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Natural Disasters and Maternal-Neonatal Health Services: Systematic Review of Services Disruption and Recovery

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Abstract

Sudden-onset natural disasters rapidly disrupted essential maternal and neonatal health (MNH) services across the disaster cycle. This systematic review synthesized the impact of such events on the disruption and recovery of antenatal care (ANC), facility delivery, and emergency obstetric and neonatal care (EmONC), as well as postnatal/neonatal care, and identified the main health-system pathways involved. Searches of Scopus, ScienceDirect, and PubMed (November–December 2025) included English-language, open-access articles published between 2021 and 2026. Eligible quantitative, qualitative, and mixed-methods studies examined sudden-onset disasters and reported disruption and/or recovery of essential MNH services. Using PRISMA procedures, PEO-based criteria, and the MMAT 2018 quality appraisal, seven studies were included, primarily focusing on floods and cyclones in South Asia, Sub-Saharan Africa, and the Caribbean islands. Disasters generated acute shocks to service delivery, workforce, supplies, referral and transport, and information and coordination, leading to declines in ANC, facility delivery/EmONC, and PNC/neonatal care. Recovery ranged from return to near baseline within about three months to prolonged and uneven restoration, with poorer, marginalized, and remote groups being consistently more affected. The findings highlighted predictable but inequitable system pathways, supporting the integration of MISP-aligned preparedness, protection of ANC/PNC platforms, securing EmONC referral and transport, strengthening supply chains, and improving routine information systems to sustain continuity and accelerate recovery.

Introduction

Sudden-onset natural disasters, such as floods, earthquakes, and cyclones, pose significant challenges to global health systems, particularly in terms of maternal and neonatal health (MNH) services. These disasters disrupt essential care delivery, jeopardizing access to antenatal care, facility deliveries, and postnatal services, and ultimately impact health outcomes in affected populations. The frequency of such events necessitates a focus on understanding the dynamics of service disruption and recovery in the context of acute disasters, enabling effective health system responses (Baten *et al.*, 2020; Harville *et al.*, 2021; Pappas *et al.*, 2024). A systematic literature review (SLR) is critical for integrating existing knowledge on how such disasters affect the continuum of care in MNH. Disruptions can lead to increased maternal and neonatal morbidity and mortality, notably

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due to delayed or insufficient care (Handayani *et al*., 2024; Maharani & Sutrisno, 2023). For instance, hospitals may face structural damage after a disaster, resulting in immediate changes to service availability and continuity of care (Jejaw *et al*., 2023; Shimoto *et al*., 2022; Tapia-Hernández *et al*., 2025).

Effective antenatal care (ANC) and skilled attendance at birth significantly contribute to improved maternal and infant outcomes. A study in Ethiopia highlighted that continuity of maternity care is crucial for improving service completion rates, particularly when healthcare providers ensure mothers return for necessary care (Asratie *et al*., 2020; Buli *et al*., 2023; Tenaw *et al*., 2022). However, natural disasters often exacerbate challenges to access and facility readiness, as shown in a systematic review focusing on the impact of disaster events on health services (Powell *et al*., 2021; Rodo *et al*., 2022; Sahoo *et al*., 2021). Maintaining health service functionality during and after crises is vital to mitigate negative health impacts (Blanchet *et al*., 2020; Dinagde & Wada, 2024).

Recovery from disruptions caused by disasters must also be viewed through a resilience framework that incorporates equity considerations. Research indicates disparities in service access exist, especially among vulnerable populations, which can be worsened by disasters (Worku *et al*., 2022). While some studies argue for targeted post-disaster interventions to effectively resume services, others caution that recovery approaches lacking an equity focus may inadvertently overlook marginalized groups (Mamo *et al*., 2021). Thus, incorporating an equity perspective into disaster response strategies is essential to ensure that all populations, particularly the most vulnerable, receive the care they need (Belay *et al*., 2025; Stimpson *et al*., 2025).

Moreover, health system resilience, the ability to absorb shocks while maintaining effective service delivery, has gained recognition as a critical component for enhancing MNH service sustainability during disasters (Raharjo *et al*., 2019; Herrera *et al*., 2025; Hertelendy *et al*., 2025). Evidence suggests that preparedness actions, such as training healthcare workers and establishing flexible response plans, significantly improve recovery times and the effectiveness of service restoration following such events (Galang *et al*., 2024; Rahman *et al*., 2021). The integration of lessons learned from past disasters and the establishment of proactive frameworks will inform more effective health policies and preparedness strategies, ultimately leading to improved maternal and neonatal health outcomes. In summary, sudden-onset natural disasters pose complex challenges to the continuity of maternal and neonatal health services, underscoring the need for a comprehensive understanding of the mechanisms of disruption and recovery. The proposed systematic literature review aims to bridge gaps in current knowledge by focusing on empirical evidence gathered post-disaster, enhancing policy formulation, and supporting the implementation of practices that foster resilient health systems.

