FACILITY-LEVEL DELAYS IN CARE PROVISION AND THEIR EFFECTS ON MATERNAL AND NEONATAL OUTCOMES IN AFGHANISTAN AND YEMEN: A retrospective analysis.

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A thesis submitted in partial fulfilment of the requirements for the degree of
Master of Science in International Health

by

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Abstract

Background: Maternal and neonatal mortality remain disproportionately high in fragile, conflict-affected, and violent (FCV) settings, with over 60% of global maternal deaths occurring in these contexts. While the Three Delays Model identifies barriers to care, the "third delay" — receiving timely and quality care after arrival at a facility — is understudied in humanitarian settings.

Objective: To evaluate facility-level determinants influencing maternal and neonatal mortality in Médecins Sans Frontières (MSF)-supported hospitals in Afghanistan and Yemen, applying the third delay framework.

Methods: A retrospective analysis of 105,979 records from three MSF hospitals (Boost, Afghanistan; Al-Jumhouri and Taiz Houban, Yemen) covering January 2023–December 2024 was conducted. Facility infrastructure, human resources, clinical processes, and time-to-death patterns were analysed using descriptive statistics and comparative analysis.

Results: Institutional maternal mortality ratio (MMR) was 181.9 per 100,000 live births, and neonatal mortality rate (NMR) was 50.6 per 1,000 live births. Boost Hospital recorded the highest MMR (271.4) and NMR (65.3), with gaps in blood transfusion utilisation, ICU effectiveness, and surgical response. Thirty-five per cent of deaths occurred within 24 hours of admission. Functional blood transfusion services were associated with a 90% reduction in postpartum haemorrhage mortality. Staffing ratios were lowest at Boost (1:10.7 doctors to beds), contributing to delayed recognition and intervention.

Conclusion: Significant facility-level disparities in infrastructure, staffing, and emergency protocols contribute to excess maternal and neonatal deaths within the same humanitarian organisation. Standardising resource allocation, strengthening emergency recognition and response, and ensuring timely use of life-saving interventions are critical to reducing third-delay mortality in FCV contexts.

Keywords: maternal mortality, neonatal mortality, third delay, fragile conflict-affected settings, humanitarian health.

Word count: [11800]

LIST OF ABREVIATIONS

CFR- Case Fatality Rate

CPAP – Continuous Positive Airway Pressure

EmONC – Emergency Obstetric and Newborn Care

FCV – Fragile, Conflict -Affected and Violent

HIS – Health Information Systems

MMR – Maternal Mortality Ratio

MSF – Médecins Sans Frontieres

NICU – Neonatal Intensive Care Unit

NMR – Neonatal Mortality Rate

OR – Operating room

SDG – Sustainable Development Goals

WHO – World Health Organisation

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Chapter 1

1.1 Introduction

This thesis examines facility-level determinants of maternal and neonatal mortality in conflict-affected healthcare settings, focusing on third delay factors that hinder life-saving interventions after patients reach medical facilities. As a health professional with experience in neonatal care, I had witnessed disparities within the same institution when providing quality care, resulting in maternal and neonatal fatalities. For that, I found it essential to explore these systemic barriers that threaten lives.

The research employs a retrospective analysis methodology to examine maternal and neonatal outcomes across three Médecins Sans Frontières (MSF) hospitals in Afghanistan and Yemen, providing evidence to understand preventable deaths. This approach reveals critical intervention opportunities and facility-specific factors that determine whether outcomes are positive or adverse, offering evidence-driven insights for improving humanitarian healthcare provision.

The structure follows a systematic progression from contextual background to methodology and actionable recommendations. Chapter 2 stabilises the research justification and objectives, while Chapter 3 details the methodology. The results are integrated in Chapter 4, with a final discussion on the implications for humanitarian health delivery in Chapter 5. Finally, Chapter 6 presents evidence-driven recommendations for mitigating third delay.

This research aims to inform MSF and other humanitarian organisations on how to contribute to and improve the quality of care provision through descriptive evidence on facility-level determinants of mortality outcomes in conflict-affected settings.

1.2 Background

1.2.1 Conflict-Affected Healthcare Settings

Some of the most demanding environments for providing healthcare worldwide are those categorised as fragile, conflict-affected, and violent (FCV). The World Health Organisation (WHO) defines these contexts as regions characterised by political instability, violence, and weakened social infrastructure, resulting in significant obstacles to healthcare access (1). These contexts disproportionately affect maternal and neonatal populations, who require time-sensitive, actionable interventions that are hindered in conflict situations (2,3).

Afghanistan and Yemen face systematic disruption across the six health system building blocks described by the WHO: service delivery, health workforce, health information systems, medical products and technologies, financing, and leadership or governance (4). These fragmentation challenges the quality of care provision, yet humanitarian large-scale medical operations run to deliver health services to a dense population (5–7).

1.2.2 Context and Challenges

Afghanistan's population of approximately 40 million is predominantly rural (70%), while Yemen's 38 million inhabitants are divided between urban and rural areas, with one-third residing in cities. Both populations are notably young, with median ages of 18 years and life expectancies of 65 years. High fertility rates, exceeding four pregnancies per woman, add challenges to already understaffed and under-resourced health systems (8–10). These limitations restrict the capacity to respond effectively to maternal and neonatal health needs, where timely interventions often determine survival outcomes.

Figure 1. *Map South Asia (Afghanistan and Yemen) Source: World Bank maps https://maps.worldbank.org*

1.2.3 Infrastructure and Human Resource Challenges

Physical destruction of infrastructure and depletion of human resources represent critical failure points in FCV health systems. Functioning health facilities operate under constraints, such as electricity shortages, scarcity of clean water, and limited surgical capacity, which directly compromise the provision of quality care to mothers and newborns (14,15). Unreliable power sources threaten cold chain systems for vaccines, and inadequate sanitation in facilities increases the risk of puerperal and neonatal infections (11,12).

Human resources shortages are particularly acute in both countries. The WHO recommends at least 4.4 qualified health practitioners per 1,000 population; however, Afghanistan and Yemen have, on average, 0.3-0.5 per 1,000 (13,14). These deficiencies result from multiple factors, including insecurity, professional burnout, inadequate financial incentives, and gender-based employment restrictions (15,16). In Afghanistan, women's exclusion from public life adversely impacts female health providers and creates gaps for culturally appropriate maternal care, making women and newborns disproportionately vulnerable groups in humanitarian disasters (17).

Cultural and gender norms exacerbate access restrictions; women's transit to facilities in Afghanistan is constrained by the requirement for male accompaniment and reduced autonomy, resulting in late care-seeking behaviour (18–20). Similarly, in Yemen, economic instability and poverty cause families to seek healthcare only when complications become life-threatening (21,22). Late arrival at the facilities and severe cases require skilled attendants and higher competencies to provide adequate, timely care to vulnerable mothers and children (23,24).

