

# **DETERMINANTS OF INFANT MORTALITY IN YEMEN**

**Mohanad Motea Abdullah Ghaleb**

**Yemen**

58th Master of Public Health/International Course in Health Development  
KIT (Royal Tropical Institute)  
Vrije Universiteit Amsterdam (VU)

## ***DETERMINANTS OF INFANT MORTALITY IN YEMEN***

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

By:

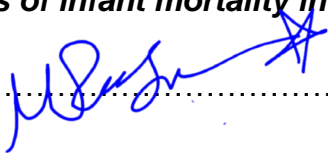
Mohanad Motea Abdullah Ghaleb  
Yemen

Declaration:

Where other people's work has been used (from either a printed or virtual source, or any other source), this has been carefully acknowledged and referenced by accordance by academic requirements.

***Determinants of infant mortality in Yemen*** thesis is my work.

Signature: .....



58th Master of Public Health/International Course in Health Development (MPH/ICHD)  
13 September 2021 – 2 September 2022  
KIT (Royal Tropical Institute)/Vrije Universiteit Amsterdam  
Amsterdam, The Netherlands  
September 2022

**Organised by:**

KIT (Royal Tropical Institute)  
Amsterdam, The Netherlands

**In cooperation with:**

Vrije Universiteit Amsterdam (VU)  
Amsterdam, The Netherlands

# Contents

List of Figures .....	II
List of Tables .....	II
List of Maps .....	II
Acknowledgment .....	III
List of Abbreviations .....	IV
Glossary .....	V
Abstract: .....	VI
Introduction .....	VII
1. Yemen Background: .....	1
1.1 Geography: .....	1
1.2 Population: .....	1
1.3 Political and Security Situation: .....	2
1.4 Socioeconomic Characteristics .....	3
1.5 Sociocultural Characteristics .....	4
1.6 Health System and Burden of Disease .....	4
2. Problem Statement, Justification, and Objectives: .....	6
2.1 Problem Statement and Justification: .....	6
2.2 Objectives: .....	8
3. Methodology: .....	8
3.1 Research Strategy: .....	8
3.2 Conceptual Framework: .....	9
3.3 Limitations of the Study: .....	10
4. Finding: .....	11
4.1 Proximal Determinants: .....	11
4.2 Socioeconomic Determinants .....	26
5. Evidence-based practice and interventions: .....	34
6. Discussion .....	37
7. Conclusion and Recommendations: .....	41
References .....	i

## List of Figures

FIGURE 1: YEMEN POPULATION PYRAMID.....	2
FIGURE 2: MOSLEY AND CHEN'S CONCEPTUAL FRAMEWORK.....	10
FIGURE 3: EARLY MARRIAGE IN YEMEN. 2006, 2013, AND 2018 .....	12
FIGURE 4: MATERNAL MALNUTRITION REACH DURING 2018 -2021 .....	17
FIGURE 5: SEVERE ACUTE MALNUTRITION (SAM) WITH COMPLICATIONS 2018 – 2021 .....	17
FIGURE 6: THE TOP LEADING CAUSES OF DEATH IN YEMEN 2019 .....	18
FIGURE 7: NEW-BORN DEATH CAUSES IN YEMEN .....	19
FIGURE 8: THE PERCENTAGE OF VACCINATED CHILDREN FROM 2016 TO 2018.....	20
FIGURE 9: ANC VISIT INDICATOR 2013, 2020, AND 2021 .....	21
FIGURE 10: SBA COVERAGE IN YEMEN 2013, 2020, AND 2021 .....	22
FIGURE 11: PNC COVERAGE IN YEMEN 2013, 2020, AND 2021 .....	23
FIGURE 12: MATERNAL COMPLICATIONS IN YEMEN.....	25
FIGURE 13: LITERACY RATE FROM 15 IN 2016 TO 2018 .....	27
FIGURE 14: UNIVERSITY ENROLMENT RATE FROM 2016 TO 2018 .....	27
FIGURE 15: THE UNEMPLOYMENT RATE IN YEMEN 2014 - 2018 .....	28
FIGURE 16: PRICE INFLATION RATE IN YEMEN 2016-2018 .....	30
FIGURE 17: YEMEN ANNUAL INCOME 2015 - 2018 (1000 YR) .....	30
FIGURE 18: TOTAL YEMEN SPENDING ON ESSENTIAL SERVICES 2014 – 2018 .....	32
FIGURE 19: THE IMPACT OF CLIMATE CHANGE ON MATERNAL AND NEONATAL HEALTH .....	33
FIGURE 20: MISP PACKAGE COMPONENTS.....	35

## List of Tables

TABLE 1: RESEARCH TABLE .....	9
TABLE 2: DISTRIBUTION OF INFANT MORTALITY AMONG RURAL AND URBAN AREAS IN YEMEN .....	19
TABLE 3: THE AVERAGE DISTANCE TO THE NEAREST HEALTH FACILITIES IN YEMEN.....	31

