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Sudan's Health System Response Amid the ongoing 2023 Conflict: An Examination Through a Resilience lens

MPH Thesis

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Sudan's Health System Response Amid the ongoing 2023 Conflict: An Examination Through a Resilience lens

A thesis submitted in partial fulfilment of the requirement for the degree of Master of Science in Public Health and Health Equity

by

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Sudan

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Table of content:

Contents

List of tables and figures:

List of tables:

List of figures:

List of abbreviations:

Abbrev.	Full term
AAR	After-Action Review

ACAPS	Assessment Capacities Project
AWD	Acute Watery Diarrhoea
CFR	Case Fatality Rate
CHW(s)	Community Health Worker(s)
CHE	Current Health Expenditure
DHIS2	District Health Information Software 2
EBS	Event-Based Surveillance
EML	Essential Medicines List
EMR	Eastern Mediterranean Region
EOC	Emergency Operations Centre
EOC-NET	Emergency Operations Centre Network
ERR(s)	Emergency Response Room(s)
EWARS	Early Warning, Alert and Response System
FETP	Field Epidemiology Training Programme
FMUG	Faculty of Medicine, University of Gezira
FMoH	Federal Ministry of Health
GDP	Gross Domestic Product
GER	Gross Enrolment Ratio
H1N1	Influenza A virus subtype H1N1
HDP	Humanitarian–Development–Peace (nexus)
HEDRM	Health Emergency and Disaster Risk Management
HEEC	Health Emergency and Epidemics Control
HEPR	Health Emergency Preparedness and Response
HIS	Health Information System(s)
HIV	Human Immunodeficiency Virus
IBS	Indicator-Based Surveillance
IDP(s)	Internally Displaced Person/People
IHR	International Health Regulations

IOM	International Organization for Migration
INGO(s)	International Non-Governmental Organization(s)
JEE	Joint External Evaluation
KI	Key Informant
KII	Key Informant Interview
MENA	Middle East and North Africa
MHPSS	Mental Health and Psychosocial Support
MICS	Multiple Indicator Cluster Survey
MoH	Ministry of Health
MSF	Médecins Sans Frontières
NCD(s)	Non-Communicable Disease(s)
NGO	Non-Governmental Organization
NMPB	National Medicines and Poisons Board
NMSF	National Medicines and Medical Supplies Fund
NPHL	National Public Health Laboratory
OCHA	Office for the Coordination of Humanitarian Affairs
PHC	Primary Health Care
PHI	Public Health Institute
PHEOC(s)	Public Health Emergency Operations Centre(s)
RDT(s)	Rapid Diagnostic Test(s)
RRT	Rapid Response Team
RSF	Rapid Support Forces
SDGs	Sustainable Development Goals
SRH	Sexual and Reproductive Health
STAR	Strategic Tool for Assessing Risks
TB	Tuberculosis
UHC	Universal Health Coverage
UHC SCI	UHC Service Coverage Index

UN	United Nations
UNFPA	United Nations Population Fund
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
VHF	Viral Haemorrhagic Fever
WASH	Water, Sanitation and Hygiene
WFP	World Food Programme
WHO	World Health Organization

Key concepts:

Crisis: *A critical event or period of instability that disrupts normal functioning and poses significant threats to health, safety, or well-being, requiring urgent and effective response.*[1]

Disaster: *A serious disruption caused by natural or human-made hazards that results in widespread human, material, economic, or environmental losses, exceeding the affected community's ability to cope using its own resources.*[1]

Resilience: *The capacity of a system or population to prepare for, withstand, and recover from shocks or crises.*[1]

Rapid response team: *A specialized group of trained professionals quickly deployed to investigate and respond to public health emergencies, such as disease outbreaks, to contain and control them effectively.*[1]

Vulnerability: *The degree to which a system or population is likely to be harmed by hazards or shocks, due to exposure, sensitivity, and limited capacity to cope.*[1]

Abstract

Introduction:

Sudan's ongoing-armed conflict has severely disrupted its health system, exposing weaknesses in preparedness and response. Understanding how elements of resilience emerged during this crisis can inform strategies for fragile settings.

Objective:

To explore how Sudan's Health Emergency system demonstrated resilience across awareness, self-regulation, integration, diversity, and adaptation during the 2023 conflict, and to derive recommendations for strengthening health emergency system capacities.

Methodology:

A qualitative design combined a systematic literature review of 62 documents with six key informant interviews from federal, state, UN, and humanitarian actors. Data was thematically analysed using an adapted Kruk et al. (2015) resilience framework, triangulating findings across sources.

Results:

Before the conflict, Sudan had multi-hazard preparedness plans, a dual surveillance system, and trained rapid response personnel, but chronic underfunding, uneven workforce distribution, and weak subnational operationalization constrained awareness capacity. Following Khartoum's collapse, the system reorganized into three operational hubs. Integration was achieved through Health Cluster coordination, humanitarian–development–peace nexus programming, and cross-border vaccination campaigns. Diversity emerged through community health workers, midwives, grassroots Emergency Response Rooms, diaspora-led telemedicine, and humanitarian corridors. Adaptive responses included conflict-oriented medical education and policy dialogues, although limited institutional learning hindered sustained change.

Conclusion:

Sudan's health system relied on decentralized operations, informal networks, and community-driven initiatives to sustain essential services during conflict. Institutionalizing these mechanisms, enhancing subnational capacities, securing protected health financing, and formalizing diaspora and community roles are critical to building sustainable resilience in similar fragile contexts.

Keywords: Sudan, armed-conflict, emergency response, resilience.

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In the name of Allah, the Most Gracious, the Most Merciful. All praise and gratitude are due to Allah, whose infinite wisdom and mercy granted me the strength, clarity, and endurance to complete this journey. Without His guidance, none of this would have been possible.

To my beloved family: your love and quiet prayers have been the invisible hands lifting me through every challenge. You believed in me when I doubted myself, and for that, I am forever grateful.

To my friends, near and far, especially those who stood by me during moments of isolation and uncertainty, you gave me strength through your words, your presence, and your unwavering belief in me. You are my chosen family, and I cherish you deeply.

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This work is a reflection not only of my efforts, but of all those who walked this path with me, in seen and unseen ways. May it serve a greater purpose.

Dedication

To the soul of my beloved father Ahmed Bashir Babikir, your absence weighs heavily, yet your love and belief in me continue to echo in everything I do. This work carries

your name in every step I took. I pray you are in heaven and that this accomplishment makes you proud.

To my mother, my home, my friend and mentor. Your hands have carried my burdens, your words have guided my path, and your prayers have guarded my soul. May Allah bless you always. This journey, this thesis, this moment it all carries your fingerprint.

To my homeland, Sudan a place of pain, beauty, and undying spirit. May peace embraces your soil and may healing reach your people. This work is rooted in your struggles and your resilience.

And to the emergency health personnel across Sudan and in all fragile and conflict-affected settings you are the guardians of life in the face of hardship. You are the soldiers of compassion, holding the line where systems fail. This is for your courage, your quiet service, and your unwavering humanity.

Introduction:

For eight years, I have worked in Sudan's health sector as a pharmacist turned public-health practitioner, focused on emergency preparedness, response, and the supply of lifesaving commodities. My roles span rapid response and early-preparedness teams, leading the

emergency supply team, and during the 2023 war serving as the focal person for emergency supplies within the Public Health Emergency Operations Center supporting Gazira and other operational hubs. I am currently pursuing a Master of Public Health at KIT Royal Tropical Institute.

During the war and concurrent outbreaks, I witnessed how Sudan's health workforce coped with extreme stress. Senior managers put on white lab coats to serve in hospital wards during the most acute periods. At the same time, I witnessed how governance fractures, disrupted communications, and supply-chain collapse strained already fragile systems, yet I also saw bright spots: leadership willingness, virtual EOC coordination, and community-led solutions that kept some services alive.

On a personal note, I am a war witness who has been displaced several times. I also lost my father three months ago yet continued to complete this degree. Like many Sudanese health workers, I try to carry that quiet strength; my contribution is modest compared with frontline sacrifices, but it shapes why I chose this topic to reflect, in a measured way, Sudan's capacity to endure and to act.

This experience motivates a resilience lens. Rather than focus on a single hazard or programme, I sought a system-wide perspective that speaks to fragility and disruption from multiple threats conflict, epidemics, and climate shocks and examines how core functions anticipate, self-regulate, integrate, diversify, and adapt under pressure. In this study, I assess how Sudan's health emergency preparedness and response system performed during the ongoing 2023 conflict, drawing on literature and key-informant interviews across national and subnational levels, to distil practical lessons for recovery and for strengthening HEPR in Sudan and similar fragile settings.

Chapter 1: Background

1.1 Health Emergencies

Health emergency as defined by WHO is "*an event that poses a substantial risk to human health, causing or potentially causing significant morbidity or mortality, and requiring a coordinated response to prevent or manage its impact*." (1).

Today these emerging events comprising natural disasters including climatic shocks, disease outbreaks and conflicts, continue to cripple the health system and harm communities, causing increased deaths, displacement, and human rights violations. They are becoming more prolonged, impacting more people and requiring greater resources to manage them including prevention (preparedness), response and recovery (2).

Health emergency preparedness and response (HEPR) involves planning and actions to manage health risks during emergencies. Key components include risk assessment, resource allocation, coordination among stakeholders, communication strategies, and training to enhance resilience against health threats and disasters (3).

Kruk and colleagues defined resilience in health emergency, as "*a health system's ability to prepare for, respond to, and recover from crises such as epidemics and conflicts while continuing to deliver essential services*" (4).

The concept emphasizes the importance of Public Health Emergency Operations Centres (PHEOCs) as pivotal coordination hubs. Frameworks like the International Health Regulations (2005) and WHO guidelines strongly advocate for the establishment of PHEOCs to enhance decision-making, coordination, and information management during health crises (5,6). The WHO's Emergency Operations Centre Network (EOC-NET) also promotes best practices and standardization of PHEOC structures globally (7). Empirical studies and field evaluations during epidemics have demonstrated that PHEOCs reduce response times, improve resource access, and strengthen intersectoral collaboration (8,9). Investing in these systems is therefore crucial for mitigating the human and economic impacts of emergencies and fostering resilient health infrastructures (6,9).

1.2 Global and Regional Context of Health Emergencies

The 21st century has witnessed a global surge in the frequency, scale, and complexity of public health emergencies (10,11,12). These challenges are profoundly magnified in fragile and conflict-affected settings, where chronic vulnerabilities such as weak health systems, displacement, and insecurity intersect with acute shocks like disease outbreaks or natural disasters to create compounding humanitarian crises (13,14). Evidence shows that health systems in such settings often lack the governance, infrastructure, and emergency response capacity needed to manage concurrent crises effectively (13,14,15).

In 2024, disasters affected 167 million people, and nearly 123 million were displaced because of conflicts. These crises damage health systems, reverse development gains, and cost hundreds of billions annually (16). Climate change, urbanization, and instability worsen the situation.

Africa and the Middle East and North Africa (MENA) region face severe and complex emergencies, where conflict, displacement, natural hazards, and fragile health systems intersect to produce compounded public health threats (17,18). Despite efforts to improve surveillance and response coordination, widespread displacement, health system fragility, and resource constraints continue to impede effective preparedness and response in many countries (19,20). Within the WHO Eastern Mediterranean Region (EMR) which includes 22 Member States and territories 13 are directly or indirectly impacted by conflicts, including Sudan, which exacerbates vulnerabilities and challenges to resilience (21).

1.3. Sudan's Context and Health Emergency Profile (Pre-2023 Conflict)

Sudan, strategically situated at the crossroads of Africa and the Middle East, embodies both chronic vulnerability and the urgent imperative driving the global movement to build robust health emergency preparedness and response (HEPR) systems (22,23). Sudan's recurring crises illustrate how health systems endure extreme stress, with repeated facility damage, service disruptions, and workforce depletion acting as tragic case studies (24,25). Understanding Sudan's geographic, socio-political, and health system context is essential for evaluating its emergency preparedness capacity before the 2023 conflict onset (26,27). This section outlines the key factors that shaped and strained the health system.

1.3.1 Country Profile: Geo-Demographic, Political and socio-economic Context

A. Implications of Geo-Demographic and Socio-economic Landscape on Health:

Sudan, the third-largest country in Africa, has a population estimated at ≈ 50.0 million in 2023, with 63.7% living in rural areas (28,29,30). It spans vast ecological zones from deserts to savannas and borders seven countries as shown in the map below (31), including Egypt, Ethiopia, Chad, South Sudan, Eritrea, Libya, and the Central African Republic, positioning it as a critical corridor for population movement and disease spread (32). These geographical factors have shaped population settlement patterns, influenced economic activities, and contributed to disparities in development and access to resources (33).