1.2.4 Médecins Sans Frontières Operations in Conflict Settings

Médecins Sans Frontières (MSF) operates extensive healthcare programs in both Afghanistan and Yemen, providing direct medical care in facilities ranging from specialised hospitals to basic health centres. MSF's operational model emphasises standardised protocols, consistent training, and quality assurance systems designed to maintain care standards across diverse contexts (25) .

In Afghanistan, MSF operates nine primary medical projects, navigating complex political restrictions while providing essential healthcare services. The organisation has adapted to ensure culturally appropriate maternity care and to keep female healthcare workers participating in operational functions, despite challenging policy environments (26,27).

MSF's Yemen program represents one of the organisation's largest global operations, providing direct care in 12 hospitals and supporting 16 additional facilities across 13 governorates. The program addresses severe healthcare access gaps created by conflict while managing complex supply chains and security challenges (28).

1.2.5 Maternal and Neonatal Health Challenges

Mother and children face particular vulnerabilities in conflict-affected settings due to their time-dependent emergency interventions and specialised care needs. Pregnancy complications, delivery emergencies, and neonatal conditions require immediate medical response that becomes critically compromised when healthcare systems are damaged or under-resourced (14,29).

Common preventable causes of maternal mortality in these settings include postpartum haemorrhage, hypertensive disorders, and sepsis. Conditions that require emergency recognition, appropriate treatment protocols, and immediate access to interventions such as blood transfusion, surgical care, and continuous monitoring or intensive care units. Similarly, neonatal mortality from preventable causes includes birth asphyxia, prematurity, and infections, reflecting systematic failures in integrated care.

The burden of maternal and neonatal mortality in FCV settings is reflected not only through inequalities, violence, and displacement. Additionally, healthcare providers often fail to deliver preventive, curative, and comprehensive care, regardless of the outcome, including comfort and end-of-life care. This breakdown occurs despite the presence of healthcare facilities and trained staff, suggesting that process factors and care quality determinants require a deeper analysis and improvement measures (20,30).

1.2.6 Healthcare Quality in Humanitarian Settings

Often, humanitarian organisations prioritise coverage and access over care quality, focusing on providing more services rather than improving outcomes. This approach may achieve broad population coverage, but it fails to address systemic and implementation problems that perpetuate preventable mortality within healthcare facilities (31).

Recent evidence suggests that healthcare quality variation in humanitarian settings may be substantial, with facility-level factors significantly influencing patient outcomes, independent of individual clinical characteristics. These variations raise important questions about equity in humanitarian health delivery and organisational accountability for care quality (7,32).

The challenge of measuring and improving healthcare quality in humanitarian settings requires diverse approaches that can identify systematic performance problems while providing actionable guidance for improvement.

Chapter 2

2.1 Problem Statement

Maternal and neonatal mortality rates in FCV areas remain concerningly high, with Afghanistan reporting a maternal mortality ratio of 638 deaths per 100,000 live births and Yemen recording 164 per 100,000 live births (23,33,34) . Neonatal mortality rates are also alarming, with 37 fatalities per 1,000 live births in Afghanistan and 27 in Yemen (35,36) . Preventable problems include postpartum haemorrhage, hypertensive disorders of pregnancy, neonatal infections, and birth asphyxia.

The Third Delay model introduced by Thaddeus and Maine provides a comprehensive framework to understand maternal & neonate mortality by identifying three critical stages where care may fail (20). The first delay involves the decision to seek care, influenced by cultural, financial, and security barriers. The second delay encompasses obstacles to reaching healthcare facilities, including geographical isolation, transportation barriers, and inadequate referral systems. The third delay, the focus of this study, is associated with the quality and timeliness of care provided within the healthcare facility upon the patient's arrival.

In FCV settings, the third delay becomes more complicated and severe due to resource constraints, disrupted care continuity, compressed decision-making timeframes, and the psychological and moral distress that impacts both patients and healthcare providers. Facility-level determinants of the third delay include delays in emergency response, limited access to critical care, diagnostic and treatment delays, and internal transfers. However, this crucial component, which impacts maternal and neonatal survival, has received insufficient attention in the humanitarian health literature.

Prolonged hospitalisations, excessive usage of specialised services, and deferred treatments and surgeries exemplify hospital deficiencies that constrain clinical decision-making, management, and leadership in FCV situations. Understanding these facility-level factors is critical because they represent the final opportunity to provide quality care after individuals have overcome significant barriers to reach healthcare services. Implementing protocols that align with best practices regardless of the outcome, thus includes quality end-of-life care.

2.2 Justification

Investigating facility-level determinants of maternal and neonatal outcomes serves multiple purposes for humanitarian health.

The few studies focus on third delay determinants in humanitarian contexts, when compared to research on first and second delays. Despite substantial investments by humanitarian organisations in establishing and maintaining healthcare facilities, there is little evidence on facility-level factors influencing maternal and neonatal outcomes, which limits efforts to optimise care delivery and prevent avoidable deaths.

This gap is particularly concerning in high-pressure humanitarian environments, where resource limitations necessitate maximum efficiency and effectiveness. Without clear insights into which facility-specific elements most significantly impact patient health results, organisations face difficulties in making informed decisions regarding resource allocation, clinical protocols, or performance improvement priorities.

MSF-supported facilities provide a unique opportunity for such analysis. Standardised protocols and training across operations create a consistent framework that allows for equitable comparisons between facilities. This approach isolates the influence of infrastructure, human resources, and clinical processes on outcomes, rather than reflecting variations in organisational approach or quality standards.

Retrospective analysis of routine clinical data from these facilities offers a detailed understanding of care processes, resource allocation patterns, and service utilisation trends. Importantly, this method enables the real-time application of findings to enhance current operations, without requiring additional investment in primary data collection—making it a cost-effective approach in resource-constrained settings.

The ethical dimension of this work is equally significant. Documented differences in outcomes between facilities within the same organisation raise essential questions about equity in care provision and organisational accountability. Understanding why such variations exist is crucial in upholding the humanitarian principles of humanity and impartiality, ensuring that survival outcomes are driven by clinical need rather than chance, and not by the likelihood of arriving at a particular facility.

Finally, the operational relevance of this research is both actionable and substantial. By identifying facility-level determinants of the third delay, humanitarian health stakeholders can target interventions with high potential for impact. Beyond MSF, the findings can serve as a reference for the humanitarian health sector, where similar facility-level challenges affect organisations across multiple conflict-affected and resource-limited settings. By doing so, this research supports global efforts to reduce preventable maternal and neonatal mortality, contributes to the 2030 Sustainable Development Goal, and ensures that humanitarian health investments achieve their intended life-saving impact.

2.3 Research Objectives

2.3.1 Primary Objective

To evaluate the impact of facility-level factors on maternal and neonatal mortality outcomes in MSF-supported hospitals in Afghanistan and Yemen, using the third delay framework to identify critical determinants of care quality.

