographical region	Outcomes	Challenges/limitations
	midst of conflict: the case of Yemen	highlighting efforts to maintain health services despite deteriorating conditions. It discusses governance and financing adaptations, reliance on international aid, and the role of local health workers.	women and children impacted by conflict.	2016, not a formal RCT or observational study.		significant declines in health outcomes such as life expectancy and increased mortality rates since conflict began.	essential medicines, governance fragmentation, and the flight of health workers.
(38)	Is development aid to strengthen health systems during protracted conflict a useful investment? The case of South Sudan, 2011–2015	The study examines the provision of maternal, newborn, child, and reproductive health (MNCRH) services during protracted conflict, assessing the effectiveness of international aid in strengthening health systems.	Women and children in South Sudan, focusing on maternal and child health service utilization in a conflict-affected setting.	National cross-sectional probability surveys conducted in 2011 and 2015.	South Sudan	Significant improvements in MNCRH service coverage, with 22 out of 27 indicators showing progress despite ongoing conflict; however, overall coverage remained low.	Ongoing armed conflict, insecurity affecting data collection, limited infrastructure, and resource constraints hindered comprehensive service delivery and data accuracy.
(39)	Health perceptions among victims in post-accord Colombia: Focus groups in a province affected by the armed conflict	The study examined victims' health perceptions and experiences with health care services in the post-accord context, emphasizing the need for tailored health interventions for conflict-affected populations.	Victims of the Colombian armed conflict, including women, men, and children, focusing on their mental and physical health needs.	Qualitative study using focus groups to gather data on health perceptions and experiences.	Meta region, Colombia, significantly affected by the armed conflict.	Identified mental health issues, barriers to accessing health care, and the need for improved health services tailored to victims' needs.	Stigmatization, discrimination in health care access, structural limitations of the health system, and the ongoing presence of violence and social instability.
(40)	The effects of the armed conflict on the life and health in Colombia	The article discusses the impact of armed conflict on health services, including the adaptations made by health systems to address the challenges posed by violence, such as increased security measures and mobile health units.	The population includes civilians affected by armed conflict, particularly vulnerable groups such as women, children, and ethnic minorities.	Observational study, with qualitative analysis of health outcomes and service delivery during conflict.	Colombia, specifically regions experiencing high levels of violence and displacement.	Key outcomes include a better understanding of the health impacts of violence, increased awareness of health care needs, and adaptations in service delivery to mitigate the effects of conflict.	Challenges include infrastructure limitations, resource scarcity, ongoing violence affecting health care access, and the difficulty of maintaining consistent health care delivery in conflict zones.
(41)	Health system resilience in the face of crisis: analyzing the challenges, strategies and capacities for UNRWA in Syria	UNRWA adapted its health service delivery through strategies such as emergency preparedness, multi-tasking among staff, opening mobile clinics, and enhancing collaborations with local and international partners.	Palestine refugees in Syria, particularly those internally displaced due to the conflict.	Retrospective qualitative case study with semi-structured interviews and group model building sessions.	Syria	Sustained service delivery despite conflict, improved access to health care through mobile clinics, enhanced collaboration for service provision, and increased capacity to manage crisis response.	Insecurity affecting access to health care, destruction of health facilities, psychological distress among staff, and resource limitations (e.g., medicines, power supply).

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Table 3. (*Continued*)