Methods

This systematic review compiles evidence from multiple studies in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, as outlined in the Cochrane Collaboration Handbook for Systematic Reviews. The main research question of this review is: *"How do sudden-onset natural disasters across the pre-disaster, impact, and post-disaster phases affect the disruption and recovery of essential maternal neonatal health services, particularly ANC, facility-based or skilled birth attendance, EmONC, and PNC/ neonatal care in affected communities?"*

Studies were identified through several databases, including Scopus, ScienceDirect, and PubMed, using advanced searches with Boolean operators (AND/OR). The keywords were refined and mapped to Medical Subject Headings (MeSH) terms to capture all relevant concepts (Table 2). The literature search was conducted from November to December 2025.

We applied predefined inclusion and exclusion criteria, structured using the PEO framework and aligned with the review objectives, to guide the selection of studies. A description of these criteria, including population, exposure, outcomes, study designs, and publication characteristics, is presented in Table 3.

Table 1. The Research Question is Formulated Using the PEO Format (Population, Exposure, Outcome).

Population	pregnant women, women during childbirth and postpartum, and neonatal, as well as users of essential maternal neonatal services.
Exposure	sudden-onset natural disasters, including floods, earthquakes, cyclones/ typhoons/hurricanes, and tsunamis across pre-disaster, during-disaster, and post-disaster phases.
Outcome	disruption and recovery of essential maternal neonatal services

Table 2. Search Query Database Scopus, ScienceDirect, and PubMed.

Scopus	(flood* OR "flash flood*" OR earthquake* OR seismic OR tsunami* OR cyclone* OR typhoon* OR hurricane* OR "storm surge") AND ("maternal health" OR pregnan* OR obstetric* OR antenatal OR prenatal OR intrapartum OR childbirth OR delivery OR postnatal OR postpartum OR "newborn care" OR neonatal) AND ("health service*" OR healthcare OR "maternity care" OR "antenatal care" OR ANC OR "skilled birth attendance" OR "facility birth" OR "institutional delivery" OR "emergency obstetric care" OR EmONC OR "postnatal care" OR PNC OR "neonatal care") AND (disrupt* OR interrupt* OR "service disruption" OR "service continuity" OR continuity OR access* OR utilization OR coverage OR "quality of care") AND (recover* OR restor* OR resum* OR "service recovery" OR resilience OR resilient* OR adapt* OR "health system resilience")
ScienceDirect	(flood OR earthquake OR cyclone OR tsunami) AND ("antenatal care" OR "skilled birth attendance" OR "emergency obstetric care" OR "neonatal care") AND disruption
PubMed	("Natural Disasters"[MeSH] OR "Floods"[MeSH] OR "Earthquakes"[MeSH] OR "Tsunamis"[MeSH] OR "Cyclonic Storms"[MeSH] OR disaster*[tiab] OR "natural disaster*"[tiab] OR flood*[tiab] OR earthquake*[tiab] OR tsunami*[tiab] OR cyclone*[tiab] OR typhoon*[tiab] OR hurricane*[tiab] OR "storm surge"[tiab]) AND ("Maternal Health Services"[MeSH] OR "Prenatal Care"[MeSH] OR "Delivery, Obstetric"[MeSH] OR "Postnatal Care"[MeSH] OR "Obstetric Emergency"[MeSH] OR "Neonatal Care"[MeSH] OR "maternal health service*"[tiab] OR "antenatal care"[tiab] OR "prenatal care"[tiab] OR ANC[tiab] OR intrapartum[tiab] OR childbirth[tiab] OR delivery[tiab] OR "skilled birth attendance"[tiab] OR "facility birth"[tiab] OR "institutional delivery"[tiab] OR "emergency obstetric care"[tiab] OR EmONC[tiab] OR "postnatal care"[tiab] OR PNC[tiab] OR postpartum[tiab] OR "newborn care"[tiab] OR neonatal[tiab] OR "neonatal care"[tiab]) AND ("Health Services Accessibility"[MeSH] OR "Continuity of Patient Care"[MeSH] OR "Quality of Health Care"[MeSH] OR disrupt*[tiab] OR interrupt*[tiab] OR "service disruption"[tiab] OR "service continuity"[tiab] OR access*[tiab] OR utilization[tiab] OR utilisation[tiab] OR coverage[tiab] OR availability[tiab] OR "quality of care"[tiab] OR barrier*[tiab]) AND (recover*[tiab] OR restor*[tiab] OR resum*[tiab] OR "service recovery"[tiab] OR resilience[tiab] OR resilient*[tiab] OR adapt*[tiab] OR "health system resilience"[tiab])

Table 3. Inclusion and Exclusion Criteria.