Specific Objectives:

1. To analyse maternal and neonatal mortality outcomes in various MSF-supported hospitals, examining hospital-level differences and contextual variables.
2. To assess asses the relationship between facility infrastructure capacity, specialised care, availability and maternal and neonatal mortality rates in the study hospitals.
3. To examine clinical process efficiency through time to death patterns and resource utilisation indicators, identifying critical points where care delivery fails.
4. To provide evidence-based recommendations for MSF and similar humanitarian organisations to enhance maternal and neonatal care delivery in conflict-affected and fragile settings.

Chapter 3: Methodology

3.1 Study Design

This research conducted a retrospective comparative analysis of standard clinical data from MSF-supported hospitals in Afghanistan and Yemen. The study examines facility-level factors that affect maternal and neonatal outcomes over a 24-month period, from January 1, 2023, to December 31, 2024.

The observational approach examines variations in facility-level characteristics and maternal and neonatal outcomes across different healthcare facilities, specialising in focusing on third delay factors within the three delays analytical framework.

3.2 Analytical Framework

3.2.1 Three-Delays Model Application

The Three Delays Model, developed by Thaddeus and Main, was selected as the foundation for this study, with a particular focus on the third delay component, which involves delays in receiving adequate care once reaching the healthcare facilities. This is particularly important in FCV situations, where hospitals face challenges such as shortages of qualified staff, high patient volumes, and insecurity.

This framework recognises three phases where maternal and neonatal mortality prevention may fail:

1. First delay involves the decision of the care-seeking (individual/social)
2. Second delay on how to reach the facility (community/transportation)
3. Third Dealy receiving quality ant timely care in the health institution (facility/ systems)

Figure 2: *Three Dealy Model source : https://www.lshtm.ac.uk/newsevents/events/time-update-three-delays-model-womens-empowerment-perspective (38)*

3.2.2 Third Dealy Operationalisation

For this analysis, the third delay determinants were organised into four interconnected groups.

Infrastructure factors: Physical and technological resources, including laboratories and blood bank, intensive care capacity, surgical facilities, diagnostic equipment, and essential medical supplies.

Human resource factors: staffing levels, skill mix, competency, specialist availability, doctor-to-patient ratio, and organisational factors that impact staff performance.

Clinical process factors: emergency recognition, protocols, triage systems, treatment decision-making, and care coordination interventions.

Temporal factors: time-to-death patterns, length-of-stay distributions, indicating emergency response effectiveness and clinical process variability.

The use of this framework guided data collection strategy, analytical approach, and result interpretations, providing a categorisation of facility-level factors' impact on mothers and neonatal outcomes.

3.4 Study setting and Population

3.4.1 Facility Selection

Three MSF-supported hospitals were selected, representing diverse operational contexts while maintaining sufficient volume to enable statistical analysis.

- Afghanistan: Boost Provincial Hospital in Helmand Province
- Yemen: Taiz Houban Mother and Child Hospital (MCH)
- Yemen: Al-Jumhouri Hospital, Taiz City

3.4.2 Population

Includes all patients receiving maternal and neonatal health care services at the three participating facilities over 24 months. This study covers the full spectrum of care rather than focusing on a specific subgroup or clinical condition.

Inclusion criteria:

- Maternal population: all women admitted for pregnancy-related care from conception through 42 days postpartum, in line with the WHO maternal period, including pregnancy complications, deliveries and postpartum complications.
- Neonatal population: all newborns admitted within 28 days of birth, regardless of their place of birth.
- Study Period: January 1, 2023 to December 31,2024

Exclusion criteria:

- Records with incomplete admission dates, admission dates or essential clinical information.
- Cases with data entry errors, such as impossible biological values or internal inconsistencies
- Records lacking outcome data necessary for mortality analysis

3.5 Data Sources and Variables

3.5.1 Health Information System

Data were sourced from MSF's standardised Health Information System (HIS), which maintains consistent data collection protocols across all operating sites. The HIS records demographic, clinical, and outcome information through structured electronic entries, ensuring data quality and standardisation across different contexts, facilitating meaningful comparisons.

The system records primary data on discharge status, diagnosis at exit, following IC10 registration, cause of death, time-to-death (stratified for first 48 hours) and length of stay.

3.5.1 Data cleaning and validation

Data cleaning and validation procedures were carried out, including analysing missing data and identifying duplicate records to prevent multiple counts and to ensure accurate records of individuals with various admissions or internal transfers.

3.6 Study variables and definitions (Annexe I. Table 1 Variable definitions)

Primary outcomes:

- Mortality at discharge (primary outcome)
- Maternal Mortality Ratio (MMR): deaths per 100,000 live births
- Neonatal Mortality Rate (NMR): deaths per 1,000 live births
- Case Fatality Rates by primary diagnoses

Facility level variables

- Infrastructure capacity: ICU beds, surgical capacity, blood transfusion services, specialised equipment.
- Clinical process indicator: time to deaths patterns, intervention utilisation rates, care coordination measures. APGAR score
- Resource availability: staffing pattern, equipment availability and service capacity.

Patient-level variables

- Demographic characteristics: age, gestational age, and single or multiple pregnancy.
- Clinical factors: admission diagnosis, interventions received, length of stay
- Outcomes: discharge status, cause of death or primary diagnosis at exit.

3.7 Statistical Analysis Plan

3.7.1 Descriptive Analysis

Includes frequencies, proportions, means, and medians to describe population characteristics, facility operations, and outcome patterns across the three studied sites.

Temporal patterns were analysed with annual trends, length of stay, and time to death in hours.

The time to death was previously recorded in the data set for 67%. Includes period <4 hours, 4-24 hours, 28-48 hours or >48 hours.

3. 7 Comparative Analysis Methods

- Chi-squared test for categorical variables (or Fisher's exact test when expected frequencies <5)
- Analysis of variance for continuous variables
- Exact methods with 95% confidence intervals
- P value was considered significant = <0.05

Time- to- Event Analysis

Time-to-death descriptive analysis examines temporal patterns in mortality. Focuses on identifying early versus late mortality patterns that may indicate emergency response failures or problems with the intensive care process

3. 8 Software and Data Management

All analyses were conducted using R statistical software (version 4 4.3.0 0) with the RStudio interface.

Data were stored and managed in accordance with MSF data protection guidelines, with all personal identifiers removed and anonymised case numbers assigned for analysis purposes.

3.9 Ethical Considerations

3.9.1 Ethical Approval

Ethical approval for this study was obtained from the MSF research committee, meeting the exception criteria set by the Ethics Review Board of MSF-OCA. Local ethical approval from Yemen and Afghanistan were adress though MSF stablish proticols prior to data analysis.

The study utilised anonymised retrospective data routinely collected as part of standard patient care, with no additional data collection from patients.

3.9.2 Data Protection and Confidentiality

The analysis complies with ethical principles of confidentiality, data security, beneficence, and justice. All data were anonymised, and personal identifiers were removed in accordance with MSF's data-sharing agreement and data protection guidelines.