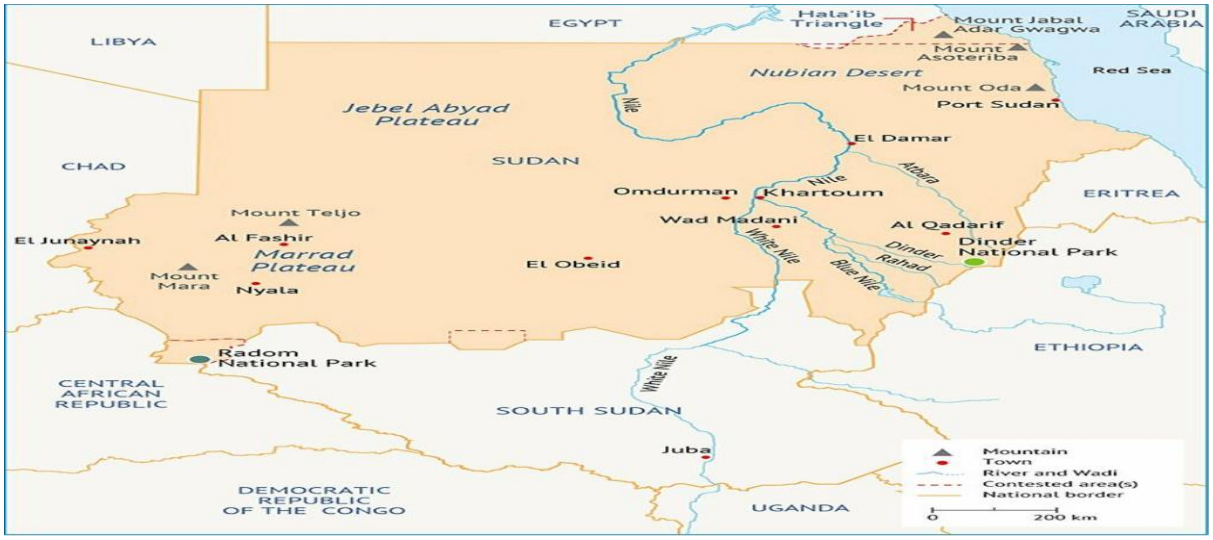


Figure 1: Sudan map. (31). Current health challenges and priorities in Sudan: https://gh.bmj.com/content/bmjgh/4/4/e001723.full.pdf (31).

Sudan is demographically young, with a life expectancy at birth of approximately 67 years (28). Around 20.4% of the population is under 14 years, and 15.4% are under five years old, and approximately 25% are women of reproductive age (15–49 years), groups particularly vulnerable to health emergencies and system disruptions (34,35,36).

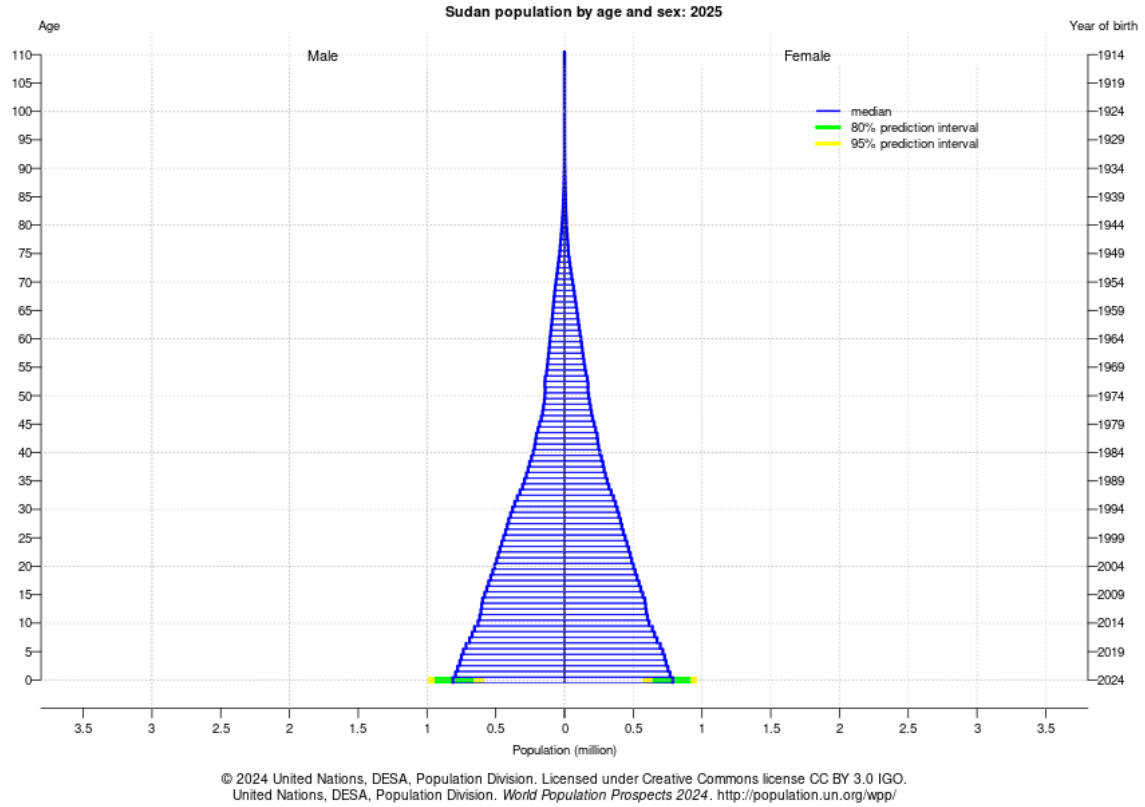


Figure 2 : Sudan population pyramid. Source: UN world population prospects 2024 https://population.un.org/wpp/graphs?loc=729&type=Demographic%20Profiles&category=Population%20Pyramids&year=2025(37). (37).

Sudan's economy has contracted by 2.5% and inflation rate was almost 140 % as reported by the International Monetary Fund estimates in 2022 (38). The inadequate public revenues, weak governance and institutional capacity, being aggravated by freezing the International Aid due to the military coup of 2021, have further hampered the Government's ability to provide access to quality social services and social protection to people specially during humanitarian crisis across Sudan (39).

In view of the above, poverty is widespread in Sudan with an estimated 50.3% of the population suffering multidimensional poverty (MDP) and an additional 17.7% vulnerable to it. Poverty due to health contributes to 21.1% of MDP (40). The rural population are more affected limiting their access to basic services including the health (41).

Education system in Sudan before 2023 faced multiple challenges with low enrolment and attainment levels. The gross enrolment ratio (GER) was about 78% in primary education and 48% in secondary education during 2013-2018, reflecting moderate increases but still the lowest compared to many regional neighbours. The tertiary enrolment ratio was even lower at 17%, despite some expansion efforts (42, 43).

Table 1 : Summarizing Key Population Indicators.

Indicator	Value
Population	50 million
Life expectancy	67 years
Primary School gross enrolment ratio	78%
Secondary school enrolment ratio	48%
Tertiary enrolment ratio	17%

B. Political Context and Governance Challenges:

Sudan follows a devolutionary decentralized three administrative levels of a federal governance system: federal (central), 18 state and 189 locality (district) levels. Each state is administered by an assigned Governor and a cabinet of ministers observed by an elected state legislature council. This reform was expected to increase autonomy in decision making and therefore improve access to essential services; yet financial constraints, political unrest, interference in planning and limited local decision-making autonomy have been obstacles to real decentralization, that impacts the health system (44, 45).

Sudan's landscape features a complex interplay of geography, demographics, and political dynamics, resulting in persistent instability and conflict. Its strategic location at the crossroads of North and Sub-Saharan Africa and the Middle East, has made it a focus for international and regional powers, while being torn by internal divisions and power struggles as of its independence in 1956, fuelling cycles of violence and political instability, the latest was on 15th April 2023 (46).

Health status

The epidemiological profile of Sudan is dominated by communicable diseases which is one of four causes leading to death. It accounts to 44.1% of deaths. with exacerbation of outbreaks, such malaria, cholera, haemorrhagic fevers, measles (28). Maternal mortality ratio is 256/100,000 live births (47), under five child and infant mortalities account to 68 and 33/1000 live births respectively, while wasting and stunting among children under five years (U5) reach 14.1% and 36.6% respectively (48,49).

non-communicable diseases (NCDs) have emerged as a major public health burden, with rising prevalence and increasing contribution to mortality across the country (50) (see figure no 3). Sudan national policy 2017-2030 estimates that NCDs are responsible for 33.9% of all deaths (51), while recent studies suggest that this value increased to over 50 % over of all deaths in Sudan, with cardiovascular diseases, cancers, chronic respiratory conditions, and diabetes mellitus identified as the most common and impactful forms (28,52,53).

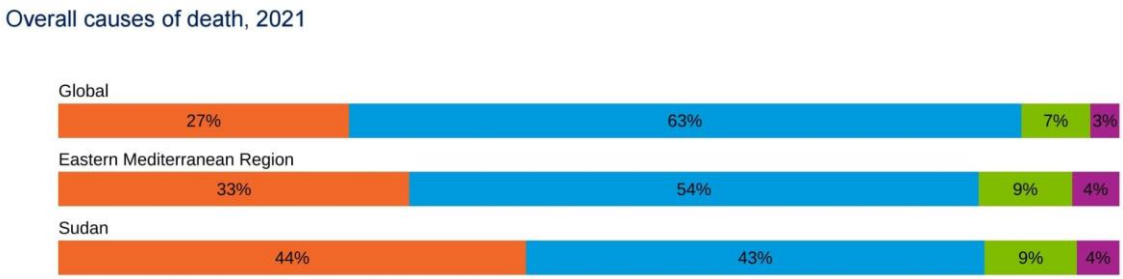


Figure 3 Overall causes of death in Sudan 2012 Source: WHO, Sudan Health at a Glance 2024. https://srhdpeuwpubsa.blob.core.windows.net/whdh/DATADOT/COUNTRY/PDF/729_Sudan.pdf (50).

1.3.2 Health System Context and Challenges

Prior to the 2023 conflict, Sudan's health system was a complex entity attempting to navigate chronic underdevelopment and recurrent crises within a fragile governance structure.

The analysis below follows the WHO six blocks of the health system.

A. Leadership and Governance:

The health system follows the three tire levels of the federal governance, where the FMOH undertakes the stewardship role for the health sector, including policy development and strategic planning, international health regulations and leading interventions on national health in emergencies, financial and technical oversight on states. Under the oversight of the National Public Health Council headed by the President (before *the Military coup of 2021*), the FMOH coordinates the entire health sector related interventions (54).

The states are responsible of developing operational planning , local legislations, in line with federal constitutions and policies and are directly responsible of overseeing localities and service delivery, while the localities are responsible of the implementation of the operational

plans and provision of health services namely at the PHC and community levels under the legal framework stipulated in the Local Federal Act updated in 2017; yet there is a great dichotomy of roles and responsibilities between the different level, leading to dual function and fragmentation of services, inadequate financing and leadership (54,55) .

B. Health System Financing

The current health expenditure (CHE) is 5% of the GDP, below the global average of 10%, while the domestic general government health expenditure and the social health insurance account to 26% and 12% of the CHE (56). With these meagre financing of health, 47.2% of the FMOH spending goes to hospitals, undermining the primary health care (PHC) -the path to universal health coverage (57).

Eighty percent (80%) of the Sudanese households' funds to encounter health spending is sourced from their own resources (out of pocket). About 19% of them cope with catastrophic health spending by reducing expenditures on other living items such as food, education and housing (58).

Moreover in 2021, a military coup took place following greatest achievements in lifting Sudan's depts, resulting in international freeze of the external aid to the country. The removal of subsidies disproportionately impacted health services and access specially during emergencies (59).