Aspect	Inclusion Criteria	Exclusion Criteria
Type of study/ publication	Primary/original research with empirical data: quantitative, qualitative, or mixed-methods. Designs may include cross-sectional, cohort, case-control, quasi-experimental, interrupted time-series, program evaluation, qualitative studies, and mixed-methods studies.	Not primary research: systematic/ narrative reviews, meta-analyses, scoping reviews, editorials, commentaries, perspectives, policy briefs, protocols, letters, conference abstracts, theses/dissertations, books/ book chapters, and single case reports.
Population/ unit of analysis (P)	Pregnant women, women in labour, postpartum women, neonates, or facilities/health workers providing maternal neonatal services in affected areas.	Populations outside maternal neonatal (e.g., only school-age children or adolescents) without any maternal/ neonatal component; general population studies without a maternal neonatal sub-analysis.
Exposure/ type of disaster (E)	Sudden-onset natural disasters: floods/ flash floods, earthquakes, tsunamis, cyclones/typhoons/hurricanes, storm surges. Multi-hazard studies are accepted if they include at least one of these hazards.	Slow-onset disasters only (drought, heatwaves, wildfires/smoke haze) without any sudden-onset component; non-natural crises (conflict/war, displacement due to conflict, pandemics/epidemics) without a direct link to sudden-onset natural disasters.
Service outcomes (O)	Provide information on disruption or recovery/resilience/adaptation of essential maternal neonatal services, for at least one of the following: ANC, facility-based delivery/skilled birth attendance (SBA), EmONC, PNC, neonatal care. Indicators may include access, utilization, coverage, continuity, quality, referral delays, stockouts, service closures, and catch-up services.	Studies reporting only clinical outcomes without service data (e.g., preterm birth/low birth weight/ stillbirth only); studies focusing solely on broader child (non-neonatal) services (under-five morbidity, general immunization, child nutrition) without a direct link to essential maternal neonatal services.
Type of services assessed	Essential maternal neonatal services: ANC, childbirth/SBA, EmONC, PNC, neonatal care.	Studies that focus solely on family planning, child nutrition, routine immunization, or general health services without any component of ANC/delivery/EmONC/PNC/ neonatal care.
Bibliographic criteria	Published between 2021 and 2026; English language; research articles; full text available; open access (according to your filters).	Outside the specified year or language range; non-article publications; not available in full text; not open access.
Duplication	The most complete/latest version of the same study.	Duplicates across databases or earlier versions that have been superseded by a final publication.

All records were managed and deduplicated in Mendeley Desktop version 1.19.8. The study selection process consisted of two stages: initial title/abstract screening against eligibility criteria, followed by a full-text assessment of potentially relevant articles. Screening was conducted independently by members of the review team, with disagreements resolved through discussion. All decisions and reasons for exclusion were documented to populate the PRISMA flow diagram. A standardised extraction form was developed before full-text review and refined through pilot testing. From each included study, we extracted bibliographic details, design, setting, population, disaster type, and disaster-cycle phase, as well as service or care context, outcomes, variables related to disruption or recovery, key findings, and reported limitations. Extraction was performed in duplicate, and all entries were cross-checked to ensure accuracy and consistency.

Due to heterogeneity in design, settings, disaster types, and outcome measures, we employed a narrative synthesis approach. Findings were organised using a structured thematic framework aligned with the PEO question and the disruption-to-recovery conceptual model. We summarised study characteristics and disaster contexts, mapped disruption and recovery across disaster-cycle phases, and synthesised recurrent system-level pathways (service delivery and infrastructure, workforce, supplies, referral and transport, information and coordination), recovery and resilience strategies (e.g. temporary or mobile services, alternative referral routes, task shifting, community support, digital solutions, supply restoration), and contextual and equity modifiers. Quality appraisal findings informed the level of interpretive confidence in each thematic domain.