Detailed information on ground operationalisation was shared through key MSF information.

Given the retrospective nature of the study, obtaining individual consent from patients was not feasible. Institutional consent from MSF was considered sufficient by the ethics committee.

3.9.3 Research Ethics and Beneficence

The study design ensures that research findings will directly benefit participating facilities and similar humanitarian operations through evidence-driven recommendations for third delay mitigation. Results are planned to be shared with operational teams and to facilitate quality improvement interventions.

3.10 Study Limitations

Methodological limitations were identified in the study design. The retrospective approach of the analysis limited the availability of certain variables that might influence outcomes, such as detailed socioeconomic status or community-level factors, which are not routinely collected in clinical records. The facility-based analysis potentially underrepresented community deaths or those unable to reach the health units, and limits population-level generalizability.

Documentation practices varied across facilities due to different staffing patterns, system capabilities, and operational workloads, potentially influencing apparent diagnosis or intervention rates. The 24-month study period may not accurately capture seasonal variations or temporal trends in conflict-affected healthcare services.

Selection bias was a potential concern, as the analysis included only MSFR-supported facilities, limiting generalization to other humanitarian organisations or healthcare systems. The focus on the third delay factor, while scientifically justified, meant that the first and second delay influences were not directly measured despite their continued relevance in FCV settings.

These limitations were taken into account in the interpretation of the findings and the discussion of the results.

Chapter 4.- Study Results

4.1 Study population

A total of 136,929 maternal and neonatal records were extracted from the MSF Health Information System across the three studied facilities over the 24 months from January 2023 to December 2024. Following data cleaning, 105,979 records were included (77.5% retention rate).

The dataset provides robust evidence of systemic third delays determinants affecting maternal and neonatal survival across different healthcare settings.

Table 4.1 *Final dataset composition by Facility*

Service Type	Al-Jumhouri (YEM)	Boost Hospital (AFG)	Taiz Houban (YEM)	Total
Deliveries	14,101 (22.0%)	37,437 (58.5%)	12,462 (19.5%)	64,000
Maternal admissions	7,616 (28.8%)	11,177 (42.2%)	7,687 (29.0%)	26,480
Neonatal admissions	2,615 (16.9%)	9,093 (58.7%)	3,791 (24.5%)	15,499
Total	24,332 (23.0%)	57,707 (54.4%)	23,940 (22.6%)	105,979

Source: Author's own analysis based on MSF HIS data (2023–2024).

Boost Hospital manages 54.4% of all cases, demonstrating the highest patient volume across all service categories.

4.2 Mortality Outcomes (objective 1)

The study reveals concerning mortality patterns reflecting institutional third delay factors. Facility-based maternal mortality ratio (MMR) was 181.9 deaths per 100,000 live births (95% CI 149.8-220.7), while institutional neonatal mortality rate (NMR) reached 50.6 deaths per 1,000 live births. These facility rates are concerningly high for an healthcare setting, where WHO quality care standards expect maternal deaths to be infrequent (70 per 100,000 live births) and neonatal mortality to remain below 12 per 1,000 (39)

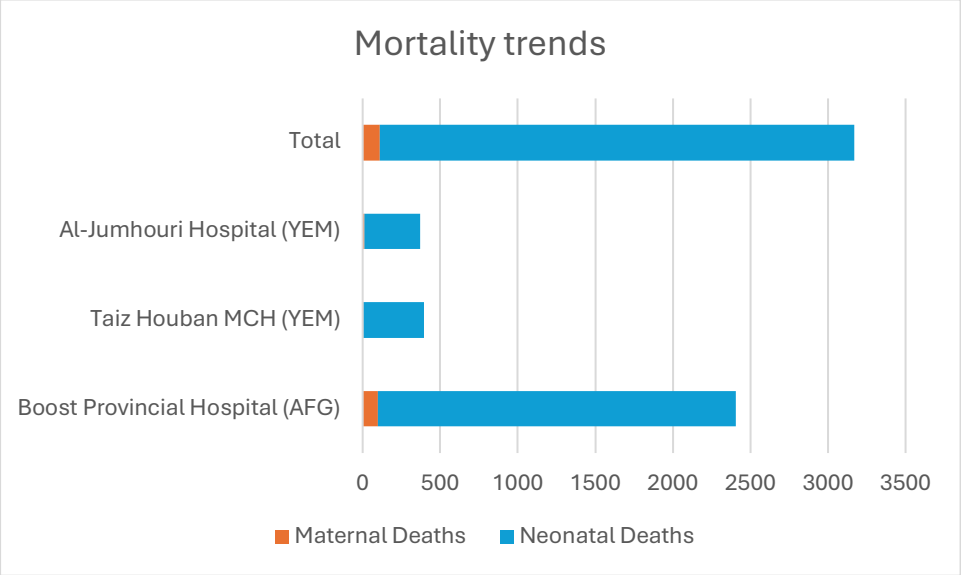

Figure 3: *Facility-Based Maternal and Neonatal Mortality Trends in MSF-Supported Hospitals, 2023–2024*

Table 4.2 *Mortality General Outcomes by Facility*

Indicator	Al-Jumhouri (YEM)	Boost Hospital (AFG)	Taiz Houban (YEM)	Total	P
Total live births	13,532	35,368	11,570	60,470	<0.001
Total maternal deaths	10	96	4	110	-
Total neonatal deaths	358	2,309	392	3,059	<0.001
Maternal Mortality Ratio (MMR)	73.9	271.4	34.6	181.8*	0.018
Neonatal Mortality Rate (NMR)	26.5	65.3	33.9	50.6**	<0.001

**MMR = Maternal mortality ratio: maternal deaths per 100,000 live births*
***NMR = Neonatal mortality rate: neonatal deaths per 1,000 live birhts*

Source: Author's own analysis based on MSF HIS data (2023–2024).

Parwise comparison demonstrated that systematic third delay fails at Boost Hospital in Afghanistan, with a 3.7-fold higher maternal mortality compared to Al-Jumhouri and almost eight times more chances for women to die when compared to Taiz Houban. Similarly, neonatal mortality showed a 50% increase and a 3.4-fold difference, respectively, compared to Yemeni institutions.

4.3 Third Dealys Infrastructure Determinants (Outcome 2,3)

Critical infrastructure gaps directly correlate with mortality differences.

Table 4.3 *Third delay Infrastructure Comparison by Facility*

Infrastructure Service Impact	Al-Jumhouri	Boost Hospital	Taiz Houban	Mortality
Blood Transfusion				
Service available mortality reduction	YES	NO USE	YES	90%
Utilization rate availability	7.80%	0.00%	10.70%	
Death with transfusion	1.20%		0.20%	
ICU Services				
ICU Avialable Highest Mortality	NO	YES	NO	Paradox
Utilization rate availability	0%	0.30%	0%	
ICU Mortality		5.80%		
Surgical Capacity				
OR Utliisation	<1%	1.20%	7.40%	High
Surgical Mortaly	7%	0.10%	0.17%	Lower
Mortality	8.20%	5.80%	0.37%	

Source: Author's own analysis based on MSF HIS data (2023–2024).