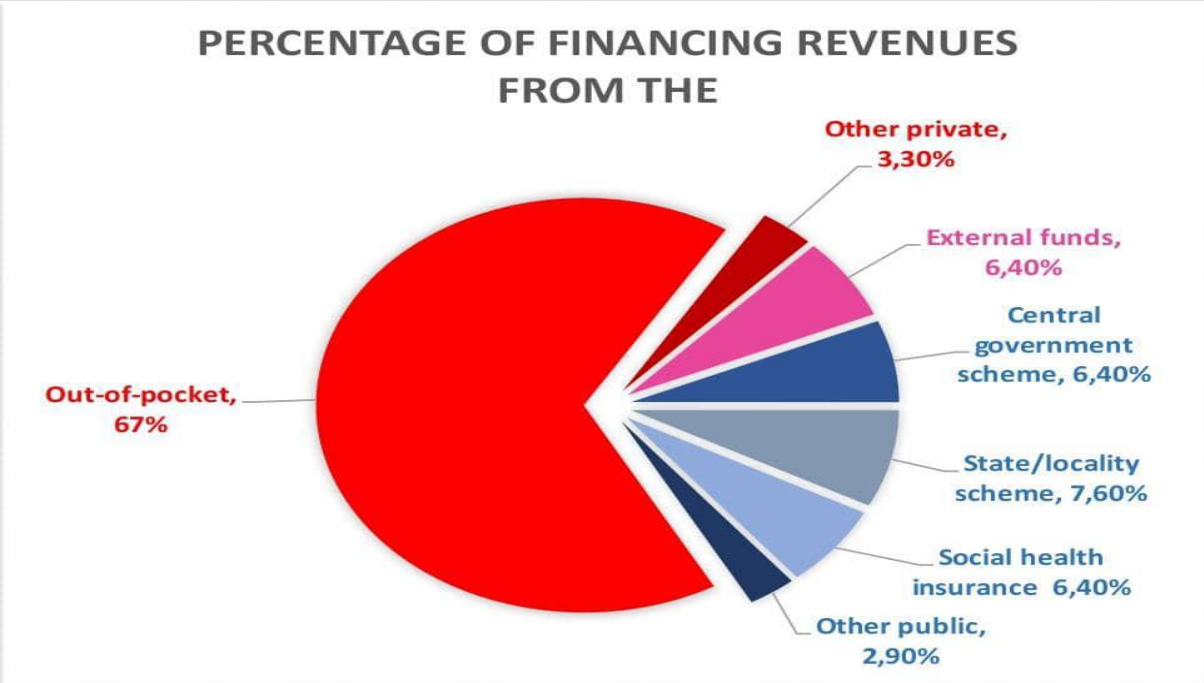


Figure 4 : Sudan Health Financing Revenues as a percentage of Total Health Expenditure, source Sudan Health Account 2018.https://bibalex.org/baifa/en/resources/document/476754 (60).

C. Health Workforce:

The production of health workforce has increased during the past two decades with the establishment of Academies of Health Sciences at state level tailoring the educational programme to local needs; however, issues of deployment and retention hamper such achievements. Absences of staffing and deployment policies, poor working and living condition in remote areas, have led to inequitable distribution of human resources where 70% serve in urban areas of 30% population (52,56).

D. Health Services Delivery and Infrastructure:

Sudan's health system, especially at PHC level, has faced chronic underinvestment, fragmented financing, and workforce shortages, leading to major disparities in access, quality, and affordability, particularly in rural and conflict-affected areas (61). The UHC Service Coverage Index was just 43.7%. A 2021 survey of 5,747 facilities across 10 states found 49% lacked electricity, while vaccination, laboratories, and essential medicines were available in only 54%, 52%, and 53% of facilities, respectively (62). These gaps reflecting limited baseline resilience, were expected to drastically worsen post-2023 conflict.

E. Health Information Systems (HIS):

Sudan's Health Information System (HIS) comprises both routine programmatic monitoring and public health surveillance, coordinated across several directorates within the Federal Ministry of Health. The integrated HIS, managed by the National Health Information Centre, operates primarily through the District Health Information Software 2 (DHIS2) platform, which was adopted in 2014 and officially launched in 2016 (54).

Significant progress has been made in building HIS infrastructure, including training over 7000 health workers nationwide and improving reporting rates from 30% in 2016 to 64% by mid-2020. However, the system remains challenged by fragmentation, particularly between routine health monitoring and disease surveillance, which are managed by separate directorates. Additional gaps include uneven data coverage, poor internet connectivity, limited data use for decision-making, and vulnerability to shocks such as political instability and pandemics as seen during Covid-19 (50,54,63).

F. Access to Essential Medicines:

Sudan's pharmaceutical sector is regulated at multiple levels and features a well-developed drug registration system, but faces persistent challenges in governance, quality assurance, and equitable access. Medicines made up16% of total health spending, with most costs paid out-of-pocket, highlighted in the national health policy 2017-2030 (50). Several government and donor-supported free treatment programs aim to alleviate this burden.

Frequent stock-outs of essential medicines are driven by poor forecasting, fragmented supply chains, and limited coordination. In response, Sudan has moved to centralize procurement

and distribution under the National Medicines and Medical Supplies Fund (NMSF) to streamline supply systems and enhance efficiency.

The Federal Ministry of Health's Directorate General of Pharmacy oversees the annual development of the Essential Medicines List (EML), while the NMSF and the National Medicines and Poisons Board (NMPB) are responsible for procurement and regulatory oversight. Efforts to strengthen local pharmaceutical manufacturing are ongoing but remain constrained by financial and logistical barriers, limiting progress toward improved medicine availability and affordability (64)

Chapter 2 problem statement, justification and objectives:

2.1 Problem Statement

Sudan's health system has long contended with a formidable array of challenges. Beyond the growing burden of non-communicable diseases and a history of recurrent epidemics (65,66), the nation is vulnerable to climate change (67,68) and has endured prolonged periods of political instability, including active conflicts in regions like Darfur, Blue Nile, and South Kordofan (69,70,71,72) as shown in the figure below.

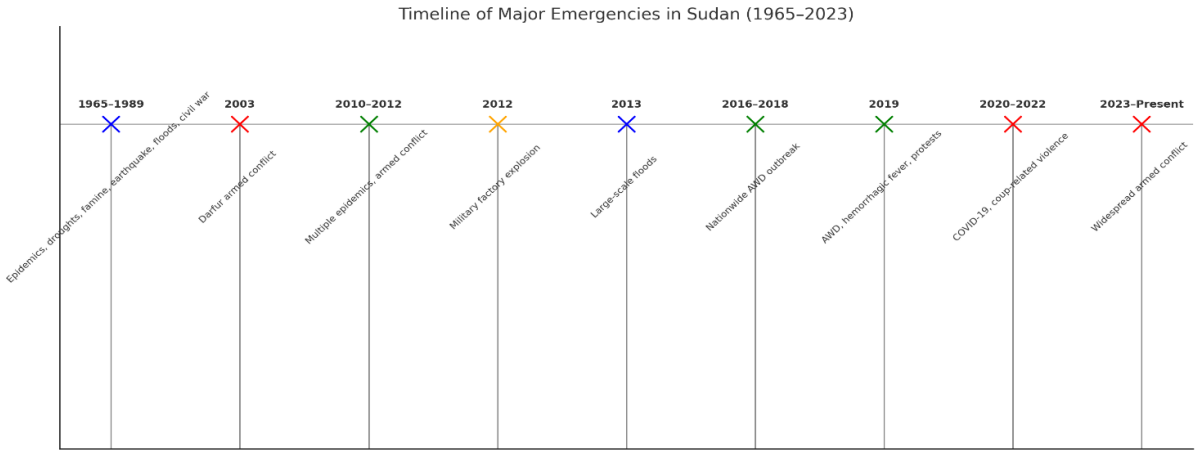


Figure 5 : Key Public Health Incidents and Disasters in Sudan, 1970s-2023. Source: Sudan Health Emergency and Disaster Risk Management Strategy (HEDRM)2017-2020. unpublished (72).

Over the past decade, Sudan with support from international partners made notable progress in strengthening emergency preparedness and response capacities at national, state, and local levels (73,74,75,76), aligning with global standards, particularly the World Health Organization's (WHO) guidance and the core capacities required under the International Health Regulations (IHR 2005) (77).

However, in the recent years, Sudan has experienced a series of overlapping and compounding crises including recurrent cholera and viral haemorrhagic fever outbreaks (78,79, 80), the COVID-19 pandemic, political instability and most recently, the large-scale ongoing armed conflict that erupted in April 2023 (81,82,83).

The 2023 conflict, in particular, plunged the health system into a multi-layered emergency. In areas directly affected by active conflict, particularly in Khartoum and parts of Darfur, the health system has suffered catastrophic collapse with widespread destruction of infrastructure, disruption of health services, and breakdown of communication, coordination and governance mechanisms (84, 85). These areas remain hard to access for response as well for research.

However, the situation in the accessible states in like eastern and northern region, presents a different critical concern. These states, though relatively spared from direct hostilities, were severely impacted by large-scale displacement reached10.8 million people in September 2024

(86), nationwide supply chain disruptions, acute health workforce shortages, and simultaneous disease outbreaks (87). The accumulated pressures stretched already under-resourced and fragile health systems to their limits creating conditions where system failure seemed inevitable.

Yet, in some of these settings, evidence suggests that certain features of resilience and coping have emerged. Health systems demonstrated varying degrees of flexibility raising important questions about the determinants of health system performance under prolonged crisis (23).

This study does not aim to generalize or portray Sudan's health system as resilient in a uniform sense. Rather, it seeks to explore and understand the context-specific factors that enabled elements of the system to exhibit response capacity during an overwhelming complex emergency. In doing so, the study aims to contribute to a more grounded understanding of resilience in fragile and conflict-affected settings.

2.2 Justification for the Study

This study is both timely and relevant. By examining core dimensions of health emergency management including anticipatory capacity, integration, adaptation, diversity, and self-regulation the study offers critical insights into the resilience of Sudan’s health system at a moment of profound national crisis.

Using a qualitative lens, the study captures perspectives from both national and subnational levels, including frontline actors and implementing partners. This approach will contribute to the current literature gap, where documentation of health emergency response in Sudan remains fragmented.

The findings will support the Federal Ministry of Health’s efforts to further assess and review the emergency response mechanisms during the 2023 crisis and will inform future strategies for recovery and system strengthening. Moreover, the study contributes to broader regional and global discussions on building resilient health systems in protracted crisis settings.

Research question:

How does Sudan's health emergency preparedness and response capacity shape the system's ability to anticipate, self-regulate, integrate, diversify and adapt its functions during the acute phase and prolonged disruption of the ongoing 2023 conflict.

Overall objective:

To explore how Sudan's national health emergency and response system demonstrated resilience, encompassing its Awareness, Self-Regulation, Integration, Diversity and Adaptation, during the ongoing 2023 conflict, to generate evidence-based recommendations for strengthening HEPR capacities in fragile and conflict-affected settings.

Specific Objectives:

1-To describe Sudan's anticipatory capacity and examine how these influenced the health system's response to the ongoing 2023 conflict.

2-To explore how institutional reorganisation, coordination mechanisms, and governance decisions shaped the health system's capacity for self-regulation and integration during the conflict.

3-To identify the operational practices that enabled or constrained the diversification and adaptation of health services, actors, and delivery mechanisms under prolonged disruption and infrastructure collapse.

4-To derive evidence-based recommendations from these findings for reinforcing health emergency preparedness and response in Sudan and similar fragile contexts.

Chapter 3: Methodology and Conceptual Framework

This chapter outlines the research methodology used to assess the resilience of Sudan's HEPR system during the 2023 conflict, covering study design, analytical framework, literature search strategy, data collection, analysis, and ethical considerations

3.1 Study Design and Analytical Framework

This qualitative study combines literature review and Key Informant Interviews (KIIs) to explore Sudan's health emergency response system during the ongoing 2023 conflict. Guided by Kruk et al.'s (2015) resilience framework and contextualised with Sudan-specific literature, the study triangulates data from diverse documents and KIIs to validate gaps.

3.1.1 Analytical Framework: Health System Resilience as Lens for Analysis

The study used an adapted version of Kruk et al.'s (2015) Health System Resilience Framework to assess Sudan's emergency response system during the 2023 conflict. It was chosen because it is relevant to fragile contexts and it enables analysis of dynamic system behaviours, like adaptation, integration, and diversity, beyond static preparedness. Furthermore, it provided a structured and flexible basis for exploring the three objectives of the study.

The framework guided the search strategy, the design of research tools such as the topic guide, the analysis of documents and literature, the analysis of interviews, and the presentation of findings in this study.