Methodological quality and risk of bias were assessed using the Mixed Methods Appraisal Tool (MMAT) 2018, which allows consistent appraisal across quantitative, qualitative, and mixed-methods studies. Two external validators independently classified each study by design, rated the five design-specific MMAT criteria as "Yes," "No," or "Cannot tell," and formulated an overall confidence judgment (high, moderate, or low) with brief justifications. Discrepancies were resolved through discussion, and final MMAT ratings were incorporated into the synthesis to contextualise the strengths and limitations of the evidence base.

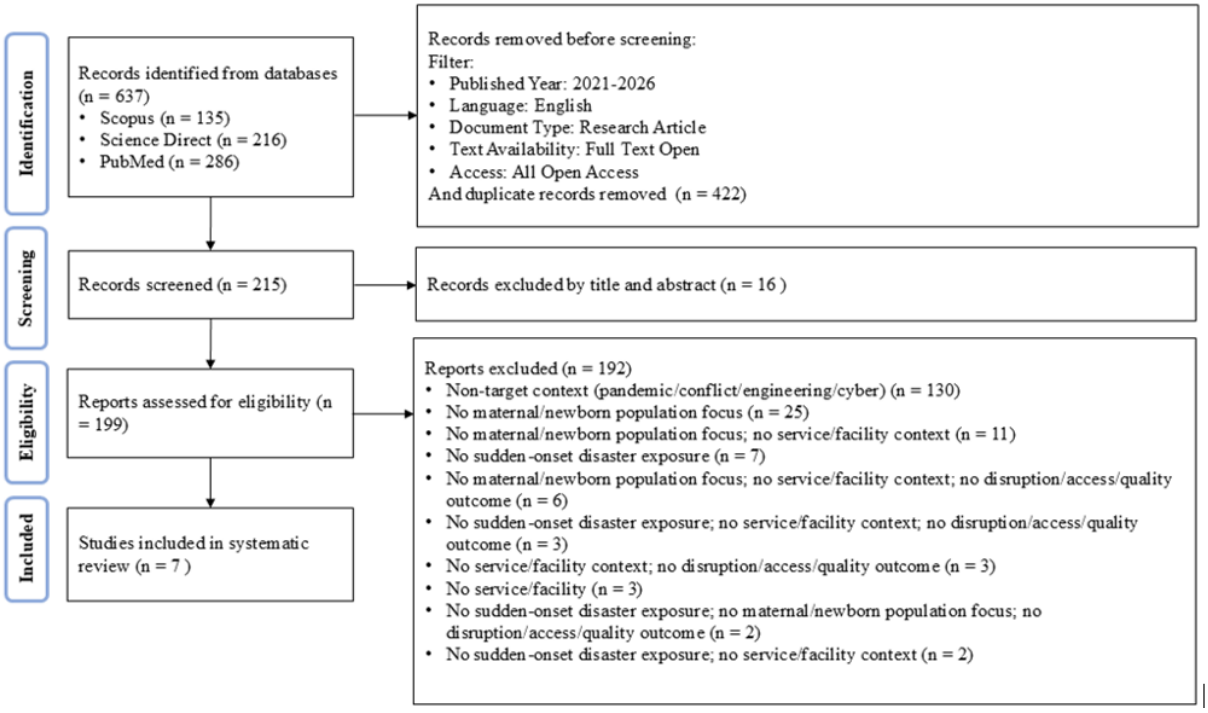

Figure 1. PRISMA Flow

Result and Discussion

The study selection process adhered to PRISMA guidelines, as illustrated in Figure 1. After filtering through relevant keywords and publication dates, a total of 637 articles were initially identified. Ultimately, 7 articles were selected for further analysis.

Seven studies that met the inclusion criteria all examined floods and cyclones/ storms in South Asia, Sub-Saharan Africa, and the Caribbean, so the available evidence specifically concerns hydrometeorological events. Quantitative evidence came from time-series analyses and routine data in Mozambique and Malawi, as well as a national survey in India, while qualitative and mixed-methods studies

Table 4. Study characteristics of the included papers.