Blood transfusion is the strongest infrastructure determinat, ICU presence without proper protocols shows pardox results

4.4 Third Delay Human Resources Determinant (Outcome 2)

Boost Hospital;s 1:10 doctor-to-bed-ratio represents critical undrstaffin that dierectly contribute to third delay mortality thoug compromise emergency response capacity

Table 4.4 *Third Dealy Resource Determinants by Facility*

Facility	Doctors	Midwives	Beds	Doctor:Bed Ratio	Annual Admissions per Doctor
Al-Jumhouri	16	28	60	01:03.8	1,521
Boost Hospital	18	71	192	01:10.7	3,206
Taiz Houban	31	33	168	01:05.4	772

Source: Author's own analysis based on MSF HIS data (2023–2024).

Gynaecologists were available only at Taiz Houban, working alongside six more doctors. The Boost Hospital information was not specific, referring to general practitioners or specialists, thus reporting the highest midwife workforce. Al-Jumhouri shared regional specialists.

4.5 Third Delay Clinical Process Determinants (Outcome 1, 2)

4.5.1 Maternal

- Eclampsia caused 20% of mortality. It was strongly associated with a higher risk of dying of 2.4 for women treated at Boost hospital compared to those admitted to Al-Jumhouri. The case fatality rate (CFR) of 7.7% starkly highlights the need for better recognition and timely treatment of seizures and high blood pressure. This could result from limited monitoring or specific drug stocks. Yemen's lower eclampsia mortality, especially in Taiz Houben (0%), likely reflects the implementation of structured emergency protocols, rapid magnesium administration, and trained multidisciplinary response teams that can diminish adverse outcomes.

- Sepsis mortality was reported only in Afghanistan, with a CFR of up to 87.5%. Sustained delays in recognition, antibiotic initiation, and surgical contamination can limit the quality of care; humanitarian facilities face fluctuations in antibiotics, testing, and laboratory results, or even basic hygiene measures when clean water is inaccessible.

- Postpartum haemorrhage represents a preventable cause of death and one of the main mortality drivers in Helmand Province. Postpartum Afghan women are at a higher risk of fatalities due to a weak blood transfusion protocol, failure in activating surgical interventional and neonatal teams.

- Abruptio placentae showed the highest mortality association, with 14 more chances of dying. This condition requires immediate surgical response. Afghanistan's higher death rates in these emergencies signal critical delays in admission, decision-making and timely intervention.

- Multiple births were recorded at Boost Hospital and Taiz Houban. Mothers and babies face higher risks of mortality and need improved intervention strategies to ensure quality care. The Afghanistan facility was 50% more likely to experience adverse outcomes when delivering twins or triplets.

4.5.2 Neonatal

Prematurity, very low weight (<1500g), and fetal distress emerge as primary drivers of mortality.

- Premature infants are three times more likely to die than term neonates; being born early also increases risks of infections, respiratory difficulties, hypothermia, feeding problems, and brain injuries. Taiz Houban had the lowest mortality in this age group; differences in resource allocation and specialised treatments affect this difference in survival compared to Boost Hospital.

- Very low weight was the significant risk factor for mortality in neonates, regardless of gestational age. Babies require rigorous monitoring, nutritional support, and prompt treatment of potential infections. Integration of low-cost measures, such as Kangaroo Mother Care, promotes skin-to-skin contact, and could reflect misopportunities in Afghanistan due to untrained staff, lack of space, and limited engagement for family participation during long hosptial stays.

- Asphyxia and low APGAR score 5 minutes after birth are associated with higher mortality, primarily in the Boost Hospital. Moderate to severe lack of oxygen generates complications or death in early newborn life. APGAR score evaluates a baby's adaptation to extrauterine life, with results between zero and ten, with ten asociated to a healthy baby. A score <7 at 1 minute reflects intrapartum complications, while the second evaluation at 5 minutes is strongly associated with delays when providing immediate care and resuscitation protocols, and availability of adequate equipment with oxygen and respiratory support.

- Outborn status. Representatives of babies born out of the facility, Boost referal status show 15 % of intake of neonatal admissions. This condition showed statistical difference in mortality patterns, with 80% percent higher chances of dying than those in Taiz Houban. Treatment delays occur when initial neonatal care, including hygiene measures, thermal stabilisation, and hourly monitoring, is not received during the first 6 hours of life, as recommended by the WHO on maternal and neonatal packages.

- Stillbirths A significant 5.5 % rate of stillbirths and neonatal immediate deaths from the total of births is reported across the facilities. (Anex Talv 4.6 Mortality during birth) These outcomes are influenced by the quality of intrapartum care that is provided in each facility, including a coordinated triage and admission process, continued fetal and maternal monitoring, the presence of skilled attendants, and timely recognition and management of complications. Taiz Houban accounted for most of these fatalities, which can reflect the specialised service on maternal and neonatal care and concentration on highly complex cases between the facilities.

- Gestational age. 80% of immediate neonatal deaths were associated with extreme gestational ages, preterm (<28 weeks) or postmature (>42 weeks). This obstetric situation requires highly responsive intervention, and survival heavily depends on immediate access to advanced neonatal support, such as thermal regulation, respiratory assistance, and infection prevention. Delays in initiating these measures result in rapid deterioration and high mortality. Facilities need to coordinate actionable protocols between obstetric and neonatal paediatric teams to ensure the health of neonates.

4.6 Temporality analysis

4.6.1 Time to death

Critical temporal analysis revealed that 35% of all deaths, including maternal and neonatal, occurred within 24 hours of admission, with a substantial 25% within the first four hours from admission time.