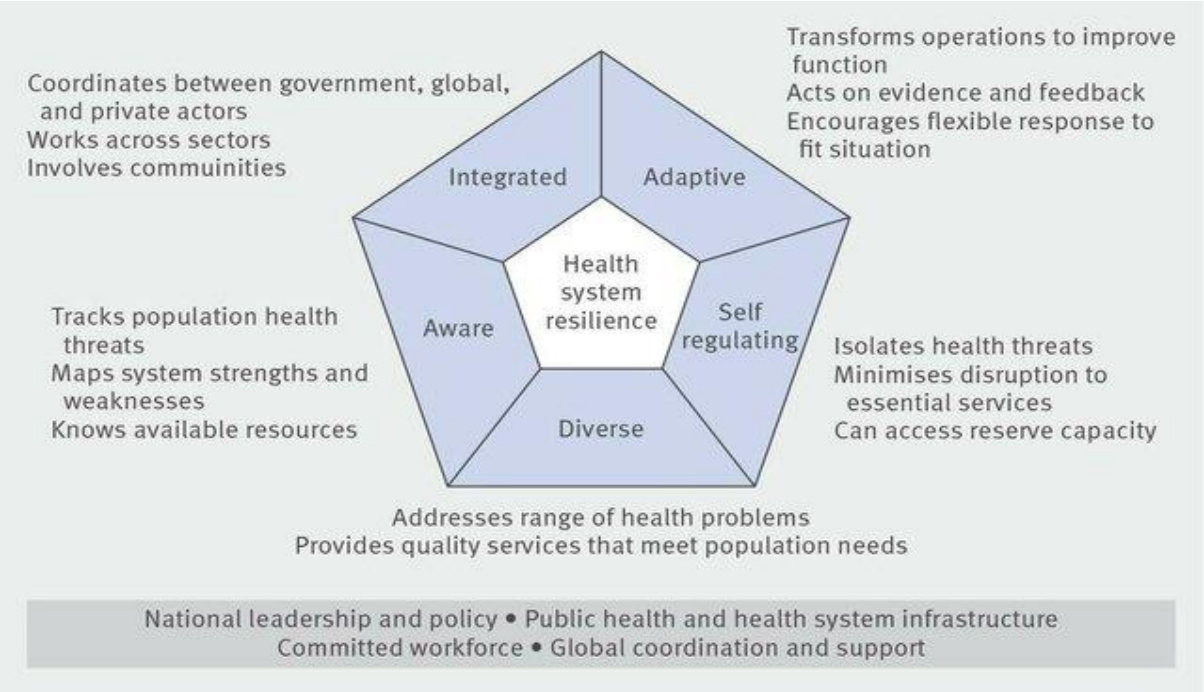


Figure 6:1 Framework for Health System Resilience. Source: Figure modified from Kruk and colleagues' framework(4), source: uploaded by Robert Marten

https://www.researchgate.net/publication/317118883_Building_resilient_health_systems_A_proposal_for_a_resilience_index/figures. (4)

The framework's dimensions have been adapted to suit core elements that are central to Sudan's response to the 2023 conflict, which were mostly aligned with the pillars outlined in the national HEDRM strategy (see table 2) (72), ensuring contextual relevance and institutional coherence.

Table 2: Study analysis matrix showing alignment between study objectives and adapted framework dimensions

Objective	Framework dimension	Main theme	Sub theme
To describe Sudan's anticipatory capacity and examine how these influenced the health system's response to the ongoing 2023 conflict.	Aware	Capacity of system to map risks and detect hazard. Trained personnel	• Existence multi-hazard plan • Surveillance systems • Lab capacity to detect diseases early • Workforce
To explore how institutional reorganisation, coordination mechanisms, and governance decisions shaped the health system's capacity for self-regulation and integration during the conflict.	Self-regulate	Reorganisation and maintenance of core functions	Substitution of national structures • Adaptive coordination mechanisms • Decentralised supply chain management • Local-level self-regulation
	Integrate	Coordination and multi-sectoral service delivery	• Health Cluster • Humanitarian–Development–Peace (HDP) nexus in programming • Cross-border and regional integration
To identify the operational practices that enabled or constrained the diversification and adaptation of health services, actors, and delivery mechanisms under prolonged disruption and infrastructure collapse.	Diversity	Adjustment in roles and operation	• Community Health Workers (• grassroots service providers • Telemedicine and diaspora health networks • Humanitarian health corridors
	Adaptation	Learning and modification	• Educational adaptation • Operational adaptation • Policy and planning adaptation

3.2 Study Area and Population

3.2.1 Study Area

The study focuses on Sudan's national Health Emergency Preparedness and Response (HEPR) system, which was coordinated from three operational hubs in Gezira, Red Sea, and Kassala states. These hubs were designated as alternative coordination centres by the FMoH following the collapse of Khartoum in 2023. These states, hosting displaced federal institutions and active humanitarian actors.

3.2.2 Study Population for Key Informant Interviews

The study targets institutional actors and technical professionals directly involved in the HEPR before and during the conflict. These participants offer invaluable firsthand insights into system operations, disruptions, adaptations, and intersectoral dynamics. (see Table 3 for the list of participants)

Table 3: Distribution of the target population by key entity

Entity	Participant code
Federal-MOH	P1
	P2
	P3
State MoH	P4
	P5 *(formal federal)*
UN agency	P6

Inclusion Criteria for KII Participants:

The study enrolled directors and programme managers, who have been in the position for the last three years to ensure their understanding of the situation through a number of crises and who have continued throughout 2023-2024.

3.3 Search Strategy for Literature Review

A systematic search strategy was employed to identify relevant literature and grey reports, ensuring comprehensive coverage of Sudan's HEPR landscape.

3.3.1 Inclusion Criteria for Literature Review

Due to the special focus on the case of Sudan, and the importance of tracing the history of emergencies, the review included literature from 2011–2025, covering Sudan's post-secession health policy context. Sources in English and Arabic were considered, with inclusion based on

relevance to system-level preparedness, coordination, legal frameworks, surveillance, risk communication, logistics, and institutional adaptation in Sudan or similar fragile settings.

- **Types of Sources:**

The literature search included peer-reviewed databases such as PubMed, Scopus, ScienceDirect, Google Scholar, and the Vrije Universiteit online library, as well as grey literature from organisations like WHO, UNICEF, OCHA, MSF, UNOCHA, and Sudan's Ministry of Health. A snowballing approach was also used, reviewing the reference lists of relevant articles to identify additional sources. In addition, strategic and operational documents, including unpublished reports, were purposively collected through direct contacts within the Ministry of Health and coordination platforms. A full list of FMoH documents included is provided in Table 4.

Table 4: FMOH documents used in the literature review

No	Document	Year
1	Sudan's National Health Policy	2017-2030
2	HEEC strategy	2017-2020
3	HEEC structure	2022
4	National Multi-Hazard Preparedness and Response Plan	2022, 2023
5	IHR Joint External Evaluation	2017
6	Rainy season response final report	2019
7	NMSF recovery strategy	2024-2028
8	EOC meeting reports	2023-2025

3.3.2 Exclusion Criteria for Literature

Literature was excluded if it:

- Focused solely on clinical outcomes or vertical programs (e.g., HIV, TB) without linking to systemic emergency response.
- Used only technical efficiency or cost-effectiveness models without addressing governance or resilience.
- Was published before 2011

3.3.3 Search Terms and Boolean Operators

Search strings utilised combinations of the following terms, adapted for each database as necessary:

- "Sudan" AND ("health emergency" OR "disaster") AND ("conflict" OR "epidemic" OR "surveillance") AND (“lab” OR “diagnostic”) AND (“supplies” OR “medicines”) AND (“human resources” OR “workforce”) AND (“Adaptation” OR “resilience”)
- Annexe 1 provides the table for keywords used in the search strategy.

3.4 Sampling, Identification, and Recruitment for Key Informant Interviews

3.4.1 Sampling Strategy

Purposive sampling was used to capture diverse perspectives across federal and state health units, UN agencies, and humanitarian actors from varied geographic settings. Snowball sampling helped reach displaced or hard-to-access technical staff. In total, 6 key informants were interviewed.

3.4.2 Recruitment Process

Participants were identified through the PHEOC platform at FMOH. Initial contacts involved phone briefings explaining the study’s purpose, confidentiality, and participants’ rights. Interviews were scheduled flexibly to accommodate participants in emergency or insecure settings.

3.5 Data Collection

Literature review: The search process identified 118 documents in total. After removing duplicates and screening the titles and abstracts for relevance, 94 documents were taken forward for full-text review. Final selection was based on how well each document related to the study objectives, the quality of the evidence, and its focus on health system response in Sudan. In the end, 65 documents were included in the analysis.

KIIs: Semi-structured interviews with national and subnational health emergency stakeholders were guided by a flexible topic guide aligned with the resilience framework. This approach enabled in-depth reflection on participants’ experiences and challenges. Interviews were conducted remotely via Google Meet in July and August due to the ongoing conflict in Sudan. Each interview lasted between 45 and 60 minutes and was conducted in either Arabic or English, depending on the participant’s preference. All interviews were recorded after obtaining verbal and written consent. They were then transcribed, and those conducted in Arabic were translated into English.

3.6 Data Analysis Plan

Literature review: The analysis was carried out manually, using tools such as Excel and techniques like highlighting and grouping by theme. For each document, sections of text relevant to the study were identified and assigned specific codes linked to key topics. These codes were then grouped into broader themes based on Kruk's Resilience Framework (2015), which provided the overall structure for the thematic analysis. To ensure consistency and transparency, this coding approach was applied in the same way to all documents reviewed.

KIIs: Data were analysed manually in Microsoft Excel using a thematic analysis approach. The adapted version of Kruk et al.'s (2015) Health System Resilience Framework provided the basis for deductive coding, with data thematically coded according to the resilience dimensions: Aware, Integrated, Self-Regulating, Adaptive, and Diverse. As the analysis progressed, additional themes emerged inductively and were incorporated under the relevant framework components. Following coding, the data were summarised to identify the study's key findings.

Triangulation with documentary analysis strengthened findings, providing a robust and contextualised understanding of the HEPR system.

3.7 Limitations of the Methodology

This study's methodology, while robust, has several limitations inherent to its design and the context of its subject matter.

Literature-Based Study Limitations

Scarcity of Published Literature: The most significant limitation is the scarcity of recent, peer-reviewed articles specifically on Sudan's health system during the 2023 conflict. Most available information is found in grey literature, such as reports from NGOs and UN agencies, which may lack the rigorous peer review of academic publications.

Key Informant Interview (KII) Limitations

1- Logistical Challenges: Conducting interviews remotely via platforms like Google Meet in a conflict-affected setting presents logistical challenges, including poor internet connectivity, security risks for participants, and the difficulty of building rapport compared to in-person interviews.
2- Translation Challenges: The process of translating interviews from Arabic to English introduces a risk of losing nuance or misinterpreting key concepts, which could impact the accuracy of the findings. This is a common issue when working with multi-lingual data.

3.8 Ethical Considerations

For the key informant interviews, ethical clearance was granted through a waiver from the Research Ethics Committee (REC) at KIT Royal Tropical Institute. Informed consent was obtained from all participants (see Annex 3), and their confidentiality was safeguarded. Collected data was stored securely in a file accessible only to the researcher and will be

destroyed after the study's completion. Anonymity and confidentiality were strictly upheld, with no personal identifiers appearing in the thesis or any subsequent publications.

In conducting the literature review, all sources were appropriately referenced, with careful attention to incorporating evidence that was balanced, representative, and reliable.

Chapter 4: Results

4.1 Anticipation: The "Aware" Dimension

This chapter presents the results on Sudan's health system's capacity for anticipation and preparedness, framed by the "Aware" dimension of the Kruk et al. (2015) health resilience framework. The findings are based on a review of pre-2023 literature and key informant insights, and they are organized into four key areas: risk profiling, surveillance capacity, laboratory infrastructure, and workforce readiness.

4.1.1 Risk Profiling and Preparedness Planning

Prior to 2023, Sudan had an established system for health-related risk assessment and preparedness planning. Annual subnational risk assessments were conducted using the WHO's Strategic Tool for Assessing Risks (STAR) to inform national multi-hazard preparedness plans (74,77). Given Sudan's long history of localized armed conflicts, the National Multi-Hazard Preparedness Plan consistently identified armed conflict as a high-likelihood, high-severity threat (88). However, key informant's interview P1 revealed that the scale of the 2023 escalation was not anticipated. Risk models and planning documents largely assumed localized or limited scenarios, not the widespread collapse that affected more than half of Sudan's states.