## List of Maps

MAP 1: YEMEN MAP.....	1
MAP 2: YEMEN DFA AND IRG AREAS .....	3
MAP 3: GOVERNORATE THAT HAS ACCESS TO IMPROVED WATER SOURCES IN YEMEN .....	13
MAP 4: GOVERNORATE THAT HAS ACCESS TO IMPROVED SANITATION IN YEMEN .....	13
MAP 5: DISTRIBUTION OF CHOLERA ATTACK RATE IN YEMEN GOVERNORATES.....	14
MAP 6: SAM PROPORTION PER DISTRICT MAY 2022 .....	15
MAP 7: MAM PROPORTION PER DISTRICT MAY 2022.....	15

## Acknowledgment

In the beginning, we thank Allah for his guidance and for lighting our paths in this life. I'm thankful to almighty Allah for giving me the strength, knowledge, patience, ability, and opportunity to understand and complete my master's courses and finalize this thesis paper. My sincere appreciation to the *Netherlands Universities Foundation for International Cooperation (NUFFIC)* and the *Royal Tropical Institute (KIT)* for giving me this chance and scholarship to get a Master of Public Health degree. My gratitude to my *academic advisor, thesis advisor, thesis back stopper, course coordinators, facilitators, administrative staff, and other KIT staff* for your great effort to make the knowledge, skills, kindness, sharing experiences, and make the surrounding environment safe and full of energy and inspiration.

Special gratitude to whom has the forehead wrinkles that facilitated my knowledge journeys - **Motea "Dad"**. To whom have always recalled my name every time and supported me since childhood - **Jamila "Mom"**. To my *brothers "Mohamed, Mustafa, Mutaz, Motasem, and Montaser"* and my *sisters "Mona and Malak"* who are an added value to my life and make me feel their souls in each step in my life. To that person who gave me life's meaning and taught me to write my chapters. To her holy soul, her unlimited patience, To her unforgettable smile - *My lovely wife Samah*. To my first inspiration, who made me feel the meaning of fatherhood, to who has always captured my heart from the first look - **Ayhm**. To my little smiley daughter, who has always mentioned my name with her tears with her missing feelings, To my heaven in this world - **Wateen**. To my beloved daughter, who had struggled to live from birth till passed away, who taught me how to stand and smile at this miserable life and spread hope to hopeless people, and knowledge to those who are looking for a better world future, to whom lost in the first hour of her life without any hope to hold her or live with *her R.I.P* - **Sulaf**.

To my *relatives, friends, colleagues, and tutors* who are always offering me visions, opportunities, and guidance, that made me what I am. To my country Yemen and all infants in this world who are standing within this war with the hope of a future. To all of you, I dedicate my master's degree and knowledge.... Thank you...

## List of Abbreviations

<b>ANC</b>	Antenatal Care
<b>BPCRP</b>	Birth Preparedness and Complication Readiness programme
<b>CBICB</b>	Community-Based Initiatives for Changing Behaviour
<b>CD</b>	Caesarean Delivery
<b>DFA</b>	De Facto Area
<b>DHOs</b>	District Health Offices
<b>eDEWS</b>	Electronic Disease Early Warning System
<b>ENC</b>	Essential New-born Care
<b>EPI</b>	Expanded Immunization Program
<b>FCDF</b>	Family Counselling and Development Foundation
<b>FP</b>	Family planning
<b>GAM</b>	Global Acute Malnutrition
<b>GBV</b>	Gender-Based Violence
<b>GDP</b>	Gross domestic product
<b>GHOs</b>	Governorate Health Offices
<b>HBB</b>	Helping Babies Breathe
<b>HDI</b>	Human Developmental Index
<b>HF</b> s	Health Facilities
<b>HIS</b>	Health Information System
<b>HS</b>	Health System
<b>IDPs</b>	Internally Displaced People
<b>IHME</b>	Institute for Health Metrics and Evaluation
<b>IMR</b>	Infant Mortality Rate
<b>IRG</b>	International Recognized Government
<b>LBs</b>	live births
<b>LBW</b>	Low birth weight
<b>LMICs</b>	low- and middle-income countries
<b>MCH</b>	maternal and child health
<b>MENA</b>	Middle East & North Africa
<b>MMR</b>	Maternal Mortality Rate
<b>MNB</b>	Maternal and New-Born
<b>MNBS</b>	Maternal and New-Born Sector
<b>MoPHP</b>	Ministry of Public Health and Population
<b>NB</b>	New-Born
<b>NGOs</b>	Non-Government Organizations
<b>NRP</b>	Neonatal Resuscitation Program
<b>PNC</b>	Postnatal care
<b>RH</b>	Reproductive Health
<b>SBA</b>	skilled birth attendants
<b>SDGs</b>	Sustainable Development Goals
<b>UN</b>	United Nations
<b>UNICEF</b>	United Nations Children's Fund
<b>VD</b>	Vaginal Delivery
<b>WASH</b>	Water, Sanitation, and Hygiene
<b>WB</b>	World Bank
<b>WHO</b>	World Health Organization
<b>YHRP</b>	Yemen Humanitarian Response Plan
<b>YNDHS</b>	Yemen National Health and Demographic Survey
<b>YNTFO</b>	Yemen National Team for Foreign Outreach