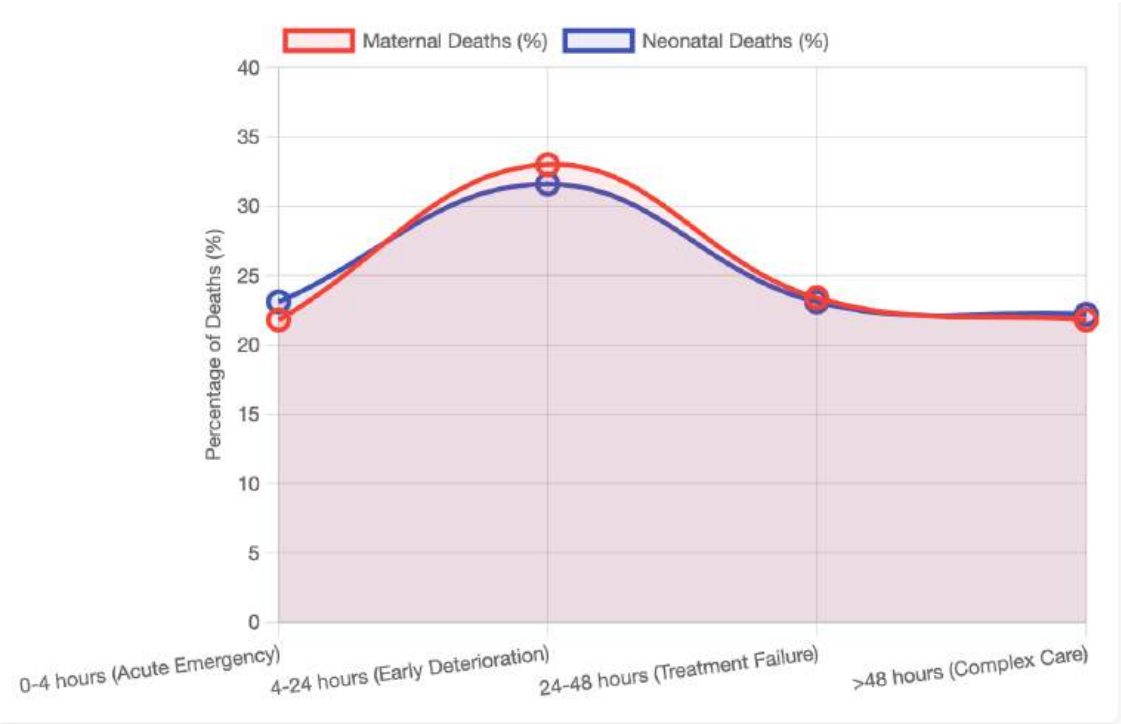

Figure 4: *Time to Death Distribution for Maternal and Neonatal Cases. Source: Author's own analysis based on MSF HIS data (2023–2024). AI created*

Clinical implications: Immediate mortality indicates triage failures and emergency recognition delays

Chapter 5. Discussion and recommendations

5.1 General

The analysis reveals profound disparities in maternal and neonatal outcomes across MSF-supported facilities in Afghanistan and Yemen, despite operating under the same organisation protocols and standards. The overall maternal mortality ratio is 181.9 per 100,000 live births, and the neonatal mortality rate is 50.6 per 1,000 live births. With Afghanistan recording significantly higher rates (MMR: 217, NMR 65.3) compared to Yemen's AL Jumhouri (MMR: 73.9, NMR 26.5) and Taiz Houban (MMR: 73.9, NMR 33.9). These findings provide critical insights into the third delay of the established Three Delay framework and highlight fundamental challenges in humanitarian health delivery, resource allocation, equity, and standardisation of care quality in fragile conflict-affected settings.

These records on mortality rates must be understood within a broader context of global maternal health. The WHO reports a significantly higher mortality in conflict-affected settings, with an estimated MMR of 350-500, while NMR is calculated between 70-90 per 1000 live births. The study has low records compared to the average conflict setting, which could suggest that medical humanitarian organisations can achieve better outcomes or great number of fatalities are happening out of facility. A study conducted in Malawi on factors associated with maternal mortality reveals similar results. It shows that 66% of maternal deaths occur associated with the third dealy, with a further 22% happening after hours of being discharged. (40) These findings provide evidence that facility-level factors are associated with poor outcomes once women had overcome the first and secon delay.

The differences observed among the three study sites cannot be attributed exclusively to facility delays; additional factors, such as limited access to healthcare and inadequate transit to quality services, are also contributors to fatalities. (41) Documented evidence adds supportive information on the strong effect of the first and second delay and how the decision of seeking care and the journey to the facility can present threats to maternal lives (42,43) Social and family contirbuites in this settings to wait for male acompanitnat travel to health unit. Increasing delays in overall care.

Maternal proactive seeking behaviour has been reported in low-resource and fragile settings like Tanzania. This contradictory effect, which attempts to improve the quality of care, also disrupts and burdens already constrained health services. (44) Inequities in the distribution of human resources and supplies can affect the prompt interventions needed for emergency responses, contributing to the high burden of acute death during the first hours of admission.

5.2 Third Dealy Determinants Analysis

Infrastructure and resource availability

The failure of Boost hospitals during haemorrhages to provide transfusions represents a critical infrastructure factor that could prevent deaths. Blood availability is fundamental to managing obstetric haemorrhage, the leading cause of maternal mortality worldwide and the primary contributor to deaths in this study. (45) The contrast between studies in Taiz and Houban, where high transfusion rates (10.7%) and zero postpartum haemorrhage mortality were achieved, is associated with the lifesaving impact of this essential service. (46,47) The literature reports described other actionable cost-effective protocols that include uterotonics or long-acting oxytocin, and promoting continuous training to health career. The primary challenges faced in this study were the sustainability of resources logistics on chain management.

This disparity raises fundamental questions about resource allocation and equity within humanitarian operations. The data suggest that organisational decisions about where to place critical resources may inadvertently create arbitrary survival advantages based on facility assignment rather than clinical need. Such variation challenges core humanitarian principles of equality and impartiality in care provision. (48,49)

The intensive care service's exclusive availability at Boost Hospital, paradoxically, combined with the highest mortality rates, indicates that infrastructure alone is insufficient to improve outcomes without investing in staff, supply management, and protocols. Broadly studied in and outside humanitarian settings, essential considerations on this theme have been thoroughly explored. Initial questions on cost-effectiveness arise when allocating these units. As Lee et al. describe, they are expensive, and their direct effects seem to be on a minor scale due to low bed capacity, costly supplies and human expertise. (51) However, their introduction in humanitarian settings follows core humanitarian principles and saving mothers' lives transcends barriers to resource allocation. For optimisation of this resource, the process should integrate team management and supportive coordination with other blocks of health systems to provide quality care. (52)

Clinical process and emergency response

Rapid mortality patterns, especially in neonates, indicate the need to redefine triage systems and skills to recognise life-threatening conditions, in order to respond to critical cases accurately.

The superior performance at Taiz Houban across multiple indicators, zero postpartum mortality, highest rates in surgical utilisation, and blood transfusion services, points to more reflective clinical process integration. This facility's specialised focus on maternal and child health may enable more integrated care pathways across deliveries and admission services. Continued monitoring, evaluation, and audits are valuable tools to address quality in care. A retrospective study in Tiaz Houban exemplifies how adaptive response during conflict needs to be implemented to maximise use of resources, without compromising care. During the

study, a restrictive police for C-section was implemented, pre- and post-evaluation showed alignment to protocols and an increase in induction of labour. (48)

Boost Hospital role as a general referral centre, managing a diverse patient population, may dilute focus and resources from mothers and child well-being, despite handling the highest volumes of cases. The facility's neonatal outborn 15% admission rate aligns with global rates describing high mortality compared to babies born in the facility.(53–55) This highlights the importance of resuscitation and immediate stabilisation, following golden hour measures and neonatal care protocols.