No	Author (Year)	Study design	Setting/ Location	Population /Participants	Condition /Context studied	Key findings on disruption/ recovery of MCH services
1	Chandra *et al*., (2025)	Secondary cross-sectional data analysis	India	Women of reproductive age who had given birth (NFHS data)	Living in flood-prone areas, as disaster risk exposure affects routine ANC services	Flood-prone districts were associated with higher odds of incomplete ANC; social inequalities exacerbated access barriers → illustrates service disruption in the context of chronic flood risk.
2	Poudel *et al*., (2024)	Mixed-methods	Nepal	Women of reproductive age and SRHR stakeholders	Climate vulnerability and recurrent flooding and their impact on access to maternal and newborn services	Flooding triggered disruptions in access to ANC/PNC and delivery of care (distance, cost, damaged facilities, social norms). Community adaptations supported partial access, but recovery was uneven.
3	Ashraf *et al*., (2024)	Concurrent rapid mixed-methods assessment	Pakistan	Women aged 15 49 years in camps, plus health workers/ authorities	2022 monsoon floods: displacement, facility damage, maternal services in relief camps	Access to maternal services was severely limited; facilities were damaged, staff and medicines were insufficient; major barriers included transport, costs, and safety concerns → recovery of services remained suboptimal.
4	Twabi *et al*., (2024)	Quantitative before after/ITS using facility surveillance data	Malawi	Aggregate data from 33 health facilities (maternal service utilization)	Impact of Cyclone Freddy on maternal newborn service utilization	Significant declines in ANC and PNC were observed immediately after the cyclone → indicates a shock to maternal service delivery requiring rapid recovery.

5	Fernandes *et al*., (2022)	Uncontrolled interrupted time series using multi-year RHIS/DHIS2 data	Mozambique	District-level aggregate MNCH indicators	Impact of Cyclone Idai and the process of service recovery	Indicators dropped sharply after Idai and then returned to near baseline levels within approximately three months, indicating evidence of recovery/ resilience in maternal newborn services.
6	Silva-Suarez *et al*., (2021)	Qualitative interpretative phenomenological analysis (IPA)	Puerto Rico	Ten women who were pregnant during Hurricane Maria	Experiences of access and continuity of care during and after the hurricane	Main themes: disruption of prenatal care, communication and transport barriers, psychological stress; services gradually improved in line with health system recovery and social support.
7	Jeffers *et al*., (2022)	Descriptive qualitative study	US Virgin Islands	Eighteen women who were pregnant during the hurricanes or within ≤2 months postpartum	Pregnancy and childbirth experiences after Hurricanes Irma and Maria (2017), including preparedness, response, and recovery of maternity services	Disruption: 66.7% experienced delayed or interrupted prenatal care (typically 2 4 weeks); maternity facilities and the workforce were affected, raising concerns about hospital capacity. Recovery/ Resilienc: continuity of high-quality maternity care; service adaptations (clinic relocation, cloud-based access to medical records, home visits, communication via social media); strong community support.

in Pakistan, Nepal, Puerto Rico, and the US Virgin Islands described women's experiences and community-level barriers to maternal-neonatal health services before, during, and after disasters.

Sudden-onset disasters are consistently described as acute shocks that weaken multiple health-system functions and undermine maternal-neonatal service readiness. In Mozambique and Malawi, Cyclone Idai and Cyclone Freddy triggered immediate declines in key maternal and child health indicators and utilisation of essential services (Fernandes *et al*., 2022; Twabi *et al*., 2024). In flood-affected Pakistan, rapid assessments documented acute shortages of SRH commodities, damaged facilities, and disorganised service delivery in camps (Ashraf *et al*., 2024). Qualitative accounts from Puerto Rico and the US Virgin Islands portray hurricanes as events that overwhelmed local service capacity, disrupted infrastructure, and created uncertainty about access to care during pregnancy and childbirth (Jeffers *et al*., 2022; Silva-Suarez *et al*., 2021).

Evidence suggests that service disruptions occur across the entire disaster cycle, rather than being confined to the response phase. In India, higher rates of incomplete ANC among women in flood-prone districts suggest that chronic hazard exposure has already weakened routine service continuity during the inter-event period (Chandra *et al*., 2025). During the acute hurricane phase in Puerto Rico and the US Virgin Islands, damaged infrastructure, transport barriers, and communication

breakdowns led to delayed or cancelled antenatal visits and uncertainty about delivery services (Jeffers *et al*., 2022; Silva-Suarez *et al*., 2021). In the early recovery phase, routine data from Mozambique and Malawi show sharp shocks in service utilisation that gradually recover, while qualitative and mixed-methods findings from Pakistan and the Caribbean indicate that access for displaced or isolated groups can remain constrained for months (Ashraf *et al*., 2024; Fernandes *et al*., 2022; Jeffers *et al*., 2022). Recurrent flooding in Nepal's river basins further affects both perceived and actual access across multiple seasons, linking climate-related risk to repeated service disruptions (Poudel *et al*., 2024).