## Glossary

<b>Family Planning</b>	“The ability of individuals and couples to anticipate and attain their desired number of children and the spacing and timing of their births. It is achieved through the use of contraceptive methods and the treatment of involuntary infertility” (1).
<b>Global Acute Malnutrition (GAM)</b>	“GAM is determined by the proportion of children either with SAM or MAM. A child is classified as SAM if they: (1) have a weight-for-height z-score (WHZ) of <-3 SD, or (2) the presence of nutritional oedema. A child is classified as MAM if they: have a WHZ of >= -3 SD and <-2 SD” (2). “GAM = (# children with SAM + # children with MAM)/ (# total children 6-59 months)” (2).
<b>Infant mortality</b>	“The death of an infant before his or her first birthday. The infant mortality rate is the number of infant deaths for every 1,000 live births” (3).
<b>Infant mortality rate (per 1000 live births)</b>	“Infant mortality rate is the probability of a child born in a specific year or period dying before reaching the age of one, if subject to age-specific mortality rates of that period” (4).
<b>Maternal mortality</b>	“The death of a woman from direct or indirect obstetric causes, more than 42 days but less than one year after termination of pregnancy” (5).
<b>Maternal mortality rate (Per 100 000 live births)</b>	“The number of maternal deaths in a given time period divided by the number of live births (per 100 000 live births) during the same period” (6).
<b>Skilled Birth Attendant</b>	“a qualified health care provider, such as a midwife, doctor, or nurse, who has received education and training to be skilled in the management of women during normal childbirth and the immediate postpartum period, and the identification, management, or referral of complications in women or newborns” (7).

## **Abstract:**

**Background:** Since the beginning of the war in Yemen, the health system has deteriorated and impacted infant health. The infant mortality rate increased to 46 per 1000 live births in 2020, far from the SDGs of 25 per 1000. There is still a need for a response to save Yemeni infants' lives.

**Objective:** To identify and discuss the determinants influencing infant deaths in Yemen and propose interventions applicable in conflict-affected settings to reduce risks of infant mortality.

**Method:** This study is a literature review of national and donor reports, and available articles using Mosley and Chen's conceptual framework.

**Findings and discussion:** The findings showed a deterioration in the utilisation of MCH, nutrition deficiency, environmental contamination, especially WASH, and infant preventive and treatment factors that are mostly affected by the current war. In addition, education and productivity of parents, household income, economic situation, and health system are the dominant socioeconomic factors. Integrated interventions with PHC services will increase access to MCH services.

**Conclusion:** The deterioration of infant health is linked to the fragile health system in Yemen even before the conflicts. Socioeconomic and proximal factors are interlinked and increase the infant mortality rate. Moreover, the weakness of HIS in Yemen plays a role in the inability to measure the determinant factors of infant mortality. Because of that, stakeholders need to respond to these factors and strengthen the health system in Yemen.

**Keywords:** Infant mortality, War, Determinants, Health System, Yemen

**Word Count:** 13,131 words



## **Introduction**

Almost ten years of working with local and international Non-Government Organisations (NGOs) in Yemen. I have worked on various health, nutrition, WASH, protection, and emergency response projects.

Since 2004, the Ministry of Public Health and Population (MoPHP) has worked to strengthen the health system through the health system reform strategy. Unfortunately, there was no chance for this strategy to be applied due to the instability of the political situation. The health system has had total deterioration since 2015, public infrastructure, economic, and security situation. The mortality rate became aggressive, especially among maternal, children, and other vulnerable groups.

There has been no survey conducted since 2013, and most of the research data in Yemen depends on estimation or Yemen National Health and Demographic Survey (YNDHS) 2013 report. The last MoPHP annual report stated, "There 80 new-borns die every day before they reach 28 days old, and 16 mothers die during pregnancy and delivery every day". In addition, the infant mortality rate is estimated at 46 per 1000 live births in 2020. Maternal mortality reached 500 per 100,000 live births in 2019 compared to 385 per 100,000 live births in 2015, which highly indicates the deterioration of health in Yemen.