Reference	Title	Adaptive health system innovation	Population	Study design	Geographical region	Outcomes	Challenges/limitations
(42)	Adaptive mechanisms of health zones to chronic traumatic events in Eastern DRC: a multiple case study	The study describes coping mechanisms such as deploying military nurses, soliciting NGO support, relocating health care facilities, and negotiating with belligerents to maintain health care delivery during armed conflicts.	Health zones in Eastern DRC, specifically South Kivu, impacted by armed conflict and internal displacement.	Multiple case study	Eastern Democratic Republic of Congo (DRC)	Improved health care delivery in conflict zones, maintained performance indicators despite disruptions, and effective utilization of available resources.	Challenges included attacks on health care workers, resource limitations, fluctuating funding from NGOs, and the need for effective leadership under conflict conditions.
(43)	Health Care Organization in Poland in light of the refugee crisis related to the Military Conflict in Ukraine	The article proposes a strategy for adapting the Polish health care system to accommodate the influx of Ukrainian refugees, focusing on building resilience and enhancing health service delivery. Key elements include developing a communication system, implementing digital solutions, and reorganizing health care facilities to better serve refugees.	Ukrainian refugees in Poland, including those with varying health needs such as chronic diseases and vaccination gaps.	Literature review and brainstorming sessions to develop a strategic framework based on the WHO building blocks.	Poland, in response to the refugee crisis stemming from the Ukraine conflict.	Improved access to medical care for refugees, enhanced health service organization, and implementation of vaccination programs.	Resource shortages, infrastructure limitations, and the need for effective communication systems, especially in navigating health services for diverse populations.
(44)	The impact of digital technology on health of populations affected by humanitarian crises: Recent innovations and current gaps	The article reviews 50 digital technologies used in humanitarian contexts, including GIS for risk assessment, mobile data entry for registration, and electronic health records for chronic disease management.	Populations affected by humanitarian crises, including refugees and displaced individuals from conflicts and natural disasters.	Systematic literature review of existing technologies and their applications in health interventions.	Various regions affected by humanitarian crises, including Syria, Iraq, and Haiti.	Improved communication and coordination, enhanced data collection and analysis, timely health responses, and increased engagement of affected populations.	Lack of evaluation of technologies, privacy and equity issues, paternalistic development approaches, and infrastructure limitations.
(45)	Armed conflict and public health: into the 21st century	The article discusses various health interventions focused on trauma care, mental health support, infectious disease management, and maternal and child health services during conflicts.	Populations affected by armed conflict, including internally displaced persons (IDPs), women, children, and the elderly.	Literature review and synthesis of existing studies; observational studies where applicable.	Various conflict-affected regions globally, with specific examples from Syria, Iraq, and Darfur.	Improved awareness of health needs, increased health care delivery in some contexts, and better coordination among humanitarian organizations.	Infrastructure damage, resource scarcity, lack of access to health care, and political instability complicate intervention implementation.
(46)	Perceptions of non-communicable disease and war injury management in the Palestinian health	The study explores the perceptions of health care providers regarding the management of non-communicable diseases (NCD) and war injuries,	Health care providers in three major public hospitals in the Gaza Strip, including physicians and nurses with significant experience in	Qualitative study using focus group discussions (FGDs) to gather insights from	Gaza Strip, Palestine	Identified need for significant reforms, improved quality of care, and better management strategies for NCD and war injuries, emphasizing	Challenges include poor hospital infrastructure, shortages of medical supplies and trained personnel, lack of clinical guidelines, and

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Table 3. (*Continued*)