Human resources and organisational factors

The staff-to-patient ratio highlights concerns at Bood's hospital, including the high number of patients and a reduced workforce. This situation affects the quality of care provided to an already overstretched team, leading to carer fatigue, less time for individual assessments, and limitations in delivering specialised interventions that require collaboration or supervision by specialists. Evidence shows contradictory results when evaluting staff ratio and outcomes. Some suggest that mortality rates are inversely correlated with the number of healthcare providers. While contemporary evidence reveals staff continuing training and engagement of local health providers, it increases competencies and creates a longer workforce compared to shift specialists from abroad. (56–59)

Different survival patterns among facilities suggest that the current MSF protocol may need to be adapted to local contexts and resource availability. The top outcomes achieved at Taiz Houban suggest that specialised maternity and child facilities may be more effective than general hospitals for managing obstetric and neonatal emergencies in resource-constrained settings.

5.3 Implications of humanitarian Health care delivery

The documented differential outcomes raise fundamental ethical questions about equity in the delivery of humanitarian health care. The concentration of preventable deaths in Yemeni facilities suggests that current resource allocation mechanisms may perpetuate health inequalities rather than address them. Allocation should be distributed within an operational system that approaches the continuum of demand and need. (16,60,61) Ingration of women's perspectives and community for a culturally sensitive approach demands actions even away from the failures.

Organisations should prioritise establishing consistent minimum standards for life-saving interventions across all facilities by redirecting resources from expansion to quality improvement. Yemen's integration of comprehensive maternal and newborn services, effective banking, and specialised staff demonstrates that quality care can be provided even in challenging FCV settings when the necessary resources and personnel are in place. Collaboration with healthcare providers, strengthening relations with community leaders to

address population needs, should be continuous work. While maintaining transparency and accountability.

However, the sustainability and replicability of this model require careful analysis. Tiaz Houban may reflect contextual factors such as staff experience, local partnerships or robust supply chains. Taking this factor into account can provide a successful scaling approach in humanitarian settings. The concentration of rapid deaths at admission time indicates the need to enhance protocols for reaching facilities. This could be improved by developing rapid assessment or intervention protocols that include community and local health forces, to prevent loss of valuable lifes.

Chapter 6 Recommendations

6.1 Summary of Key Findings

This study evaluated facility-level determinants of maternal and neonatal mortality in three MSF-supported hospitals in Afghanistan and Yemen, applying the third delay framework. The analysis revealed marked differences in mortality outcomes, despite the use of standardised protocols within the same organisation. Boost Hospital (Afghanistan) reported the highest institutional maternal mortality ratio (271.4 per 100,000 live births) and neonatal mortality rate (65.3 per 1,000), significantly exceeding rates at Al-Jumhouri and Taiz Houban in Yemen.

The main determinants included :

- Infrastructure gaps: Underutilisation of blood transfusion services despite availability; paradoxical high ICU mortality suggesting deficits in recognition, referral, and intensive care management; and lower surgical intervention rates for obstetric emergencies.
- Human resource shortages: The lowest doctor-to-bed ratio at Boost (1:10.7) compromised timely assessment, monitoring, and emergency interventions.
- Clinical process delays: Higher case fatality rates for eclampsia, sepsis, postpartum haemorrhage, and abruptio placentae at Boost indicated deficiencies in early detection, protocol activation, and multidisciplinary response.
- Temporal factors: Over one-third of deaths occurred within 24 hours of admission, underscoring critical failures in emergency recognition and rapid intervention capacity.

These findings confirm that third-delay determinants directly influence survival outcomes in FCV contexts and that such determinants differ between facilities within the same organisation.

6.2 Interpretation about Existing Literature

The high mortality rates observed align with evidence from FCV contexts, where resource constraints and system fragility undermine care quality (43,62). The association between functional blood transfusion services and reduced postpartum haemorrhage mortality is consistent with global estimates showing transfusion as a key determinant of maternal survival in obstetric emergencies (56,63)
The paradox of ICU availability with poor outcomes reflects literature from humanitarian settings, which highlights that infrastructure alone is insufficient without adequate staffing, continuous monitoring, and effective referral pathways (1,52)
The staffing disparities mirror WHO's documented health worker shortages in Afghanistan and Yemen, exacerbated by conflict, gender restrictions, and insecurity (64,65) The elevated early mortality aligns with studies from sub-Saharan Africa and South Asia showing

that delays in triage and intervention within the first 24 hours are critical predictors of preventable death (66)

6.3 Implication for Humanitarian Health Practice

These findings have operational and policy implications for MSF and similar organisations.

- Standardisation of critical care protocols
- Strengthening emergency recognition
- Optimising resource use
- Human resource allocation
- Data-driven quality improvement

6.4 Limitations and considerations

This facility-based design directly excludes community deaths and those who could not reach the healthcare centre. Thus, it potentially underestimates the total mortality burden and limits generalizability to population-level outcomes. The retrospective design restricts the available variables and impedes the collection of additional data that might better explain the observations.

The assessment period is relatively short to evaluate all seasonal trends. The provision of care reveals that even with ongoing conflict, the impact on access to services in facilities remains evident. Generalizable findings are limited due to specific organisational factors and resources available, which may differ between humanitarian actors.

While this study identifies an association between facility characteristics and adverse outcomes, establishing causality remains a challenge due to unmeasured confounding factors. Patient-specific biological and clinical characteristics, referral patterns, and community-level factors may vary between the studied sites. Data were not always captured and available, potentially influencing the reported differences.

These observational design limitations could be overcome by future research using a quasi-experimental design while implementing new strategies on-site.

7. Conclusion

This study demonstrates that facility-level determinants, including infrastructure, human resources, clinical processes, and emergency response capacity, critically influence maternal and neonatal survival in fragile, conflict-affected, and violent (FCV) settings.

Analysis of over 105,000 maternal and neonatal records from three MSF-supported hospitals revealed significant disparities in mortality outcomes despite operating under the same organisational protocols. Boost Hospital in Afghanistan experienced markedly higher maternal and neonatal mortality compared to the Yemeni facilities, driven by underutilisation of available resources such as blood transfusions, insufficient human resource capacity, and delays in recognising and responding to emergencies.

The findings confirm that the third delay — receiving timely and quality care after arriving at a facility — remains a decisive factor in determining survival in humanitarian healthcare contexts. Addressing these facility-level gaps through standardised emergency protocols, strategic staff deployment, effective use of available infrastructure, and continuous quality monitoring is essential to reduce preventable deaths.

Ultimately, improving maternal and neonatal outcomes in FCV contexts requires not only the presence of healthcare facilities but also the assurance that they are equipped, staffed, and managed to deliver rapid, high-quality, and life-saving care at the point of need.