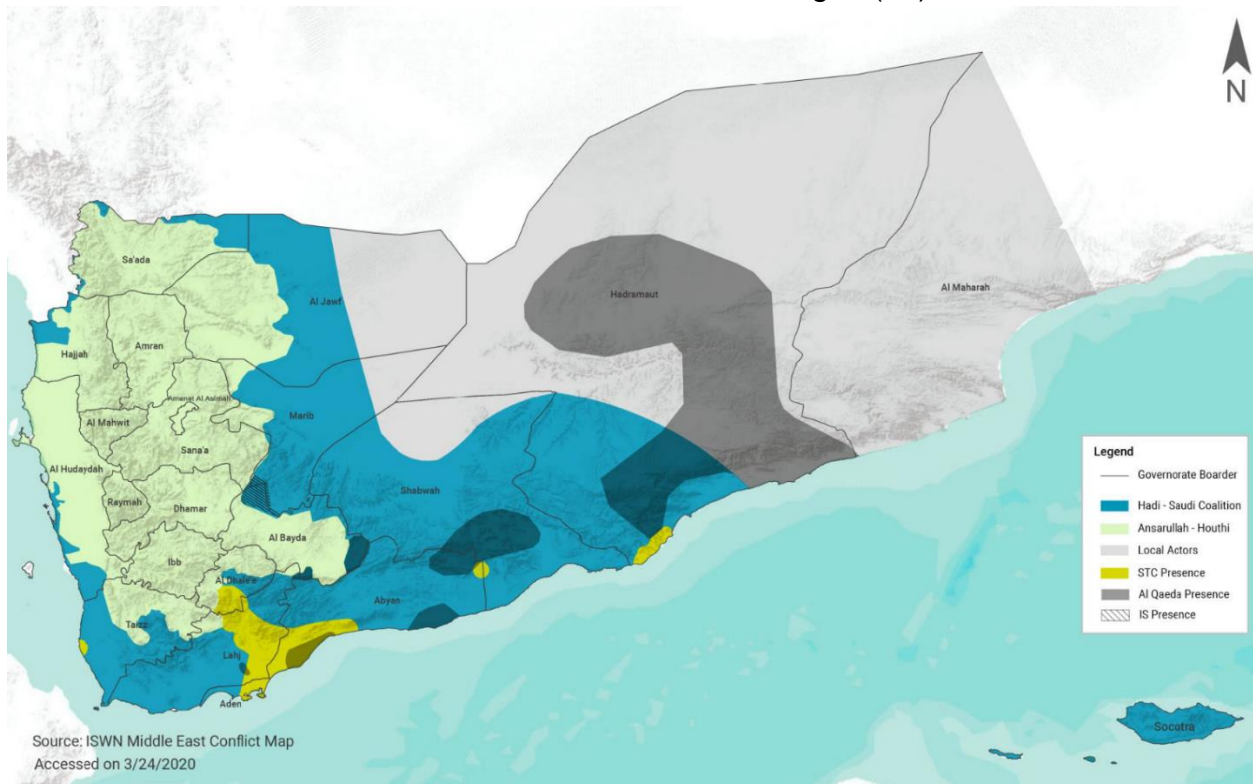
To the author's knowledge, no studies were conducted during the war about determinants of infant mortality in Yemen. Many infants died in this wartime, and my daughter was one of those infants who died before reaching their first birthday.

This study will analyse the determinants of risk factors for infant deaths in Yemen, aiming to propose recommendations to promote infant health.

# 1. Yemen Background:

## 1.1 Geography:

Yemen is the second largest nation in the Arab peninsula. It lies in the southern corner of the Arabian Peninsula. Saudi Arabia surrounds it in the north, Oman in the east, the Gulf of Aden and the Arabian Sea in the south, the west by the Red Sea and the Bab el Mandeb strait, which connects the Red Sea with the Gulf of Aden. Yemen has a total area of around 527,970 km<sup>2</sup> (Map 1) (8,9). The coastal plain area, the mountainous highlands region, the mountain basins region, the desert region, and the Yemeni island group are the five primary geographical regions that make-up Yemen (10). Yemen is one of the countries with the most minor natural freshwater supplies in the world. Yemen's agriculture heavily relies on finite resource groundwater extraction (9). Yemen is made up of twenty-one governorates and a single municipality. The governorates are divided into 333 districts and 2,210 sub-districts, and 38,284 villages (10).



Map 1: Yemen Map

Sources: "ACAPS, Yemen: Outlook for April-September 2020" (8)

## 1.2 Population:

Based on United Nations (UN) estimation, Yemen's total population reached 30.5 million in 2021 (11), with 61.5% and 38.5% of the people residing in rural and urban areas, respectively. The birth rate was 29.87 births per 1000 people in 2019, the annual average population growth rate was 2.25% in 2020, the fertility rate was 3.70, the life expectancy was 66 years, and the people density per square meter was 56 people. The aged 0 - 14

years are the most common group with 38.4% (Figure 1). Females represent 49.63% of the total population (12).