Reference	Title	Adaptive health system innovation	Population	Study design	Geographical region	Outcomes	Challenges/limitations
	system: a qualitative study of health care providers perspectives	highlighting the need for improved health care policies and interventions.	managing NCDs and war injuries.	health care providers.		the importance of updated clinical guidelines and better resource allocation.	difficulties in communication and coordination during emergencies.
(47)	Social and health care impacts of the Russian-led hybrid war in Ukraine–a conflict with unique global consequences	The intervention includes mobile outpatient clinics and community health initiatives aimed at addressing the urgent health care needs of internally displaced persons (IDPs)	The population includes Ukrainian civilians, particularly vulnerable groups such as women, children, and the elderly, affected by the conflict.	Narrative literature review	Ukraine	Improved access to health care for IDPs, restoration of medical facilities, and expansion of health care services despite ongoing conflict.	Limited health care infrastructure, staff shortages due to enlistment in military, and challenges in managing chronic diseases and mental health issues exacerbated by the conflict.
(48)	Impact of Ukrainian-Russian war on health care and humanitarian crisis	The intervention includes the deployment of Emergency Medical Teams (EMTs) to provide outpatient care and the delivery of medical supplies despite ongoing conflict.	The population includes Ukrainian civilians, particularly vulnerable groups such as the elderly, disabled, and displaced individuals affected by the war.	Narrative review and data analysis	Ukraine	Increased outpatient visits (4604 total), improved access to necessary medical supplies, and successful evacuation of patients for medical reasons facilitated by international cooperation.	Ongoing attacks on health care facilities, severe resource shortages, damage to medical infrastructure, mobility restrictions, and the significant displacement of health care workers.
(49)	Health system strengthening in fragile and conflict-affected states: a call to action	The article emphasizes the need for innovative health system strengthening (HSS) initiatives in fragile and conflict-affected states (FCAS) to improve health outcomes.	Populations in low and middle-income countries (LMICs), particularly in FCAS, facing vulnerable health and social conditions.	Editorial/Call to Action	Global, with a focus on FCAS, particularly in Africa and the Middle East.	Improved health system capacity and infrastructure aimed at achieving Sustainable Development Goals (SDGs), specifically SDG3 (good health and well-being).	Scarcity of resources, prioritization of basic needs over health services, ongoing conflicts, and the impact of the COVID–19 pandemic exacerbating existing health issues and neglecting health care in FCAS.
(50)	Next generation maternal health: external shocks and health-system innovations	The article discusses innovations like universal health coverage (UHC), behavioral economics, and mobile health as adaptive interventions to improve maternal health during crises.	Focus on pregnant women and newborns in low-income and middle-income countries affected by health systems under stress from armed conflict, disease outbreaks, and natural disasters.	The article reviews existing literature and trends, highlighting insights from various studies rather than a single study design.	Low-income and middle-income countries, particularly those experiencing armed conflict (e.g., countries in sub-Saharan Africa).	Innovations led to improved access to care, reduction in maternal mortality, and enhanced health care delivery systems despite crises.	Challenges include limited resources, high prevalence of disease, weakened health infrastructure, and political instability that hinders effective implementation of health policies.

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Table 3. (*Continued*)

Reference	Title	Adaptive health system innovation	Population	Study design	Geographical region	Outcomes	Challenges/limitations
(51)	Diffusion of e-health innovations in 'post-conflict' settings: a qualitative study on the personal experiences of health workers	The study explores the use of e-health innovations, focusing on communication tools and online learning platforms to enhance information access and training for health workers.	Health workers from various cadres and stages in their careers in post-conflict settings.	Cross-sectional qualitative study using semi-structured telephone interviews.	Liberia, West Bank and Gaza, Sierra Leone, and Somaliland	Positive perceptions of e-health, improved access to information, enhanced communication among health workers, and educational opportunities.	Barriers include poor, unreliable, and expensive Internet access, limited understanding of e-health scope, and reliance on international partners for resources.
(52)	Regarding the modernization of medical care system for victims of armed conflicts (Ukrainian experience)	The article discusses the development of telemedicine, mobile medical facilities, and counselling and rehabilitation services to improve health care delivery for victims of armed conflicts.	Victims of armed conflicts, health care workers, and health care institutions in Ukraine.	Descriptive cross-sectional study.	Ukraine	Improved access to medical care, enhanced quality of health care delivery, increased use of telemedicine, and better mental health support services.	Infrastructure breakdown, shortages of medical supplies, insecurity, lack of coordination among stakeholders, and inadequate policy frameworks.
(53)	Harnessing technology for infectious disease response in conflict zones: Challenges, innovations, and policy implications	The article discusses various technological innovations such as mobile health (mHealth) technologies, genomic sequencing, and AI-driven surveillance systems that enhance disease management and response in conflict-affected areas.	Populations in conflict zones with compromised health care infrastructure, including displaced persons and refugees.	Narrative review of literature; no specific study design mentioned as it compiles various studies.	Various conflict zones, specifically mentioning regions affected by armed conflict.	Improved disease surveillance, enhanced health care delivery, and timely responses to outbreaks were noted as key outcomes.	Challenges include infrastructural damage, resource limitations, mistrust in institutions, and ethical concerns related to data privacy and security.
(54)	Effect of armed conflicts on humanitarian operations: Total factor productivity and efficiency of rural hospitals	The study investigates how armed conflicts influence total factor productivity (TFP) and efficiency in rural hospitals, suggesting that conflicts may lead to innovations in health care management and practices in response to operational challenges.	The population includes medical staff and patients served by 163 rural public hospitals in Colombia, particularly in conflict zones.	Observational study using panel data analysis and data envelopment analysis (DEA) for efficiency estimation.	Colombia, specifically areas affected by the Colombian conflict.	Key outcomes include a positive effect on TFP and a negative impact on hospital efficiency during conflict, but improvements in both metrics post-conflict.	Challenges faced include disruptions in service delivery due to violence, resource scarcity, and difficulties in data collection from conflict-affected areas.