System-level disruptions contributed to decreased access, coverage, and continuity of essential MNH services, particularly ANC and PNC/neonatal care. In Malawi and Mozambique, Cyclones Freddy and Idai were linked to immediate reductions in the utilisation of ANC, PNC, and key maternal and child health indicators (Fernandes *et al*., 2022; Twabi *et al*., 2024). Survey-based analysis in India showed that living in flood-prone districts increased the likelihood of incomplete ANC, indicating that structural hazard exposure can weaken service continuity even outside acute disaster periods (Chandra *et al*., 2025). Facility delivery and EmONC were likewise affected: damage to public facilities, staff shortages, and limited referral options in flood-affected Pakistan impeded safe facility-based childbirth (Ashraf *et al*., 2024), while in Malawi, post-cyclone declines in facility deliveries and caesarean sections reflected constrained obstetric capacity during the shock period (Twabi *et al*., 2024). Postnatal and neonatal care appeared particularly vulnerable, as routine data from Malawi and Mozambique documented sharp short-term decreases in PNC visits and early childhood immunisation following major storms (Fernandes *et al*., 2022; Twabi *et al*., 2024).

Evidence indicated that service disruption was distributed across the disaster cycle rather than confined solely to the response phase. In India, higher rates of incomplete ANC among women living in flood-prone districts suggested that chronic exposure to hazard risk was already weakening routine service continuity during the inter-event period (Chandra *et al*., 2025). During the acute phase of hurricanes in Puerto Rico and the US Virgin Islands, women reported that damaged infrastructure, transport barriers, and communication gaps led to delayed or cancelled prenatal appointments and uncertainty about delivery services (Jeffers *et al*., 2022; Silva-Suarez *et al*., 2021). In the early recovery phase, routine data from Mozambique and Malawi documented sharp utilisation shocks that gradually attenuated over time, while qualitative and mixed-methods studies from Pakistan and the Caribbean indicated that access could remain constrained for months among displaced or isolated populations (Ashraf *et al*., 2024; Fernandes *et al*., 2022; Jeffers *et al*., 2022; Twabi *et al*., 2024). Poudel *et al*. (2024) further demonstrated that recurrent flooding in Nepal's river basins affected both perceived and actual access across multiple seasons, thereby linking climate-related risk to recurrent service disruptions (Poudel *et al*., 2024).

The severity and distribution of service disruption were shaped by contextual and equity-related factors. In India, women from socially marginalised groups living in flood-prone districts had substantially higher odds of incomplete ANC than women outside these groups and areas, indicating that hazard exposure and social stratification interact to widen service gaps (Chandra *et al*., 2025). In Malawi, post–Cyclone Freddy declines in maternal service utilisation varied by region, reflecting place-based differences in vulnerability and recovery capacity (Twabi *et al*., 2024). Poverty, displacement to camps, and remoteness in rural or river-basin settings compounded barriers related to transport, supplies, and workforce availability (Ashraf *et al*., 2024; Poudel *et al*., 2024). Qualitative accounts from Puerto Rico and the US Virgin Islands highlighted additional challenges for women in isolated island environments, where evacuation and access options were limited, and recovery of formal services was slower (Jeffers *et al*., 2022; Silva-Suarez *et al*., 2021). Taken together, these findings support an equity-sensitive perspective that resilience and recovery are socially patterned rather than evenly distributed.