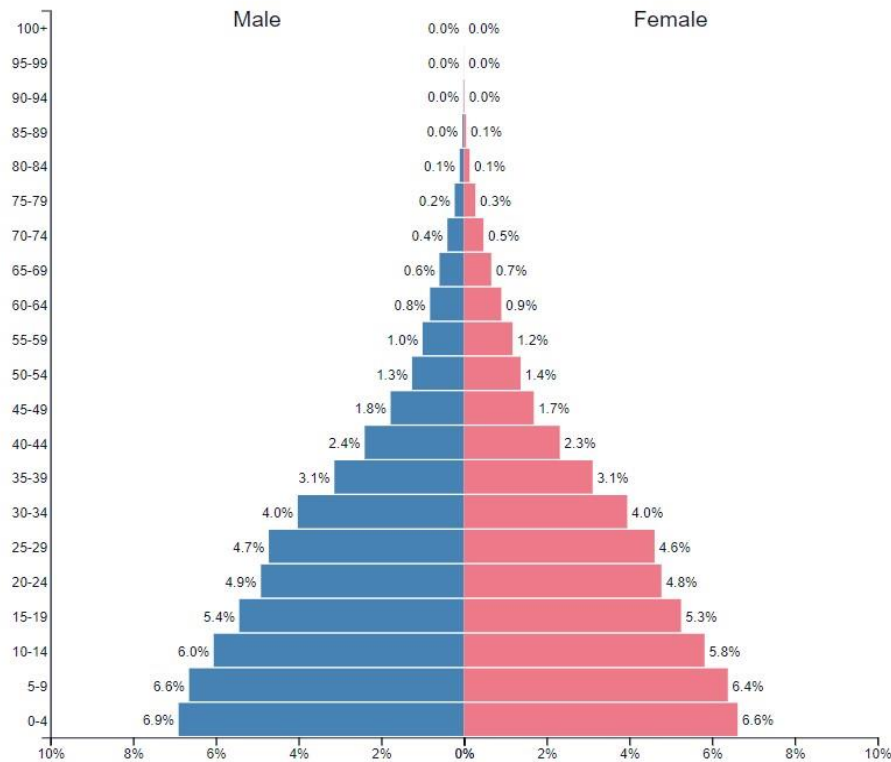
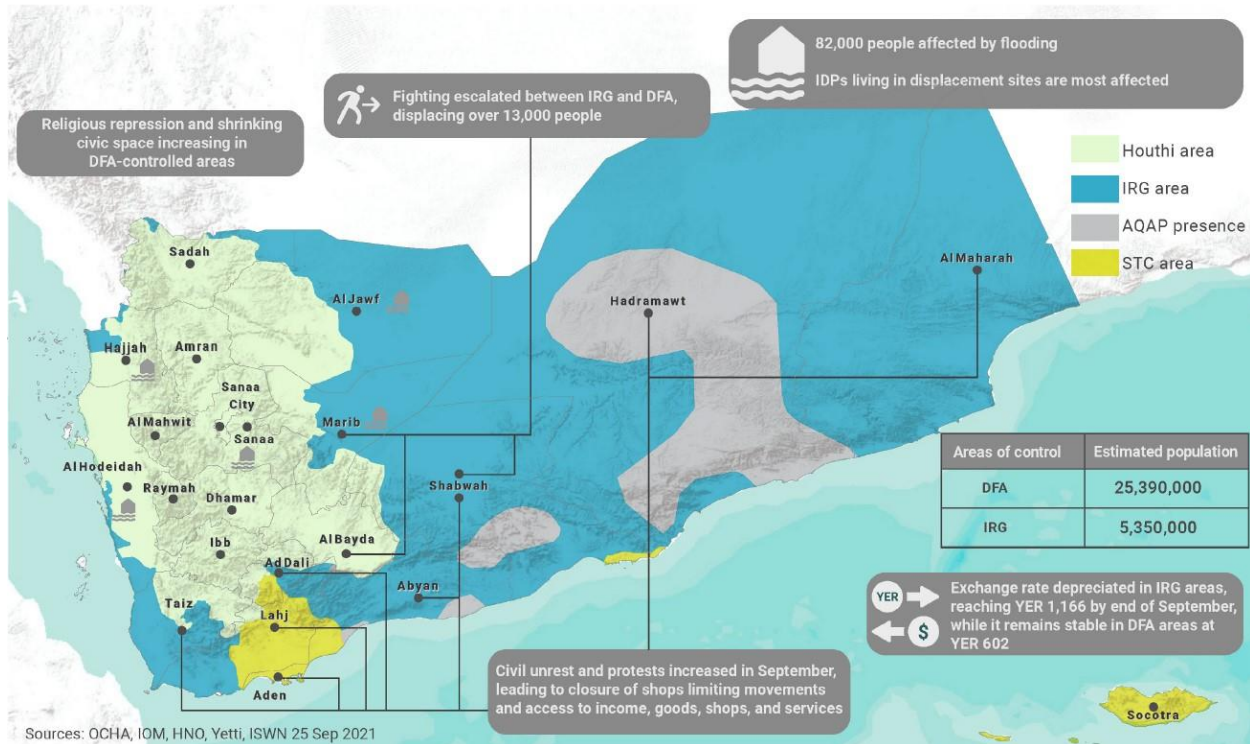


Figure 1: Yemen Population Pyramid  
Sources: “Population Pyramids of the World” (13)

### 1.3 Political and Security Situation:

The Republic of Yemen has been divided by several violent wars for more than ten years; these conflicts have weakened Yemen's central government and divided the country into numerous local centres of authority. After Yemeni President Abdu Rabbu Mansour Hadi requested international assistance in March 2015, Saudi Arabia started a military attack to re-establish Hadi's administration and drive Houthi forces out of the capital and other cities. Since then, the battle in Yemen has resulted in tens of thousands of deaths, substantial humanitarian suffering, and severe infrastructural destruction. According to estimates, as of October 2021, at than 145,000 Yemenis have died since 2015. The living condition in Yemen is much more difficult due to the breakdown of the public institutions, which made Yemen one of the biggest humanitarian catastrophes in the world (14). Currently, Yemen is divided into two governments De Facto Area (DFA) in the North, led by Houthi with 25.4 million of the population, and the International Recognized Government (IRG) in the South, led by the Hadi Government with 5.35 million (Map 2) (15). On April 7th, 2022, Rashad Muhammad al-Alimi was announced as Chairman of the Presidential Leadership of Yemen instead of President Hadi (16). Yemen placed number 1 out of 178 nations in the Fragile State Index for 2022 (17).