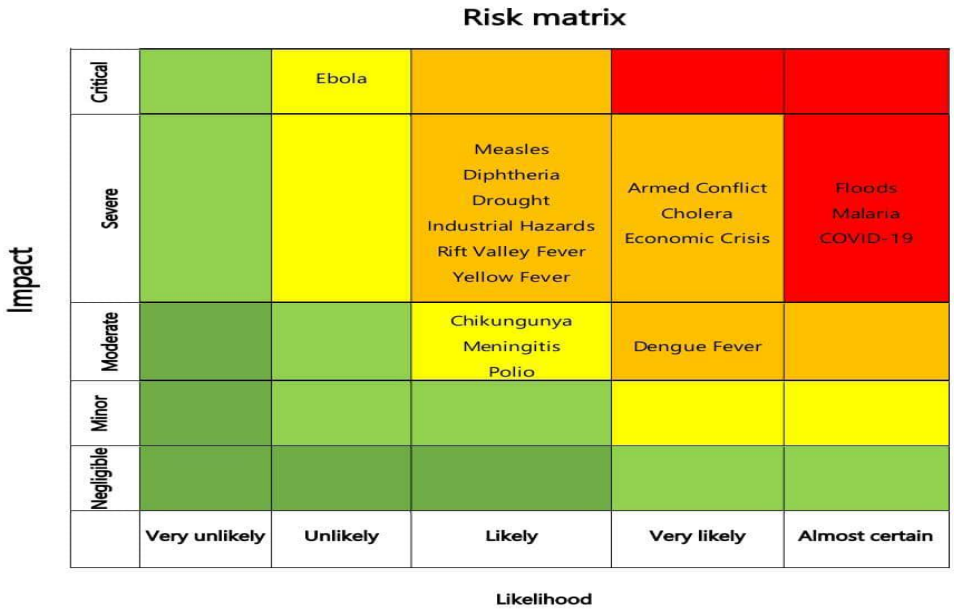


Figure 5: Risk Matrix, Sudan Multi-Hazard Plan, 2021

Figure 7 : FMoH Sudan multi-hazard plan 2021-unpublished report. (88)

While annual preparedness plans were developed with input from government and partners, their implementation was chronically underfunded. According to Key Informant Interview (KII) P1, most support for preparedness focused on training rapid response teams (RRTs) and distributing emergency supply kits, primarily funded by international partners, and this is consistent with partners reports (89,90,91).

"*The government's contribution was mainly in the vector control and water safety supplies. This chronic underfunding often led to delays in procurement and inconsistencies in the prepositioning of supplies. In some cases, states resorted to using emergency stocks from cholera kits such as IV fluids before the rainy season due to routine stock shortages, which compromised readiness for actual outbreaks*. P1".

This observation is consistent with earlier study that found preparedness plans for the 2016–2018 acute watery diarrhoea outbreak was underfunded, and prepositioned supplies were often used prematurely (92).

4.2 Surveillance System Capacity

Sudan's health emergency preparedness system relies on a dual-track disease surveillance model, integrating Indicator-Based Surveillance (IBS) and Event-Based Surveillance (EBS). Established in 2002, the IBS operates as a sentinel-based system, covering nearly 30% of public health facilities with weekly reporting. The national EBS, introduced in 2016, complements the IBS with community, hotline, media, and partner-based surveillance streams (93,94).

The 2023 conflict compromised the overall reporting system, with information systems collapsing in affected states due to telecommunication outages and workforce displacement (22, 23, 95, 96). Despite this, in more stable states where the system remained functional, surveillance successfully tracked several outbreaks, including cholera, dengue, and measles (97). A study on the cholera outbreak that emerged on August 26, 2023, reported that the system tracked its spread to 10 states, documenting 9,581 confirmed cases and a case fatality rate (CFR) of 2.48%. The study also acknowledged that decreased surveillance detection and underreporting contributed to variations in the CFR (98).

According to (KII P2), reporting in conflict-affected areas like Darfur was largely managed through partner-based surveillance, where partners shared data with the national surveillance team due to limited government capacity. This shift led to the adoption of the WHO's electronic Early Warning Alert and Response System (EWARS). The EWARS was launched in August 2023 with support from WHO and the participation of government staff, UN, and INGO agencies (99). A paper noted that following a pilot in 2014, the system was expanded to the entire Darfur region in February 2025 and had 453 active reporting sites from 19 partners as of late March 2025 (100). This tool was also evaluated in Sudanese children in

refugee camps in eastern Chad where it found to be practical with need to enhance timeliness (101).

Despite this progress, a study on the 2023 cholera outbreak in Gedaref identified challenges at the state level. State surveillance department staff lacked adequate equipment, such as computers and telecommunication tools, which restricted their ability to timely compile, analyse, and interpret data for decision-making (102).

4.3 Laboratory Infrastructure for Early Detection

Robust laboratory capacity is a critical component of anticipatory preparedness. The National Public Health Laboratory (NPHL) in Khartoum served as the primary facility for confirmatory testing prior to 2023 (77). Its seizure in April 2023 by fighters led to the expulsion of technicians and the unmanaged storage of pathogen collections, creating a "huge biological risk" that compromised the national diagnostic capacity at a critical time (103).

As an alternative, a laboratory in Port Sudan was upgraded to serve as an interim national reference facility, with WHO support. By August–September 2023, this lab was able to confirm epidemic-prone diseases, filling a critical gap (104).

4.4 Workforce Readiness

The readiness of the health workforce is fundamental to the system's anticipatory capacity. Sudan made significant investments in this area over the past decade. The Disaster Management Program, established in 2009, trained 122 emergency focal points at the federal and state levels, many of whom now hold leadership positions (72). Additionally, RRTs were institutionalized at the state level, and the Field Epidemiology Training Program (FETP), launched in 2017, strengthened epidemiological capacity (105).

The FETP has been instrumental in outbreak surveillance and data analysis, particularly during the COVID-19 pandemic and the ongoing conflict, where residents played key roles in field investigations (105, 106). However, the impact of these investments has not been uniformly realized across the country.

A persistent challenge is the unequal distribution and utilization of trained personnel. A study on the cholera response in Gedarif state found that the State Ministry of Health did not engage available FETP residents, highlighting an implementation gap (102). Additionally, conflict-prone and remote regions experienced high staff turnover, with FETP graduates disproportionately concentrated in central states prior to 2023 (105). An official (KII P4) noted that their state had only two SFETP graduates, one of whom had left due to low salaries.

Conversely, some informants described localized successes. KII P1 reported that three current state-level Health Emergency and Epidemic Committee (HEEC) directors are either FETP graduates or hold master's degrees in disaster management.

4.2 Self-Regulation

This chapter presents the findings related to the Sudan health system response capacity for self-regulation which is defined as the system's ability to adapt its functions and structures and establish new governance mechanisms to maintain performance. The results below are including the reorganization of central functions, the establishment of new coordination mechanisms, and the adaptation of resource management to a decentralized reality.

4.2.1 Reorganization of Central Health Functions

Following the fall of Khartoum, the FMoH and its key departments, including the HEEC, PHC, and Curative Care were relocated to safer states to maintain essential functions. The relocation resulted in the establishment of three distinct functional hubs, supported by designated core staff "Federal Support Health Teams" (107,108,109).

As described by P3, Red Sea Hub (Port Sudan) resumed leadership, logistics, and financial management responsibilities roles. This was facilitated by the relocation of other key government ministries, such as the Ministry of Finance and the Central Bank, to Port Sudan, Red Sea state. Gezira Hub (Wad Madani), served as the operational and service delivery hub, initially responsible for re-establishing reporting, alert tracking, and Health Cluster coordination. This hub became the de facto national emergency centre until the fall of Wad Madani in late 2023, which was then re-established in Kassala January 2024.

River Nile Hub took the responsibility for administrative procedures, including the coordination of internships, professional licensing, and the storage of medical supplies. described by P3.

This reorganization was formalized through a ministerial decree issued by the Minister of Health, which directed other non-core displaced staff to support local efforts in their respective states (107). However, the financial support for this non-core relocated staff was found to be inconsistent, depending on the available budget and capacity of the local State Ministry of Health (MoH). The Ministry of Finance's financial commitment was limited to the designated core staff in the three federal hubs, mentioned by P5.

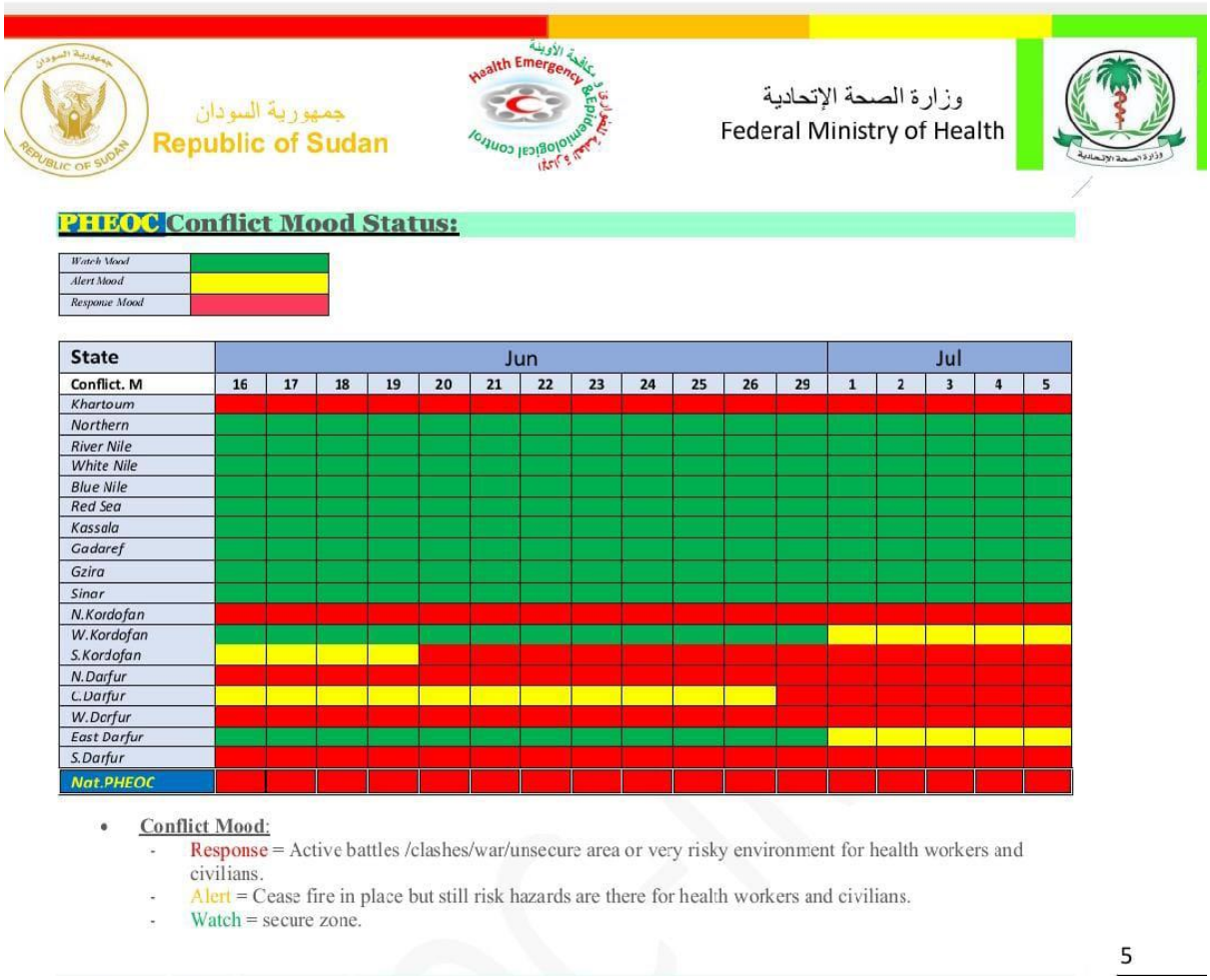
4.2.2 Regulating Coordination and Communication Mechanisms

This part examines how the health system demonstrated adjustment in its communication and coordination mechanisms, leveraging pre-existing structures and establishing new ones.

Leveraging virtual and physical EOC:

Immediately following the outbreak of the conflict, a virtual EOC was established via WhatsApp. This platform connected emergency managers, HEEC staff, state-level focal points, and partners. It was utilized for daily situation updates, monitoring of mass casualties

and hospital functionality, and resource mobilization. This virtual EOC operated under the direct command of the Minister of Health, enabling rapid decision-making and information dissemination (110), figure 4.3 EOC bulletin.


جمهورية السودان
Republic of Sudan
وزارة الصحة الإتحادية
Federal Ministry of Health

PHEOC Conflict Mood Status:

Watch Mood	
Alert Mood	
Response Mood	

State	Jun												Jul				
Conflict. M	16	17	18	19	20	21	22	23	24	25	26	29	1	2	3	4	5
Khartoum																	
Northern																	
River Nile																	
White Nile																	
Blue Nile																	
Red Sea																	
Kassala																	
Gadaref																	
Gzira																	
Sinar																	
N.Kordofan																	
W.Kordofan																	
S.Kordofan																	
N.Darfur																	
C.Darfur																	
W.Darfur																	
East Darfur																	
S.Darfur																	
Nat.PHEOC																	

- **Conflict Mood:**
  - Response = Active battles /clashes/war/unsecure area or very risky environment for health workers and civilians.
  - Alert = Cease fire in place but still risk hazards are there for health workers and civilians.
  - Watch = secure zone.