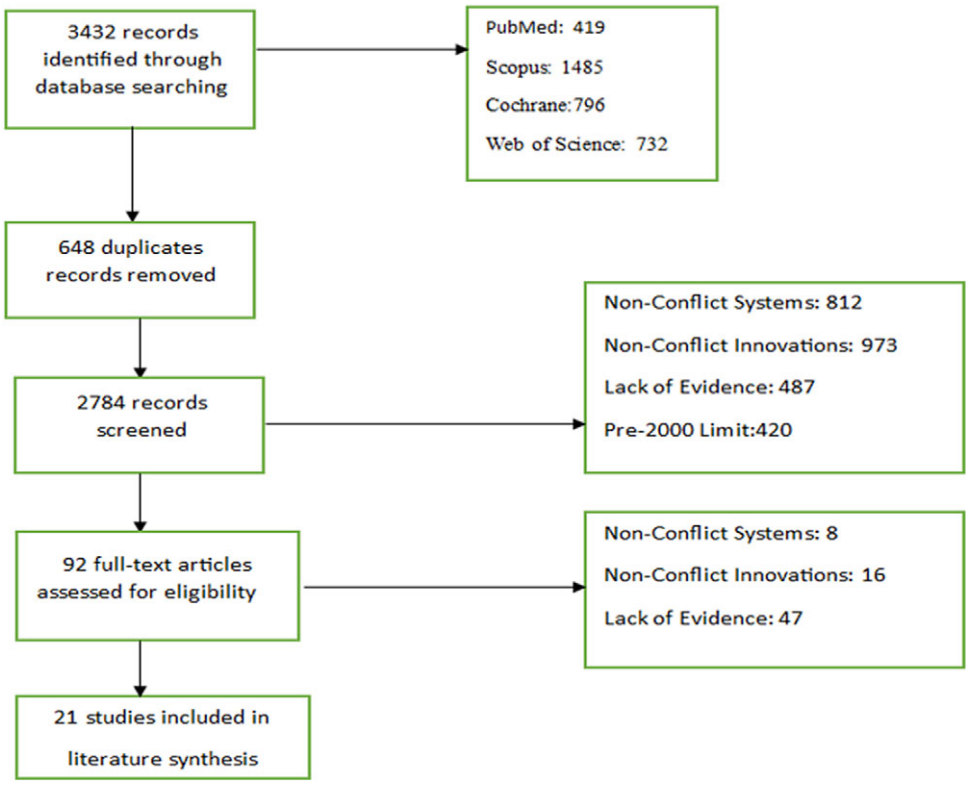


Figure 1. Systematic PRISMA article identification process inclusive of literature from January 2000 to February 2024. 1 Search engine suggestions of relevant studies and existing knowledge and resources. 2 Some articles excluded for more than 1 category.

Mobile Health Units and Increased Security: The establishment of mobile health units addresses the challenges posed by violence and instability. These units can reach populations that are otherwise inaccessible, providing critical health services and enhancing the overall security of health care provision in conflict zones.