Map 2: Yemen DFA and IRG areas

Sources: “ACAPS, Yemen: social impact monitoring July - September 2021” (15)

### 1.4 Socioeconomic Characteristics

Yemen is in a severe economic crisis because of seven bloody years of conflict and growing financial problems making it increasingly unlikely for the government to continue providing essential public services. As the war has continued, Yemen's economy has increasingly become a parallel economy, divided between regions under IRG and DFA rule, with revenues considerably short of necessary expenditures. The Yemeni rial's buying power was significantly diminished in 2021 because of the IRG's continuing monetisation of its budget imbalance. As a result, 2021 saw an actual decline in public spending due to rising inflation. Meanwhile, Sanaa's DFA handles its fiscal policy exclusively on a cash basis, which has kept inflation in DFA-controlled regions low and steady (18).

On the other hand, price increases for Yemen's essential imports have been exacerbated by the conflict in Ukraine. The second-largest import into the nation is wheat, and about half of Yemen's wheat imports come from Russia and Ukraine. Currency devaluation has led to a 25% increase in domestic food costs during the past year, and shocks to the world grain market might burden importers who supply food for the needy, further eroding food security. The conflict's direction and general stability on the ground strongly influence Yemen's economic prospects. On the other side, escalating conflicts combined with steadily increased import costs would worsen the situation for the private sector (18). Yemen Human Developmental Index (HDI) ranked 179 out of 189 countries

in 2020 (12), and poverty affects more than 71% of Yemen's population, most of whom are women (19).

### **1.5 Sociocultural Characteristics**

Tribes are the main component of Yemen's structure. Due to weak governmental institutions and unstable security, tribes in Yemen continue to perform near to state-like duties. In the north, tribal systems are very robust. Tribes from the south typically have less national impact. The official language in Yemen is Arabic, and Islam is the main religion, with 35% Shia and 65% Sunnis. Yemen is the world's least gender-equal society. There is no law to combat domestic abuse, which is said to be pervasive. However, exact statistics are not accessible. It forbids women from leaving the house without their husband's consent, even for seeking health services. In addition, there is no legal age requirement for marriage (9). In a report released in 2019, United Nations Children's Fund (UNICEF) found that 32% of women got married before 18, and 9% were married before the age of 15 (20).

Yemen has a poor level of educational attainment; the adult literacy rate is 77% for males and 43% for women. Parents may find it difficult to send their daughters to school as just 27% of teachers are female, and few schools have female staff members. Children are kept from acquiring education for monetary, access, and social reasons (9).

Since 2015, 4.4 million Yemeni people have been internally displaced (IDPs). Women and children make up more than 77% of the IDPs and are at higher risk of Gender-Based Violence (GBV), including child marriage, sexual abuse, and exploitation. The risk of arbitrary arrest and forced recruitment is most significant for boys and men. The 3.2 million Muhamasheen, approximately 10% of Yemen's population, suffer unique difficulties, including access to essential services (21). The conflict was the primary cause of IDPs' displacement in 91% of cases in 2021 compared to 83% in 2020. Natural calamities, such as flooding and excessive rains, forced 12% of people displaced in 2020 to flee their homes (22).

### **1.6 Health System and Burden of Disease**

Before the conflict, Yemen's health sector experienced severe governance problems, and the delivery of health services was already disjointed and dependent on outside financing. Yemen's health care system was set up at the primary, secondary, and tertiary levels, with a sparse number of specialised facilities located in metropolitan regions. Governorate Health Offices (GHOs) managed health at the governorate level. Thus, there were three layers of healthcare administration in Yemen before the conflict: the Ministry of Public Health and Population (MoPHP) at the national level, GHOs, and District Health Offices (DHOs). The MoPHP's governance mandate comprised four areas: primary healthcare, population health, curative care, and planning (23).

The health of Yemenis is reportedly deteriorating due to the continuous conflict. The leading causes of mortality in Yemen include maternal and infant diseases,

malnutrition, and infectious illnesses. As a result, the conflict is now thought to be Yemen's third leading cause of mortality. Over 80% of the population has difficulty accessing food, clean water, and health care services, and just 50% of health facilities (HFs) are now completely operational. Healthcare delivery is hampered by a lack of personnel, tools, and supplies (23). In addition, the war has exacerbated health problems and left the nation with two health ministries, one in Sana'a for the DFA and one in Aden for IRG. Since there are now two governments, the oversight of the healthcare system is weak in both ministries (15).