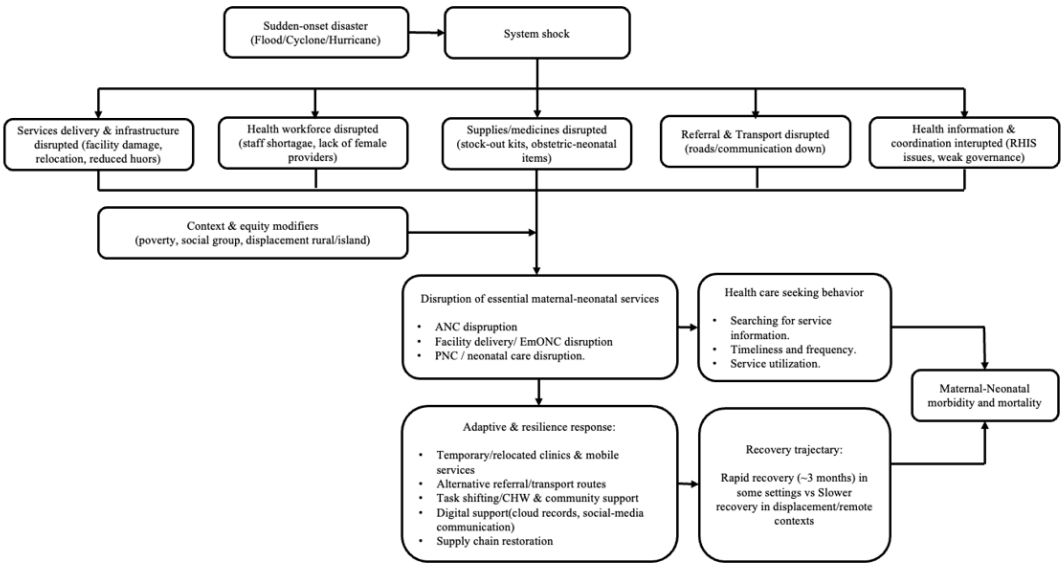

Figure 2. Conceptual Model of Disruption-to-Recovery for Essential Maternal Neonatal Health Services Across the Disaster Cycle

Although disruptions were substantial, the studies described multiple adaptive responses that helped sustain the continuity of MNH services. In Pakistan and the Caribbean, services were relocated or reorganised through temporary or alternative service points and adjusted operating hours to reach affected populations (Ashraf *et al*., 2024; Jeffers *et al*., 2022). Family, neighbours, and community networks provided transport, information, and psychosocial support for women in the US Virgin Islands and Puerto Rico, enabling them to continue pregnancy care (Jeffers *et al*., 2022; Silva-Suarez *et al*., 2021).

Individual coping strategies were also prominent, with women actively managing stress and seeking to protect their pregnancies amid uncertainty (Silva-Suarez *et al*., 2021). At the system level, Mozambique's ability to track MNH indicators through routine information systems illustrates how data platforms can strengthen resilience by enabling more targeted recovery efforts (Fernandes *et al*., 2022). Taken together, these adaptations are consistent with the conceptual model's emphasis on adaptive and resilience responses as key mediators between disruption and recovery.

The most promising way to protect and improve coverage of maternal-neonatal services in disasters is a bundle of adaptive strategies that bring care closer to women while keeping referral pathways functional. Relocated or temporary clinics and mobile outreach help sustain access when fixed facilities are damaged or unreachable, and alternative referral and transport routes ensure that obstetric and neonatal emergencies can still reach appropriate levels of care. Crucially, these structural adaptations are only truly effective when communities are mobilized: community health workers, family networks, and local leaders play a central role in organizing transport, circulating timely information, and encouraging women to keep seeking ANC, safe delivery, and PNC even under highly disruptive conditions. Recovery trajectories differed across countries and types of services. In Mozambique, most maternal and child health indicators returned to pre-cyclone levels within a few months, reflecting a relatively rapid rebound as information systems and core health-system functions were restored (Fernandes *et al*., 2022). In Malawi, the analysis mainly captured the immediate post-cyclone decline, recommending a slower recovery

where infrastructure damage, transport disruption, and resource constraints are more severe (Twabi *et al*., 2024).

Qualitative evidence from Puerto Rico and the US Virgin Islands shows that, although formal services eventually stabilised, women continued to depend on informal networks and faced ongoing psychosocial stress during early recovery (Jeffers *et al*., 2022; Silva-Suarez *et al*., 2021). In flood-affected Pakistan, persistent infrastructure and supply challenges in camps pointed to a longer and more uneven recovery (Ashraf *et al*., 2024). Taken together, these findings support a disruption-to-recovery model in which disasters trigger system shock, followed by multidimensional service disruption and heterogeneous recovery trajectories shaped by context, equity, and adaptive capacity.

The synthesis enabled the development of a conceptual model of disruption-to-recovery (Figure 2). The model links sudden-onset disasters to an initial system shock, mediated by five core health-system functions (service delivery, workforce, supplies, referral/transport, and information/coordination), which in turn generate disruptions in ANC, facility delivery/EmONC, and PNC/neonatal care. Contextual and equity modifiers (poverty, displacement, social marginalisation, and remoteness) intensify these disruptions, while adaptive and resilience responses (temporary or mobile services, alternative referral routes, community and digital support, and supply-chain restoration) shape diverse recovery trajectories.

This review synthesises how floods, cyclones, and hurricanes trigger system shocks that disrupt core health-system functions service delivery and infrastructure, health workforce, supply chains, referral and transport, and information and coordination and how these upstream shocks translate into reduced ANC use, facility delivery and EmONC, and PNC/neonatal care, especially for services requiring repeated contacts (Begum & Hamid, 2023; Fatema *et al*., 2023; Suter & Aagaard, 2023). Disruption occurs along the entire disaster cycle: chronic residence in flood-prone areas is associated with "latent disruption" of routine care, while recovery trajectories range from relatively rapid rebound in districts with stronger information systems and baseline capacity to protracted and uneven restoration in displacement camps and remote island settings (Jejaw *et al*., 2023; Orderud, 2024; Topcu, 2023; Worku *et al*., 2022).