5

Figure 8 : FMOH-EOC situation report bulletin, unpublished report (110).

By July 2023, officials displaced in Gezira state have successfully re-established a physical EOC in Wad Madani (111). This new EOC aimed to institutionalize reporting, alert tracking, and situation updates. However, a key informant noted that the effectiveness of this centre was challenged by incomplete reporting and inconsistent information sharing and coordination across three hubs, mostly due to issues of sustained communication system as highlighted by P6. The infrastructure of the communication has been subject to several attacks during the conflict.

4.2.3. Subnational decentralized Structures:

The pre-existing MoH structures and trained staff at the subnational level were instrumental in enabling a swift initial response to the influx of Internally Displaced Persons (IDPs),

conflict-related injuries, and disease outbreaks. These structures leveraged their existing expertise to adapt to the new demands of the crisis, as described by a KI P1.

Similar with the NMSF, the formal body for medical procurement, storage, and distribution, was severely impacted by the conflict. The main central stores in Khartoum were occupied by the rebelling Rapid Support Forces (RSF), leading to damage and loss of supplies (112). In response, the NMSF adapted its decentralized operations (see figure below), similar to the FMoH, the NMSF resumed its tasks from the designated zonal hubs (Red Sea, Gezira, and River Nile) (113).

As further described by KI P5, NMSF adopted new management modalities, where the initial management of medical supplies was coordinated through virtual ad-hoc committees. These groups were responsible for needs assessment, coordination of reviving aid and donations, managing logistics, adjusting resource allocation according to population movements and the service burden on health facilities, and designate a portion of the government budget for procuring essential medicines and supplies. In a similar vein, published accounts on medical supply modalities highlighted that the provision of essential medicines was severely constrained by widespread insecurity and the destruction of all 26 pharmaceutical factories facilities that were entirely concentrated in Khartoum, further compounding the supply chain challenges (107).

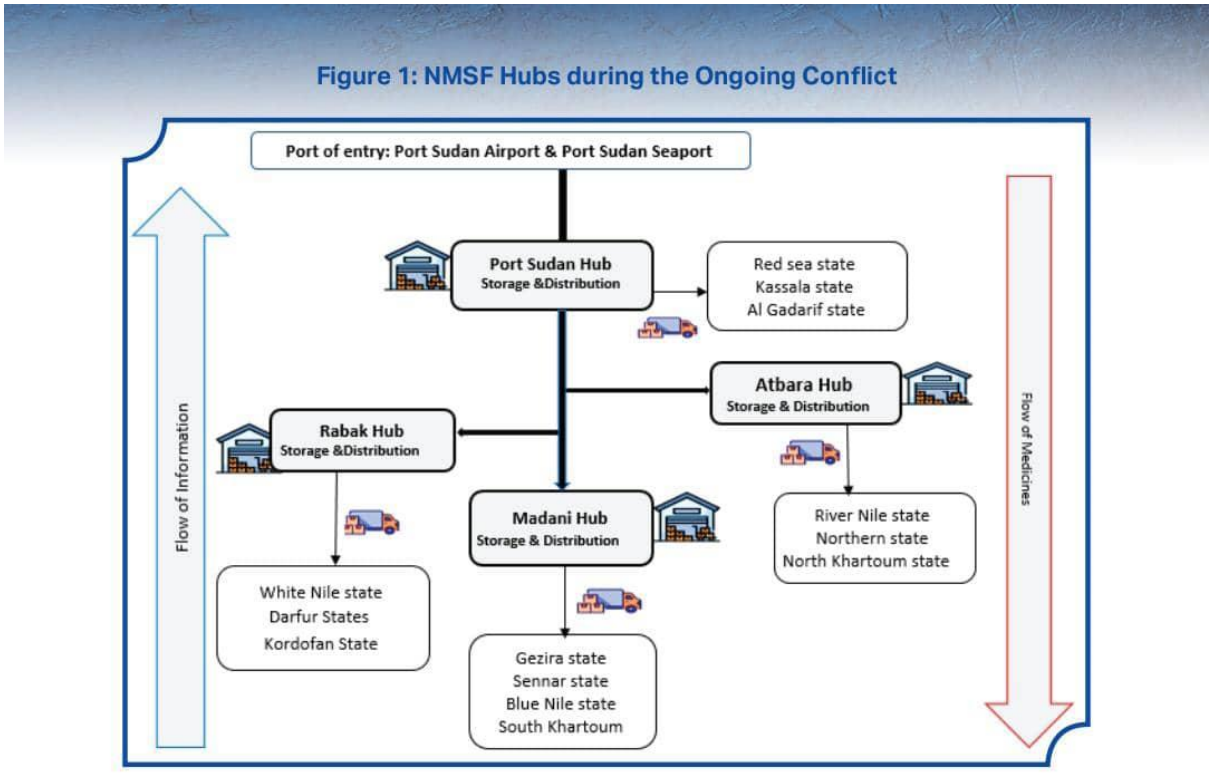


Figure 9. NMSF Zonal Hubs during the ongoing conflict. Source NMSF recovery strategy 2024-2028: https://nmsf.gov.sd/includes/pdf/NMSF_Book_final3.pdf (113).

KI P5 commended the shift towards increasing storage capacity at the regional level to accommodate decentralized storing and distribution, moving from the more centralized previously system and building local capacity.

4.2.4 Local-Level self-regulation and Response

At the state level, local authorities, hospital management, and communities showed self-regulation by taking on notable roles in maintaining health services and addressing humanitarian needs.

In highly affected states, facilities like Bashair Teaching Hospital in South Khartoum adapted to a high-volume trauma care environment. The hospital's management, staff, and volunteers worked alongside international organizations like Médecins Sans Frontières (MSF) to provide emergency surgical services to thousands of patients. This response involved direct coordination of mass casualty events and the organization of local logistics, such as securing fuel for generators to maintain operations during electricity blackouts (114,115,116,117).

The response to the influx of IDPs was largely driven by local communities and families rather than formal state-run camps. Assessments by organizations such as the Norwegian Refugee Council (NRC), Internal Displacement Monitoring Centre (IDMC), and the UN Office for the Coordination of Humanitarian Affairs (OCHA) confirm that the majority of IDPs (more than 50%) were hosted within local communities and families (118,119). This community-led IDP response aligns with traditional Sudanese social norms of hospitality and communal solidarity, representing a significant form of community-level self-regulation in the face of a large-scale displacement crisis (120,121).

4.3 Integration

4.3.1 The Integration Dimension of Health System Resilience in Sudan's Emergency Response

As the conflict led to the world's largest displacement crisis and a catastrophic food and nutrition emergency (122), it has been challenging to effectively integrate health system response.

This chapter examines the integration dimension of Sudan's health system response. It analyses the system's ability to manage interdependence and multi-sectoral dynamics, highlighting both the challenges and the emergent and resilient examples of coordination that have facilitated service delivery in the face of adversity.

4.3.2 Integration through Health Cluster Coordination:

The Health Cluster, led by the WHO, has become the primary mechanism for integration and coordination. Through sub-national coordination meetings and technical working groups, the cluster connects different partners and levels of the response (123). A prime example is integrating essential life-saving and specialized care into existing primary health care (PHC) structures (124). This includes the provision of comprehensive mental health and psychosocial support (MHPSS) services in 21 PHC centres, which up to October 2024 assisted over 4,600 individuals, including IDPs and host communities. Similarly, non-communicable disease (NCD) services are being integrated into 25 of the 59 WHO-supported PHC centres, ensuring that long-term health needs are not neglected amidst the ongoing crisis (125).

4.3.3 The Humanitarian-Development-Peace Nexus as a New Integration Paradigm:

The concept of the Humanitarian–Development–Peace (HDP) nexus has gained considerable influence as a framework for cohesive and sustainable crisis response which aims to bridge immediate crisis response with longer-term resilience building (126). In Sudan, the International Organization for Migration (IOM) explicitly operationalizes this framework by delivering multi-sectoral assistance that bridges immediate humanitarian needs with longer-term resilience building.

The 2024–2025 Sudan Crisis Response Plan highlights IOM's commitment to an integrated approach that cuts across health, water, sanitation, and hygiene (WASH), protection, shelter, transport, and cash-based interventions. By addressing the interconnected drivers of vulnerability such as lack of safe water, inadequate shelter, health system collapse, and protection risks IOM's integrated programming enhances operational efficiency. For example, water and sanitation interventions are paired with protection activities and shelter support in displacement settings, ensuring that basic needs are met in a coordinated manner rather than through fragmented efforts (86).

4.3.4 Cross-Border and Regional Integration:

The massive displacement of people has necessitated a regional response, with countries like Chad, South Sudan, and Egypt now part of a broader health crisis. The WHO, UNHCR and other agencies' work in coordinating with host country health systems and providing services to refugees is a form of cross-border integration. An example of this is the collaborative effort to manage measles and polio vaccination campaigns for Sudanese refugees in Ethiopia and Uganda, where host country health authorities, UNHCR, and international NGOs have successfully integrated their immunization programs to prevent and contain outbreaks like measles among highly mobile populations (127,128).

4.4 Diversity:

According to Kruk et al, diversity refers to the "range and variety of services, resources, actors, and response options that a health system can draw on, in order to respond effectively to both routine and unexpected challenges" (4).

This section explores how diversity within the health system, encompassing a range of actors and delivery models, has been crucial to the crisis response. It focuses on key examples to demonstrate the system's adaptive capacity beyond formal structures.

4.4.1 Conceptualizing Diversity in Sudan's Health System

Sudan's vast geography and the longstanding disparity between centre and periphery necessitate a health system that accommodates diverse delivery models. Diversity in Sudan manifests through the mixed nature of healthcare provision comprising public sector services under the Federal and State MOH, a significant private sector, humanitarian organizations, traditional health providers, and increasingly, diaspora-led telemedicine initiatives (129,130).

Each contributes uniquely to service availability during crises, though with varying degrees of coordination and effectiveness.

However, the eruption of conflict in April 2023 exacerbated these structural weaknesses. The cessation of services in Khartoum and major urban centres, due to targeted attacks on hospitals and looting, revealed the fragility of urban health service diversity. Private hospitals shuttered operations due to insecurity and supply chain collapse, while public services dwindled due to the exodus of health workers (22,23).

4.4.2 Diversity in Crisis Response

Despite these challenges, Sudan's health system has demonstrated some diversity features through the activation of non-state actors and alternative modalities during the ongoing emergency.

4.4.2.1 Community Health Workers (CHWs):

During the ongoing conflict in Sudan, community health workers (CHWs) and community midwives emerged as indispensable actors in sustaining essential health services when formal systems were disrupted or inaccessible. The Global Fund (2025) reported that CHWs "continue to play a vital role" in delivering malaria prevention, testing, and treatment in conflict-affected areas, with a planned scale-up to equip over 3,500 CHWs across multiple states with rapid diagnostic tests (RDTs), antimalarial medicines, and mobile PHC team support (131).

This decentralized model enabled service continuity in areas where more than 70% of hospitals were non-functional. Similarly, UNFPA documented the distribution of approximately 600 midwifery kits to community midwives operating in nine states Gedaref, Kassala, Red Sea, Blue Nile, White Nile, North and South Kordofan, and North and South Darfur allowing for safe home and facility births amid widespread hospital closures (132). According to WHO and UNFPA joint reporting (2023), Sudan's network of an estimated 27,000 midwives continued to attend up to four births per day in some locations, sustaining sexual and reproductive health (SRH) care despite insecurity and targeted attacks on healthcare facilities (133). Field accounts from 2025 further highlight that midwives staffed maternity wards under active conflict, facilitating nearly 8,000 safe births across the country (134).

4.4.2.2 Emergence of Community-Led Response Rooms (bottom-up delivery model):

Reports underscore that, as formal humanitarian infrastructure collapsed in the wake of Sudan's 2023 crisis, Emergency Response Rooms (ERRs) emerged originally from neighbourhood-level resistance committees and became de facto lifelines in many affected areas. ERRs operate as grassroots mutual-aid networks originally coordinated via WhatsApp including over 600 locally led centers across at least eight states and staffed by approximately 4,600 volunteers (135).

Emergency Response Rooms scaled rapidly and diversified functions: running hundreds of communal kitchens, operating ad-hoc clinics, organizing evacuations, and coordinating medicine, water, and food distribution. For example, the Khartoum State ERR reported 335 communal kitchens and over 40 health clinics by April 2024, alongside women's cooperatives and alternative education spaces (136). International media and policy analyses likewise note that "over 600" ERRs were active nationwide by early 2025, providing food, shelter, and medical aid where international actors had limited access (137). Funding shocks and insecurity severely constrained this model: analyses shows that around 1,400 community kitchens operated by ERRs at the start of 2025, of which more than 60% were shut down after the USAID freeze reducing coverage near 2 million people; other field reporting cites closures up to 80% in some locations (138). Targeting and criminalization of volunteers further undermined operations, with documented arrests, attacks, and killings of ERR members across several states (139).