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Annex I Methods

Table AI: *Variables Categorization.*

Category	Variable	Definition	Measurement / Unit
Primary Outcomes	Mortality at Discharge	Survival status at discharge from facility	Binary (0 = Survived, 1 = Died)
	Maternal Mortality Ratio (MMR)	Facility-based maternal deaths per 100,000 live births	Deaths per 100,000 live births (per facility)
	Neonatal Mortality Rate (NMR)	Facility-based neonatal deaths per 1,000 live births	Deaths per 1,000 live births (per facility)
	Case Fatality Rates	Mortality rate by primary admission diagnosis	% deaths among cases of specific diagnosis
Facility-Level Variables	Infrastructure Capacity	Availability of blood transfusion services, ICU beds, surgical facilities, specialised equipment	Categorical (Available / Not Available) and counts (number of beds, units)
	Human Resources	Doctor-to-bed ratio, specialist availability, annual admissions per provider, adequacy of staffing patterns	Ratios, counts, categorical
	Clinical Process Indicators	Presence of emergency response protocols, intervention utilisation rates, coordination of care, quality indicators (e.g., Apgar score documentation)	Binary (Yes/No), % rates
	Service Utilisation	Rates of transfusion, surgical intervention frequency, ICU admissions, emergency response activations	% of admissions / number per admissions
Patient-Level Variables	Demographic Characteristics	Maternal age, gestational age, birth weight, multiple pregnancy status	Age in years, days, weeks, grams, binary (Yes/No)
	Clinical Risk Factors	Admission diagnosis, comorbidities, delivery complications, intervention requirements	Diagnosis codes, binary (Yes/No)
	Temporal Variables	Length of stay, time to death, date of admission, date of exit, date of birth	Days, hours, categorical
	Outcome Variables	Discharge status, cause of death, survival duration for deceased patients	Binary (Alive/Dead), cause of death category, days survived

Source: Author's own analysis based on MSF HIS data (2023–2024)

Appendix I: Detailed Statistical Analyses

Table A!.1: *Final dataset demographics by facility*

Variable	Al-Jumhouri (YEM)	Boost Hospital (AFG)	Taiz Houban (YEM)	Total
Deliveries	14,101 (22%)	37,437 (58.5%)	12,462 (19.5%)	64,000 (100.0%)

Multiple	330 (2.3%)	1,109 (3%)	434 (3.5%)	1,873 (2.9%)
Birthweight kg	2.3 kg ± 0.4	2.3 kg ± 0.4	2. 2kg ± 0.5	2.3kg ± 0.4
Antenatal care	3,239/ 14,101 (23%)	9,517/ 37,437 (25.4%)	2,444 / 12,462 (19.6%)	15,200 / 64,000 (23.8%)
Maternal	7,616	11,177	7,687	26,480
Age (years): Mean ± SD	28.2 ± 6.7	31.5 ± 6.7	30.7 ± 7.0	30.4 ± 6.9
Length of stay (days): Mean ± SD	1.3 ± 1.3	1.7 ± 1.5	1.5 ± 1.1	1.6 ± 1.4
Neonatal	2,615	9,093	3,791	15,499
Age at admission (days): Mean ± SD	2.2 ± 3.7	4.6 ± 6.3	2.1 ± 3.8	3.6 ± 5.5
Sex Male	1,450 / 2,615 (55.5%)	5,694/9,093 (62.6%)	2,260/ 3,791 (59.6%)	9,404/15,499 (60.7%)
Length of stay (days): Mean ± SD	3.8 ± 5.5	4.3 ± 4.6	5.9 ± 5.6	4.6 ± 5.1
<28 weeks (extremely preterm)	4/66 (6.1%)	6/168 (3.6%)	2/85 (2.4%)	12/319 (3.8%)
28-33 weeks (very preterm)	9/66 (13.6%)	20/168 (11.9%)	3/85 (3.5%)	32/319 (10.0%)
34-36 weeks (moderate preterm)	12/66 (18.2%)	34/168 (20.2%)	10/85 (11.8%)	56/319 (17.6%)
≥37 weeks (term)	41/66 (62.1%)	108/168 (64.3%)	70/85 (82.4%)	219/319 (68.7%)

Source: Author's own analysis based on MSF HIS data (2023–2024)

Table AII.2 : *Mortality pairwise comparison*

Neonatal		**pairwise comparison**	
Comparison	Relative Risk	Risk Difference (%)	95% CI for RD (%)
Al-Jumhouri vs Boost	0.405	-3.88	[-4.26, -3.51]
Al-Jumhouri vs Taiz	0.781	-0.74	[-1.17, -0.32]
Boost vs Taiz	1.927	3.14	[2.72, 3.56]
Maternal			
Comparison	Relative Risk	Risk Difference (%)	95% CI for RD (%)
Al-Jumhouri vs Boost	0.272	-0.64	[-0.92, -0.35]
Al-Jumhouri vs Taiz	2.138	0.04	[-0.02, 0.10]
Boost vs Taiz	5.795	0.69	[0.39, 1.00]

Source: Author's own analysis based on MSF HIS data (2023–2024)

Table AII.3: *Facility resources analysis*

	Yemen Taiz houband	Yemen taiz city	Afghanistan - Helmand
Total Beds	168	60	192
ER Beds	24		
ITFC Beds	22		37
Neonatal Beds	46	22	53
Pediatric Beds	25		42
Maternity Beds	35	23	30
Birth unit			
Isolation Beds	16		
Doctors (MDs)	31	16	18
Gynecologists	6		
Midwives	33	28	71
Midwife Assistants			21
OT Availability	Yes	Yes	Yes (3 OTs: 2 active, 1 standby)
Laboratory Service	Yes	Yes	Yes
Blood Bank	Yes	Yes	Yes
Radiology	No	Yes (MOH)	Yes (Digital)
Ultrasound	Yes	Yes	Yes (1 maternity + 2 hospital + portable)
Phototherapy	Yes	Yes	Yes
NICU Beds	46	22	53

Source: Author's own analysis based on MSF HIS data (2023–2024)

Table AII.4 *Maternal Risk Factors*

Odds ratio for martenal mortality			
Risk Factor	OR	95% CI	p-value
Abruptio placentae	14.04	6.52-30.6	<0.001
Eclampsia	2.40	1.14-5.20	0.021
Advanced maternal age (≥35)	1.71	1.10-2.60	0.015
Admitted for C-section	1.81	1.66 – 1.96	0.021
Multiple birth	1.50	1.32-1.84	<0.001

Source: Author's own analysis based on MSF HIS data (2023–2024)

Table AII.5: *Neonatal Risk factor*

Risk Factor	OR	95% CI	p-value
Prematurity	3.091	2.79-3.42	0.017
Very low weight <1500g	6.61	3.52-13.80	0.046
Fetal distress	3.69	1.72-7.89	0.002
Asphyxia	1.83	1.62-2.03	<0.001
Low Apgar score <5 at 5minute	1.86	1.74-1.90	<0.001
Outborn status	1.85	1.66-2.06	<0.001
cPAP use ***	11.2	5.274-23.84	0.046

**** Selection bias*

Source: Author's own analysis based on MSF HIS data (2023–2024)

ANNEX III

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. Chat GPT	Word count, Grammar. R check command and correct funtions
2. Grammarly	British English dictionary and spelling
3. Claude	R check command and correct funtions