By linking hazard exposure to specific health-system functions and integrating women's qualitative accounts from Puerto Rico and the US Virgin Islands, the review moves beyond event-specific or hazard-centric descriptions and frames disruption to recovery as a continuum that is deeply shaped by fear, uncertainty, social support, and pre-existing vulnerabilities (Hochrainer-Stigler *et al*., 2023; Rodo *et al*., 2022; Silva-Suarez *et al*., 2021). The disruption pathways closely mirror the pillars of the Minimum Initial Service Package, and observed collapses in ANC continuity, impaired EmONC referral, and obstetric–neonatal stock-outs in Pakistan, Malawi, and Mozambique suggest that MISP components should function as preparedness benchmarks in hazard-prone districts, including safeguarding ANC/PNC platforms, ensuring redundant referral and transport routes, and strengthening last-mile logistics for essential MNH commodities (Ashraf *et al*., 2024; Fernandes *et al*., 2022; Hermawan *et al*., 2023; Nugroho *et al*., 2025; Twabi *et al*., 2024). An equity-sensitive reading of the evidence shows that poverty, social marginalisation, displacement, and geographic isolation in India, Pakistan, Nepal, and the Caribbean magnify service disruption and delay recovery, underscoring that resilience is always "resilience for whom?" and calling for targeted preparedness and response for high-risk groups rather than solely universal approaches (Ashraf *et al*., 2024; Chandra *et al*., 2025; Ferreira *et al*., 2024; Jeffers *et al*., 2022; Kim *et al*., 2025; Poudel *et al*., 2024; Silva-Suarez *et al*., 2021). At the same time, the studies demonstrate that adaptation is possible through relocated or temporary services, outreach and mobile clinics, community health workers, and digital tools, yet most evidence remains descriptive, with few rigorous evaluations of the impact of such strategies on MNH continuity or outcomes (Maita *et al*., 2024; Munyuzangabo *et al*., 2021; Sheerazi *et al*., 2025).

Methodological gaps are substantial:

most studies capture only short-term effects, quality of care is rarely measured, and resilience metrics are inconsistently defined, restricting comparability and synthesis. Standardised indicators such as time to recovery, magnitude of immediate decline, stock-out days for key commodities, and workforce retention could strengthen the evidence base (Biddle *et al*., 2020; Dsouza *et al*., 2024; Fleming *et al*., 2022; Pasquier *et al*., 2024). This SLR's strengths lie in its PEO-based question, mixed-methods appraisal, and use of a conceptual model derived from the included studies, but its conclusions are constrained by the small number and regional clustering of eligible studies, their focus on floods and storms, and search limits to three databases, English-language, and open-access full texts (Ashraf *et al*., 2024; Chandra *et al*., 2025; Fernandes *et al*., 2022; Jeffers *et al*., 2022; Poudel *et al*., 2024; Silva-Suarez *et al*., 2021; Twabi *et al*., 2024). Future reviews should expand database coverage, language inclusion, and publication types to encompass a broader range of disaster-affected settings, particularly in low- and middle-income countries.

Conclusion

This review demonstrates that sudden-onset natural disasters, particularly floods and cyclones, consistently disrupt essential maternal and neonatal health services through system shocks that affect service delivery, workforce, supplies, referrals, transportation, and information and coordination. These upstream disruptions lead to declines in ANC, facility delivery/EmONC, and PNC/neonatal care, with services requiring repeated contacts appearing most vulnerable across the disaster cycle. Disruption and recovery are not evenly distributed: poverty, social marginalisation, displacement, and remoteness intensify service gaps and delay restoration, highlighting the need to frame resilience as equitable recovery, not only rapid recovery.

Operationalising MISP-aligned preparedness as a routine benchmark in hazard-prone settings by protecting ANC/PNC platforms, securing EmONC referral and transport, strengthening supply chains, and utilising robust routine information systems offers a concrete pathway to safeguard continuity of care for the most at-risk groups. The limited number of studies, heterogeneity of designs, and short follow-up periods underline the need for stronger evidence. Future research should standardize indicators of disruption and recovery, and rigorously evaluate resilience strategies, including mobile and outreach MNH services, as well as strengthened health information systems, to inform policy and practice in disaster-prone contexts.

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