4.4.2.3 Telemedicine and Diaspora Networks:

In contexts where physical access to health facilities was severely constrained, telemedicine and diaspora health networks played a critical role in maintaining service continuity. Reports indicate that Sudanese American medical professionals, organized under network initiatives like the Sudanese American Physicians Association (SAPA), coordinated virtual consultations and remote diagnostics via accessible platforms such as WhatsApp and Signal. For instance, a Guardian analysis highlights how these diaspora-led networks provided medical advice and remote support when institutions could not operate (140). A peer-reviewed study of teleconsultations during the conflict further confirms that Sudanese doctors leveraged these digital channels to sustain remote patient management despite disrupted hospital care (141).

4.4.2.4 Humanitarian Health Corridors:

Building on earlier examples of cross-regional integration, this section highlights the use of parallel and diverse delivery models during the 2023 conflict, where humanitarian actors adapted operational routes to sustain emergency health services in areas cut off from regular access channels. For instance, on 23 March 2024, a WFP convoy of 16 trucks carrying approximately 580 metric tons of food and nutrition supplies crossed the Tina border into North Darfur. A separate convoy of 37 trucks delivered 1,300 metric tons of supplies to West and Central Darfur via Adré (142).

A crossline convoy movement was also notable: on 25 December 2024, a combined WFP, UNICEF, and MSF convoy including 22 WFP trucks delivered about 750 tonnes of food, medicine, and supplies to southern Khartoum, reaching approximately 78,000 people in areas besieged since the conflict began (143).

However, the effectiveness of these corridors was often limited by security threats such as aerial and ground attacks on aid convoys alongside bureaucratic delays and seasonal obstacles that consistently restricted access and delivery, mentioned by KI P6.

4.5 Adaptation:

Unlike immediate absorption, adaptation involves learning from shocks and modifying the system to improve performance (144). As the Sudan's health system is still struggling to respond, this section will shed light on its efforts to adapt.

4.5.1 Models of adaptation:

In the context of Sudan where the health system has endured decades of political instability, recurrent economic crises, and, most recently, the devastating civil war since April 2023 adaptation has become less a strategic choice than a survival necessity, as highlighted in earlier dimensions. Yet, systemic fragility continues to limit the health sector's capacity for institutional learning and iterative improvement. As noted by interviewee P3, the system remains overstretched, responding to multiple, simultaneous emergencies that constrain opportunities for structured reflection and course correction. For instance, although an After-Action Review (AAR) was conducted following the first wave of the 2023 cholera outbreak, successive waves, compounded by chronic funding shortages, weak infrastructure, and operational bottlenecks, hindered the translation of lessons learned into concrete system improvements.

This pattern mirrors challenges documented in other fragile-state health systems, where urgent response demands repeatedly crowd out opportunities for sustained preparedness enhancement reinforcing a cycle of reactive rather than proactive adaptation (145,146).

Despite these constraints, examples of adaptive capacity are emerging. One notable case is the Faculty of Medicine at the University of Gezira (FMUG), which has adapted medical education to the realities of conflict. By adopting flexible learning models and online platforms, FMUG has sustained medical training despite displacement and insecurity. The introduction of a specialized "War and Health" curriculum module designed to prepare future healthcare professionals with critical skills for managing trauma, mental health, and infectious diseases prevalent in conflict settings. These initiatives embed resilience into medical education by equipping students to operate effectively in crisis environments and by maintaining access to education for displaced and marginalized learners through adaptable modalities (147). Medical schools managed to graduate interns who filled the gap in service provision.

At the policy level, the 2025 "Reimagining Sudan's Health System in Conflict" workshop convened a broad spectrum of participants from health, academia, and civil society to deliberate on pathways for decentralized governance, community-driven models, and digital innovations in health service delivery. The workshop underscored a shift from merely restoring pre-crisis health structures towards establishing a responsive, inclusive, and conflict-adapted health system architecture. These exchanges demonstrate that adaptation within Sudan's health sector encompasses not only operational improvisation at the frontlines but also strategic rethinking at policy, planning, and educational levels. While still at an early stage, such collaborative, multisectoral initiatives provide critical entry points for long-term transformation (140).

Chapter 5: Discussion:

5.1 Introduction

This discussion chapter provides a critical analysis of Sudan's health system performance during the ongoing war, using the Kruk et al. (2015) resilience framework as a guiding analytical tool. It synthesizes the study's findings on the system's anticipatory capacity, self-regulation, integration, diversity, and adaptation, reflecting on how these dimensions manifested in both pre-crisis preparedness and the post-April 2023 emergency response. The analysis contextualizes Sudan's experience within a broader landscape of health system challenges in fragile and conflict-affected states, drawing comparative insights from cases in similar contexts. The chapter concludes by critically assessing the framework's utility, identifying key conclusions, and proposing a set of clear and actionable recommendations for future policy and practice.

5.2 Anticipation: Awareness and Preparedness

Sudan's pre-conflict efforts demonstrated a high degree of institutional awareness, as evidenced by its proactive risk profiling and alignment with IHR. National and subnational risk assessments, which used tools like the WHO's STAR, consistently identified armed conflict as a severe potential hazard, reflecting a critical understanding of the link between public health and security. However, as the findings reveal, this institutional awareness did not translate into an effective anticipatory capacity at the subnational level. The core challenge was not a lack of planning but a failure to operationalize these plans due to chronic underfunding and fragmented governance. This was also noted in Kassala state outbreak and inadequate dengue fever preparedness in 2019 highlights the persistent challenge of operationalizing plans (148). This is a recurring theme in fragile contexts, mirroring the experiences of South Sudan and Chad, where well-intentioned national policies and preparedness frameworks were repeatedly undermined by political instability and limited resource flow to local levels (149,150,151). The lesson here is that identifying a risk is not equivalent to mitigating it unless it is supported by stable governance and reliable funding mechanisms at all administrative levels. Without these, local health systems are forced into a reactive stance, as seen in the inadequate preparedness for Dengue fever outbreak in Kassala state.

Similarly, while Sudan's dual surveillance system demonstrated potential for effective signal detection as seen in the 2019 Rift Valley Fever outbreak, it suffered from a significant gap between capacity and practice (152). Evaluations revealed weak case detection by healthcare providers and a lack of consistent integration between community-level signals and the formal health system (94). This vulnerability is not unique to Sudan; Sierra Leone, which also operates a dual surveillance system, faced similar issues during the Ebola outbreak, where health facility-level detection was weak and the linkage between community signals and the formal system was inconsistent (153). These shared gaps highlight a common weakness in resource constrained systems: a focus on national level strategic frameworks without

adequate investment in the lower-level capacity building needed to improve case detection and ensure an efficient response during emergencies.

The findings on workforce readiness further underscore this challenge. Programs like the FETP and the disaster management program successfully built a cadre of trained professionals, but their impact was unevenly distributed. Remote areas, like Darfur and Kordofan, faced chronic shortages, and many trained graduates were underutilized or left due to low retention and poor salaries. This problem is not confined to Sudan. Nigeria's Field Epidemiology and Laboratory Training Program established in 2008, while played a key role in improving outbrek detection and response during Ebola outbreak 2014 and Covid-19, also struggled with uneven distribution of trained personnel and retention issues due to poor remuneration, highlighting a systemic challenge in public health workforce development across the region (154). The lesson from these cases is clear: building a robust workforce requires not only training but also a commitment to equitable distribution, adequate remuneration, and career pathways to ensure sustained retention and impact.

5.3 Self-regulation and Reorganization

The post-April 2023 conflict response revealed the dynamic self-regulation capabilities of Sudan's health system. The rapid relocation of central health functions to subnational hubs and the swift shift to a virtual EOC via platforms like WhatsApp are powerful examples of adaptive resilience. This ability to reorganize central functions and leverage decentralized structures reflects a core feature of resilience, where systems can maintain critical functions by shifting their operational model. This is analogous to the experience in Nepal after the 2015 earthquake, where the Ministry of Health and Population utilized virtual coordination platforms and set up temporary EOCs in less-affected areas to ensure the continuity of coordination and response. Similarly, the experience in Uganda demonstrates the critical role of subnational PHEOCs in strengthening regional responses and mitigating the adverse impacts of public health emergencies (155,156).

Sudan's decentralized medical supply chain also demonstrated significant self-regulation. By relocating logistics operations to states and using virtual platforms to coordinate needs assessments and distribution, the system adapted to the collapse of its central infrastructure. This approach mirrors the strategy adopted in Yemen, where conflict forced the health system to create decentralized supply hubs in safer regions, using virtual communication tools to manage logistics (157). These measures highlight that supply chain resilience in emergency settings depends less on static infrastructure and more on flexible governance, strong leadership, and local-level coordination. While these ad-hoc solutions were effective as substitutes, both the Sudanese and Yemeni cases underscore the need for sustained financing and inter-agency coordination to institutionalize these mechanisms beyond temporary coping strategies.

At the local level, self-regulation was most visible through the actions of local health workers and community-led initiatives. Health facilities and community members demonstrated an ability to accommodate mass casualties and displaced populations, underscoring the importance of investing in subnational capacities and social capital. This is consistent with

lessons from the Democratic Republic of Congo and Liberia's Ebola responses, which found that empowering a local healthcare workforce and engaging community-based surveillance teams improved communication, trust, and the overall resilience of the health system (158,159).

5.4 Integration and Diversity: The Backbone of Crisis Response

The conflict in Sudan highlighted the critical role of integration and diversity in a resilient health system. Integration was demonstrated through the multi-sectoral coordination of the Health Cluster, which brought together national platforms and international partners like the WHO and UN agencies. An inspiring example was the integration of mental health services into primary healthcare; a model of care not widely practiced before the conflict. This reflects a key feature of resilience, the ability to reconfigure and integrate new services to meet emergent needs. However, the experience of Lebanon in responding to the Syrian refugee crisis serves as a cautionary tale, demonstrating that while integration can expand services through primary healthcare, it may fail to address systemic gaps, such as financial barriers to accessing referral facilities (160). This reminds us that true integration requires institutionalized and sustained adaptation, not just improvised collaboration.

The vast geography and longstanding disparities in Sudan necessitate a diverse health system that can accommodate a range of delivery models. The presence of community health workers (CHWs) and community midwives proved to be a significant strength, particularly in remote areas where formal services had collapsed. Their key role in malaria prevention and delivery services mirrors similar successes in the DRC during Ebola outbreaks, where local workforces were instrumental in providing care and supporting surveillance (158). The emergence of community-led Emergency Response Rooms (ERRs) as a bottom-up delivery model is a powerful example of functional diversity. This experience is comparable to Lebanon's post-Beirut port explosion, where grassroots networks and volunteers filled critical response gaps left by overwhelmed institutions (161). These examples underscore how pre-existing social capital and community organizations can transform into effective emergency response mechanisms when formal systems fail.

Furthermore, the engagement of the Sudanese diaspora and the use of telemedicine networks added another layer of diversity. The use of virtual communication platforms, initially leveraged during the COVID-19 pandemic, was extended to the current crisis, enabling remote consultations and mentorship. The Sudanese diaspora beside their financial remittances and support to extended families, is another face of diverse platform of distant service delivery, reflecting the integration as well with nationals outside the country. This reflects the Ukrainian experience of using technology and international support to adapt primary care during the ongoing war (162). The literature emphasizes the role of the diaspora in shifting from traditional top-down aid to locally led interventions is a fundamental aspect of reshaping global health partnerships and strengthening community resilience (163).

5.5 Adaptation: The Path from Coping to Institutionalized Resilience

While Sudan's health system demonstrated remarkable adaptability, its long history of recurring crises has limited its capacity to transition from short-term coping mechanisms to long-term, institutionalized adaptation. The findings suggest that the lessons learned from previous emergencies, such as the COVID-19 pandemic, were not fully utilized to inform real adaptation, leaving the system vulnerable to the current shock. This phenomenon, where over-reliance on short-term adaptations can mask systemic deficiencies and hinder long-term resilience, is a well-documented barrier to healthcare resilience in other contexts (164).

Despite these systemic limitations, growing examples of adaptation are emerging. The relocation of central health functions and the adoption of virtual EOCs were not just reactive but also involved the learning and reorganization of a new operational model. The medical education sector, through institutions like the University of Gezira, is adapting its curriculum to the realities of conflict, embedding a resilience-oriented mindset into future health professionals. These initiatives move beyond mere coping by fundamentally altering the system's structure and knowledge base, providing critical entry points for long-term transformation.