- **Maternal and infant health:** Yemen's Maternal Mortality Rate (MMR) was estimated at 500 per 100,000 live births (LBs) in 2019 (24), and Infant Mortality Rate (IMR) is 46 per 1000 LBs (25). Yemen also has a high prevalence of adolescent pregnancy and a very low rate of deliveries attended by skilled birth attendants (SBA) (9). In 2021, 39% of women were delivered by skilled birth attendants, meaning almost 4 out of 10 Yemeni women got SBA coverage services (24). A Yemeni woman has 3.7 kids on average (12). Since 2015, Yemen's Expanded Immunization Program (EPI) has seen interruptions because of insecurity and a lack of gasoline and power (9). World Health Organization (WHO) indicates the average ratio of all vaccines given to children was 71.6% in 2018 (20).
- **Nutrition and Food Security:** Yemen's catastrophic food insecurity and hunger crisis have worsened in 2022, with 17.4 million people in need of aid. It is anticipated that 1.3 million pregnant and breastfeeding women will have acute malnutrition, and an additional 2.2 million children under the age of five, more than half a million, will be severely malnourished in 2022. More families are coping with the economic crisis by selling off assets and relying on assistance (26). Many households are in a precarious position because of these bad coping mechanisms, and any abrupt shocks would worsen food insecurity and severe malnutrition. Extreme food shortages and malnutrition are primarily caused by conflict and economic crises. According to the forecast for 2022, these trends are expected to persist, with a chance that conflict will continue to escalate in key hotspots and result in further displacement (26).
- **Waterborne disease and Water, Sanitation, and Hygiene (WASH):** Yemen has a wide range of infectious diseases, which are rendered worse by a lack of WASH infrastructure. Yemen WASH assessment in 2020 showed that 65% of the population has urgent WASH requirements, while 30–40% of individuals typically have access to better water sources. In general, 45–50% of the population has adequate access to sanitation services, while 30–40% of people have access to adequate hygiene services (27). Sanitation services are typically not provided by a government agency in rural regions. Yemen has a high prevalence of diarrhoea, and outbreaks of waterborne illnesses, such as dengue and malaria, especially in rural regions (9).



## **2. Problem Statement, Justification, and Objectives:**

### **2.1 Problem Statement and Justification:**

The growth and transformation of families and children depend on the infant's life. The increases in morbidity and mortality during the first 12 months of a baby's life destructively influence overall improvement. WHO classified a baby less than one year of age as an infant (28). By 2030, the Sustainable Development Goals (SDGs) 3 goal 3.2 aims to eliminate unnecessary deaths among all children. To achieve this goal, all nations aspire to decrease new-born (NB) deaths to less than 12 per 1,000 LBs and under-five deaths to less than 25 per 1,000 LBs (28). Based on recent data, 53 nations will fail the under-five mortality target, over 60 nations will fail the NB mortality target, and 48 million babies will die before the age of 5 between 2020 and 2030, roughly the population of Uganda today. Between now and 2030, we could save 11 million babies' lives if the nations reach the SDG objective of under-five age mortalities (29).

NB period is the most critical time for children under the age of five, with a global rate of 17 fatalities per 1,000 LBs and around 6,700 neonatal fatalities every day. In 2019, the likelihood of fatalities after the first month and before reaching the age of one was expected to be 11 deaths per 1,000 LBs, while the likelihood of fatalities after reaching the age of one was assessed to be ten deaths per 1,000. According to a recent study, about a third of all NB fatalities happen during the first day of life, and nearly three-quarters happen within the first week. Regionally, Sub-Saharan Africa had the maximum NB mortality rate of 27 fatalities per 1,000 LBs, followed by Central and Southern Asia with 24 fatalities per 1,000 LBs. NB deaths are ten times more likely to occur in Sub-Saharan Africa than in high-income countries for NBs (29).

While the world has achieved tangible success in the last 30 years in decreasing the mortality rate, it is now on the verge of a worldwide child mortality catastrophe brought on by the consequences of the COVID-19 pandemic. According to preliminary estimates of the indirect impact on child deaths, significant reductions in the coverage of life-saving implementation programs and rises in malnutrition might result in over one million more under-five deaths in only six months (29).

Children in fragile situations are especially at risk. In 2019, the death rate for children under the age of five in the 36 nations categorised as 'fragile' by the World Bank (WB) was nearly three times higher than in 'non-fragile' nations. The under-five mortality rate in fragile nations is expected to be 83 fatalities per 1,000 LBs, more than twice the worldwide average of 38 fatalities per 1,000 LBs. Fragile nations accounted for approximately 40% of all under-five fatalities. Because of the high mortality and poor rate of improvement in these settings, 26 of the 36 'fragile' nations are in danger of missing the SDG target for under-five mortality by 2030 (29).

Yemen continues as one of the world's greatest humanitarian crises, with 24.4 million people – 80% of the entire population – in need of aid. The impact of the war on children is enormous. Almost 45% of malnourished children under the age of five are

dying from severe acute malnutrition complications (23), and more than 15.4 million people need urgent WASH services. These circumstances make cholera, malnutrition, and other WASH-related illnesses more likely. At the national level, vaccination coverage has deteriorated, with 37% of children under the age of one year losing their scheduled vaccines. Measles, diphtheria, and other vaccine-preventable illnesses are causing frequent outbreaks across the country (30). There is more than a 20-year delay in human development because of the current war in Yemen (23).