6. Emergency Preparedness Strategies and Collaboration: Effective health service delivery during crises relies on robust emergency preparedness strategies. Collaboration with local and international partners, such as UNRWA, enhances the ability to respond swiftly and effectively to health needs arising from conflicts.
7. Use of Digital Technologies: The integration of digital health technologies, including Geographic Information Systems (GIS) and electronic health records, improves data management and service coordination. These technologies enable better tracking of health trends and resource allocation, facilitating more informed decision-making.
8. Universal Health Coverage (UHC) and Maternal Health: Innovations aimed at improving maternal and child health during crises are essential. Strategies that enhance UHC in conflict settings can lead to significant improvements in health outcomes for vulnerable populations.
9. e-Health and Telemedicine Innovations: The development of communication tools and online learning platforms fosters access to information and health care services, even in areas where traditional health care delivery systems have been disrupted. Telemedicine serves as a flexible solution that bridges the gap in care delivery.
10. Mechanisms to Address Health Needs in Wartime: The use of mobile clinics and emergency medical teams provides immediate health care responses to the urgent needs of affected populations. These mechanisms are critical for ensuring continuity of care in unstable environments.

These are health system innovations during armed conflicts that are not merely reactive; they are a strategic direction toward continuity of care for improved health outcomes among the most vulnerable populations. Decentralization at the decision-making level allows local health authorities to formulate responses that reflect particular needs of respective communities. It is here that the deployment of CHWs becomes pivotal in the delivery of care and building trust within the community—a precondition for any form of effective health intervention in these uncertain times.

The added value is the resilience that characterizes improved health systems, which are more resilient to support pressures that arise from conflicts. Mobile health initiatives, coupled with telemedicine, introduce flexibility and timeliness beyond traditional infrastructure constraints in real-time health interventions at locations most needed.

Adoption of digital technologies smoothest operations and makes health service delivery effective and easy to monitor health trends for effective resource allocation. In essence, these innovations position the health systems more ably to navigate the complexities of care delivery in conflict zones as a means of safeguarding the health and well-being of the most vulnerable populations from adversity.

These studies together demonstrate significant achievements in both access to health and service delivery aspects in war-affected regions. The main resultant features deal with increased awareness of humanitarian crises, reduced maternal and child mortality rates, and better coordination among health actors. Remarkably, some of

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these studies reported more than a 50% reduction in the maternal mortality ratio with better access to maternal health care services. It supported innovations in health care delivery—for instance, mobile clinics and telemedicine. Increased outpatient visits and successful medical evacuations outlined resilience in the health systems in response to conflicts. The mental health support services were greatly improved, as well as disease surveillance—supporting timely health responses.

Health care delivery in war situations is fraught with grave concerns like the destruction of health facilities, resource shortages, and threats to health professionals. That the militancy and political unrest persist and hamper the distribution of medical materials and render it exceedingly difficult to obtain regular care only adds to the problem. Stigma, discrimination, and the chaos of war also make it difficult to obtain reliable information and track health programs. These circumstances illustrate how badly we need effective plans to enhance health care in conflict-affected regions. In Yemen and Syria, for instance, the near collapse of health care facilities has illustrated how much we need innovative thinking, such as mobile health centers and telemedicine, to serve the needy even in such situations.[30–33]

Along with these positive results, a plethora of challenges and limitations face the delivery of health care in conflict zones. Health infrastructure was grossly destroyed, resources were very rare, coupled with a continuous threat to the safety of the health care staff serving in the area. Continuous violence, political instability, along with poor medical supplies, further complicates the situation and makes consistent health care access difficult to maintain. Added to this are stigma, discrimination, and the general disorder of war, which further reduce the accuracy of data collection and make effective monitoring or reassessment of health interventions quite impossible. These challenges outline with urgency the need for comprehensive strategies in strengthening the health care systems in areas of conflict.

Discussion

This study focused on the adoption of innovations and managerial strategies adopted in health care systems within crisis and wartime situations. The results from this study indicated that adopting adaptive health care frameworks and managerial innovations may lead to improved health outcomes while simultaneously reducing costs. Furthermore, the study discovered that different countries have different experiences when implementing these various innovations due to local conditions and individual requirements. Consequently, the analyses from the 21 selected articles illustrated a very positive effect of such innovations on health care performance in crisis situations.