5.6 Cross-Cutting Comparative Lessons

Across the five resilience dimensions, Sudan’s experience reveals patterns common to other fragile and conflict-affected health systems. Persistent gaps in translating national preparedness frameworks into effective subnational action mirror the challenges observed in South Sudan and Chad, where governance fragility and funding shortfalls undermine local implementation. Weaknesses in surveillance and frontline detection parallel those seen in Sierra Leone during Ebola, underscoring the importance of sustained investment in facility-level and community-level capacity. The rapid reorganization of health governance and logistics into decentralized hubs reflects lessons from Yemen and Nepal, where flexible operational models helped maintain core functions during crisis. Community-led service delivery through Emergency Response Rooms, CHWs, and diaspora networks echoes the experiences of Lebanon, the DRC, and Ukraine, where grassroots and remote support mechanisms filled critical gaps left by overwhelmed institutions. Together, these parallels reinforce that resilience in such contexts depends not only on national policy frameworks but on empowering local actors, diversifying delivery models, leveraging digital and diaspora networks, and ensuring predictable resources for subnational systems areas where Sudan’s response showed innovation but remains far from institutionalized.

5.7 Strengths and Weaknesses of the Study

A key strength of this study is its ability to deliver a timely and comprehensive examination of Sudan’s health system resilience during an active conflict an area where published research is scarce. By combining an extensive literature review with key informant interviews and drawing on unpublished reports from official bodies such as the FMoH and affiliated institutions, the study provides a unique, ground-level perspective that is rarely accessible in

academic discourse. This triangulation of diverse data sources helps address gaps in publicly available information and offers valuable insights into institutional, operational, and community-level responses.

However, the study has several limitations. The scarcity of peer-reviewed literature on Sudan's health system in conflict settings meant that the analysis relied heavily on unpublished reports. This introduces potential biases and verification challenges. Furthermore, security constraints, displacement, and communication disruptions prevented participation from some key informants, particularly those in remote or severely affected areas. As a result, certain perspectives especially from the most isolated regions and grassroots actors may be underrepresented. While the study captures successes and adaptive practices in several states, the situation in inaccessible areas may be more severe and less well-documented. Future research should prioritise field-based studies and quantitative data collection when conditions allow, to validate and expand upon these initial findings.

5.8 Reflection on the Use of Kruk et al. (2015) Resilience Framework

The Kruk et al. (2015) health system resilience framework was originally developed in the aftermath of the West African Ebola outbreak as a conceptual lens to analyse how health systems can absorb shocks, adapt, and transform while maintaining core functions.

It was chosen for this study because it offers a system-wide lens that can be applied to a range of shocks including, but not limited to, epidemics. Its five dimensions capture institutional, operational, and community capacities that underpin resilience in fragile or disrupted health systems, whether the disruption stems from conflict, outbreaks, natural disasters, or multiple hazards combined.

For this study, the dimensions were adapted to reflect Sudan's multi-hazard reality, enabling an assessment of resilience capacities in the context of prolonged, system-wide disruption while retaining the comparative value of an internationally recognised model.

While the framework provided a valuable organising structure, certain limitations were evident. Its dimensions are broad and do not explicitly account for the structural and political determinants of fragility such as chronic governance breakdown, humanitarian aid dependence, or deep regional disparities that were central to Sudan's crisis. By treating resilience capacities as system-wide characteristics, it risks masking substantial geographic inequities, where innovation in some regions coexisted with near-total collapse in others. Furthermore, while it identifies what constitutes resilience, it offers less guidance on how to prioritise or sequence resilience-building actions in protracted, resource-constrained settings. These gaps did not diminish its utility in this study, but they highlight areas where future frameworks could be refined to better capture the dynamics of long-term, multi-hazard disruptions.

5.9 Conclusions

Sudan's experience demonstrates that a resilient health system is a dynamic, multifaceted entity. While the pre-conflict system showed institutional awareness and anticipatory capacity through strategic plans and training, its effectiveness was undermined by weak governance, chronic underfunding, and a lack of subnational operationalization. The crisis, however, forced the system to exhibit remarkable self-regulation, integration, and diversity. The rapid shift to virtual coordination and decentralized operations, coupled with the leveraging of community-led responses and diaspora networks, proved to be the backbone of the emergency response. These ad-hoc innovations and the reliance on informal networks were critical for survival but are not a substitute for long-term, institutionalized resilience. To move from a reactive to a proactive state, the health system must learn from these coping mechanisms and transform them into sustainable, well-resourced, and decentralized structures. The Kruk et al. framework provided an excellent lens to structure this analysis, particularly in highlighting the interplay between institutional foresight (anticipation) and a system's spontaneous ability to cope (self-regulation, integration, diversity) when faced with an overwhelming shock.

5.10 Recommendations

Based on the analysis, the following recommendations are presented to key stakeholders to help institutionalize resilience within Sudan's health emergency and overall health system:

For the Federal Ministry of Health (FMoH):

1- Institutionalize Decentralized Operations: Formally empower state-level, health authorities with clear mandates, reliable budgets, and digital infrastructure to manage emergency operations and medical supply chains.

2- Strengthen Subnational Surveillance: Prioritize investment in lower-level surveillance capacity, focusing on real-time reporting, equipping health facilities, and strengthening the linkage between community-based signals and formal systems.

3- Enhance Workforce Retention and Distribution: Create incentives, such as hardship allowances and career pathways, to retain trained personnel like FETP graduates in remote and conflict-prone areas. Formalize flexible education models, including online and diaspora-facilitated training.

For Higher Political Leadership:

1- Ensure Protected Health Financing: Implement policies to ring-fence and protect funding for emergency preparedness and health workforce salaries, ensuring that resources reach the subnational level consistently, even during political instability.

2- Establish Enabling Policies for Diaspora Engagement: Establish legal and financial frameworks that formalize the role of the Sudanese diaspora in rebuilding the health system, facilitating resource flows, and knowledge transfer.

For International and National Stakeholders (UN agencies, NGOs, donors):

1- Prioritize Local-Led Capacity Building: Shift the focus from short-term service delivery to long-term capacity building for local institutions. Co-design interventions with local actors and communities, recognizing their contextual knowledge.

2- Invest in Data Systems: Fund and support the development of data systems and virtual platforms, ensuring seamless information sharing and coordination between government, NGOs, and community structures.

For Communities and Diaspora:

1- Formalize Grassroots Initiatives: Support the transition of grassroots initiatives like Emergency Response Rooms (ERRs) from ad-hoc networks to formalized community-based organizations with legal recognition and sustainable funding models.

2- Promote Knowledge Transfer: Leverage diaspora professionals to provide virtual mentorship and policy advising, facilitating knowledge transfer and technical support to national and subnational health authorities.

Chapter 6: References

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Annex 1:

Combination of words used in search strategy:

	OR		
	Key word	**Situation**	**Geography**
AND	Aware	Conflict	Sudan
	Anticipate	Emergency	Republic of Sudan
	Track	Epidemic	Khartoum
	Surveillance	Outbreak	Gazira
	Reporting	War	Red Sea
	Early warning	Infectious disease	Darfur
	Information	Response	Fragile setting
	Multi-hazard	Displacement	
	Risk	Insecurity	
	Preparedness		
	Laboratories		
	Sample		
	Diagnostic		
	Workforce		
	RRT		
	FETP		
	Coordination		
	Cluster		
	Operation center		
	Supplies		
	Logistics		
	WASH		
	Nutrition		
	Mental health		
	Integration		
	Convoy		
	Community resilience		
	Adaptation strategies		

Annex no 2:

Informed Consent Form

Introduction

Greetings,

My name is Mona Ahmed Bashir Babikir, and I am an MSc student in Public Health at the Royal Tropical Institute (KIT) in the Netherlands. I am currently conducting a study titled:

"Health System Response Amid the ongoing 2023 Conflict: An Examination Through a Resilience lens"

This study seeks to understand the challenges and enabling factors that shaped the delivery of supplies during the early months of the conflict in Sudan with focus on cholera key supplies. The research particularly looks at how the supply system interacted with other parts of the health system, such as governance, financing, human resources, service delivery and health information.

Given your role in the health response in Sudan, I would like to invite you to participate in this study as a key informant. Your knowledge and experience are important to help us understand how decisions were made and what can be improved in future outbreaks.

Participant Information

Participant Code:	
Gender:	Female ☐ Male ☐
Organization:	FMoH ☐ NMSF ☐WHO ☐ UNICEF ☐ INGO ☐ Other ☐
Age:	<30 ☐ 30–40 ☐ >40 ☐
Education:	_____
Position/Role: **(*Please describe your current role in the cholera response or supply system.*)**	_____
State/Location of Work:	_____

Informed Consent and Procedures

- The interview will be conducted remotely (zoom/google meet) in a private setting to ensure confidentiality, and will take about **45–60 minutes**.
- With your permission, I would like to **record the conversation** to ensure accuracy.

- All responses will be **anonymous**. Your name or organization will not be used in any reports or publications.
- Notes and recordings will be securely stored and will only be accessible to the researcher. Recordings will be deleted within six months of study completion.

Voluntary Participation and Right to Withdraw

- Your participation is entirely voluntary.
- You may skip any question or stop the interview at any time without giving a reason and without any consequences to your role or professional standing.

Risks and Benefits

- There are no physical, psychological, or economic risks involved in participating in this interview.
- While there may be no direct personal benefit, your contribution will help improve humanitarian health supply systems and emergency response in fragile contexts like Sudan.

Results Sharing

- The study results will be shared in a final thesis submitted to KIT.
- A summary report will also be shared with relevant stakeholders such as the Federal Ministry of Health, UN agencies, and humanitarian partners.
- If you would like a copy of the final report, please let me know and I will ensure you receive it.

Consent

Do you have any questions about this study?
Would you like me to clarify anything?
Do you agree to participate in the interview?

Declaration – To Be Signed by the Participant

I confirm that I understand the purpose of this interview and consent to participate in this research study conducted by Mona Babikir.

Participant Name: _____

Signature: _____ **Date:** _____

Witness Name: _____

Signature: _____ **Date:** _____

For further information or concerns about this study, you may contact:

- **Mona Babikir**
  MSc Public Health student, KIT
  Email: munabashir23@gmail
  m.babikir@student.kit.nl

Phone: +249123390453

- **Contact for Ethics Committee:** researchethics@kit.nl

Annex no 3: Topic guide for KII

Dimension	Focus Area	Key Questions
Introduction	Respondent background – role and involvement	• Can you briefly describe your current role and responsibilities in the health system? • How were you involved in health system functions or emergency response during the 2023 conflict?
Aware (Anticipation)	Risk profiling, surveillance, laboratory capacity, workforce readiness	• Before the conflict, how did your organization identify and prepare for possible health emergencies? • Can you describe how disease surveillance worked during the conflict? • What laboratory capacity was available for early detection, and how did it change after April 2023? • How prepared was the health workforce in your area to respond to emergencies?
Self-regulate	Reorganization, governance changes, decentralized functions	• What changes were made to maintain essential health services after the collapse of central functions? • How did relocation of functions (e.g., hubs) affect service delivery in your area? • What was the challenges in sustaining these new arrangements?
Integrate	Coordination mechanisms, multi-sector collaboration	• How did health actors (government, NGOs, UN, community groups) coordinate during the conflict?
Diversity	Multiple actors, delivery models, community involvement	• What different types of service providers were active in your area (public, private, NGOs, community)? • How did community-led groups or diaspora networks contribute to health service delivery?
Adaptation	Learning and changes during the crisis	• Can you give examples of changes or innovations introduced during the conflict that helped improve health service delivery? Were there opportunities to reflect and learn from earlier outbreaks or emergencies?
Reflections	Challenges, successes, recommendations	• What were the biggest challenges in maintaining health services during the conflict? • What worked well and should be sustained? What would you change to improve the health system's future emergency preparedness? What lessons from Sudan's experience could be useful for other conflict-affected countries?

Annex no 4:

Declaration of use of AI:

KIT Institute (Masters or Short course) Participants

Declaration for Use of Generative AI (GenAI)

Please complete and submit this form as an annex on the last page of your assignment file, and not as a separate document.

Check the box that applies to your completion of this assignment:

☐ I confirm that **I have not used** any generative AI tools to complete this assignment.

☒ I confirm that **I have used** generative AI tool(s) in accordance with the *"**Guidelines for the use of Generative AI for KIT Institute Master's and Short course participants".*** Below, I have listed the GenAI tools used and for what specific purpose:

Generative AI tool used	**Purpose of use**
1. Scispace, Perplexity	Literature search
2. Gemini, ChatGPT	Brainstorming