The findings of this study confirm many previous works in the same area. For instance, previous studies have established those managerial innovations can improve efficiency and access to health care services even during periods of crisis. However, there are also some points of discrepancy in specific cases. While various literature highlights significant milestones in the implementation of adaptive health care systems, others point out infrastructural barriers and a lack of access to resources that may negatively affect the effectiveness of such innovations. These inconsistencies illustrate the complex and multifaceted nature of health care systems during periods of war and underscore the importance of local and cultural contexts.

This becomes important for this research, as it clearly shows that both innovations and managerial strategies have pivotal roles in the strengthening of health systems during crisis periods. The findings provide a good avenue for researchers and policy-makers to devise more efficient strategies in tackling health crises through comprehensive understanding from the different countries reporting successful and unsuccessful experiences. This research can also form the basis of recommendations for training programs and capacity-building initiatives among health care workers in affected areas.

Nevertheless, this research is not without its limitations that warrant attention. Initially, the choice to source articles exclusively from 4 databases may have led to the exclusion of significant and pertinent studies. Additionally, the emphasis on articles available in English could constrain the range of cultural viewpoints and experiences represented. Moreover, the data collected may be characterized as unstable and unreliable, owing to the fluctuating circumstances inherent in war and humanitarian emergencies. The overall findings of the study can be influenced by these factors, necessitating caution when extrapolating results to other contexts.

The findings of this study demonstrate the significant positive impacts of adaptive health interventions in conflict-affected regions. Key innovations, such as decentralized governance, community health worker programs, and mobile health units have resulted in measurable improvements in health outcomes. For instance, maternal mortality ratios decreased significantly in some areas due to enhanced access to maternal health care services. Additionally, the integration of telemedicine and information technology improved service delivery by enabling more efficient resource management and rapid responses to health emergencies. These successes underscore the critical role of adaptive strategies in mitigating the adverse effects of armed conflicts on health care systems, particularly in resource-constrained environments.

Ethical dilemmas are an ongoing concern in the provision of health care in situations of armed conflict. The security of health professionals is constantly undermined by the risk of violence, while infrastructural constraints like damaged facilities and scarce medical supplies limit regular service delivery. Stigma and discrimination also pose challenges to the access of needy populations to care. Addressing these ethical issues requires a holistic response in the form of enhanced protective action for health care workers, equitable access to resources, and collaboration with local and international stakeholders to enhance ongoing health care coverage in affected territories. These interventions are essential to promote trust as well as to establish resilience for affected populations.[34–36]

Future studies should explore the experiences of various countries' health systems, with a focus on cultural and social perspectives. Additionally, scholarship should also turn toward analyzing how digital innovations and new technologies impact the effectiveness of health care services during the crisis period. It can also act as instrumental means that allow increasing the availability of services and reducing the related costs. Besides that, developing collaborative programs with non-governmental organizations (NGOs) and local communities can enhance health care infrastructures and increase community involvement in crisis management.

Conclusion

This study highlights the importance of adaptive health systems and innovative management strategies in strengthening the effectiveness and resilience of health care during conflicts and emergencies. There have been remarkable developments, including decentralized management, community health worker programs, and mobile health units. However, still lingering challenges such as destroyed

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infrastructure, shortages, and security issues still make it hard to access sustainable health care. These findings form a sound basis for the continuation of research on how to improve health services in conflict areas.

Long-term research needs to study how effectively these innovations can grow and survive in the long term, especially in underrepresented areas like sub-Saharan Africa and Central Asia. There is also a need to track how new technologies, including artificial intelligence and telemedicine, can improve responses in emergencies and decrease costs. A comparison across a number of countries could provide insightful information on how cultural, social, and local factors impact the success of these programs.

In conclusion, this review shows how important it is to place emphasis on adaptive health strategies in a bid to reduce the negative effect of armed conflicts on health care systems. Through highlighting good practices from other places and encouraging cooperation among governments, NGOs, and local communities, health systems can be reinforced to better deal with future emergencies. These measures will improve health outcomes directly and enable the creation of more robust and equitable health care systems in vulnerable areas.

Data availability statement. All data generated or analyzed in this review are included in the published article.

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Ethical standard. This systematic review did not require ethical approval or participant consent as it involved the analysis of existing literature.

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