Yemen's health statistics and reproductive health (RH) conditions are among the worst in the Arab world. MMR is the greatest cause of death among Yemeni women of reproductive age, with 500 women dying per 100,000 because of pregnancy and childbirth problems. Sixteen mothers and 80 infants die every day during pregnancy and birth (24). According to estimates, Yemen has an IMR of 46 per 1000 LBs (25). In addition, only a quarter of all deliveries are attended by qualified staff (31).

The IMR in Yemen has dropped from 89 per 1000 LBs in 1990 to 46 per 1000 in 2020. The SDGs aim for infant mortality in 2030 is 25 per 1000 LBs (25). The inability to meet this target is primarily due to Yemen's socioeconomic circumstances, maternal and new-born, nutrition, and communicable illnesses, as well as current political and conflict situations. Yemen is far from the target and would need health decision-makers to focus on the coming years (32).

Unfortunately, the number of studies on infant health in Yemen is scarce due to the lack of accessibility and validity of data resources. In addition, infants' mortality causes, and underlying determinants are not fully understood. Most infants' health policies and strategies are designed without in-depth analysis and collaboration of stakeholders on the ground. This research seeks to explore the maternal, nutrition, injury, environment, and infant disease factors that contribute directly to IMR and socioeconomic factors, identify health-system gaps and determine how we can improve the situation through evidence-based practices. The author will provide potential ideas and evidence-based strategies to address the country's IMR problem. The author will not conduct a comprehensive policy analysis, which would be out of the scope of this research.



## **2.2 Objectives:**

### **2.2.1 General Objective:**

To identify and discuss the determinants influencing infant deaths in Yemen and propose interventions applicable in conflict-affected settings to reduce risks of infant mortality.

### **2.2.2 Specific Objectives:**

- To identify the proximal and socioeconomic factors that contribute to infant mortality.
- To review the intervention strategies related to infant health in other countries with similar conflict-affected setting contexts.
- To provide recommendations to the policymakers, public health experts, international and local NGOs, and public and commercial health sectors to adopt the proposed intervention strategies for better infant health.

## **3. Methodology:**

### **3.1 Research Strategy:**

This is a literature review paper. It included published studies, articles, peer-reviewed, grey literature, and reports from good sources such as MoPHP and NGOs. It is conducted through various search engines and websites Google Scholar, VU Library, PubMed, Research Gate, and NGOs journals.

The inclusion and exclusion criteria to find valid information about IMR in Yemen as the following: **a)** using the English language as a primary method for searching and the Arabic language to get relevant information, which is not available in English, **b)** using national documents and reports from MoPHP, **c)** limiting the searching period since 2015 till now and using snowball methods to find more relevant data, and **d)** due to scarcity of information, author tailored other country findings with the same context of conflict and IMR such as Ethiopia.

The author would like to highlight that most of the available data was taken from the annual Maternal and New-Born Sector (MNBS) 2021 report, national SDGs report 2019, and donor reports.

The research strategy and keywords are mentioned in Table 1 below. An example of keywords search: “infant mortality” AND “risk factor”, “nutrition” AND “infant death”, “maternal death” AND “infant” OR “new-born” OR “stillbirth”.

Table 1: Research table				
Type of the Study		Sources		
Published peer-reviewed studies	Google Scholar, VU library, research gate, journals, PubMed.			
Reports and grey literature	NGOs and MoPHP reports, google scholar, and websites.			
AND				
OR	Key factors		Diseases	Locations
	Determinants, Risk Factors, Infant, Neonate, Stillbirth, Maternal, War, Conflict, Humanitarian Response, Age, Sex, Socio-Economic,	Education, Fragile, Immunization, Marriage, ANC, Postnatal Care, Delivery, Pregnancy Complication, Nutrition, Psychological, Rural, Urban, Qat/Kat, Climate	Mortality, Death, Morbidity.	Yemen, Low- And Middle-Income Countries, Global, Eastern Mediterranean Region, Middle East and North Africa, Fragile Setting, Sudan, Ethiopia

### 3.2 Conceptual Framework:

Mosley and Chen's conceptual framework has been designed for developing countries, and Yemen is one of these countries. The author will use this framework to analyse the determinants of IMR in Yemen.

The analytical framework strives to clarify how many factors contribute to a family producing healthy children and serve as a basis for developing health policies and interventions. The model's key benefit is organising the proximal variables into a logical framework where they are connected, child survival on the one hand and socioeconomic factors on the other. The goal is to emphasise the social and medical roots of the issue. It is like the conventional epidemiology method to start with a biological issue in the host and then look for its social factors to establish effective control strategies (Figure 2) (33).

Any social or economic factor to impact a child's survival must pass through proximal determinants. The five proximal determinants are “maternal factors, environmental contamination, nutrient deficiency, injury, and infant illness control”. The impact of how quickly healthy individuals get ill is reached through the first four factors in proximal determinants. "Infant disease and control factors impact the rate of sickness and recovery through prevention or treatment" (33).

We then look at various socioeconomic factors and shows how they interact with the proximal factors to affect the rate of growth faltering and mortality. The social science literature divides them into three categories: determinants at the “individual-level variables: education and productivity of parents, and traditions, and household and community level variables: income/wealth, economy, health system, and ecological” (33).

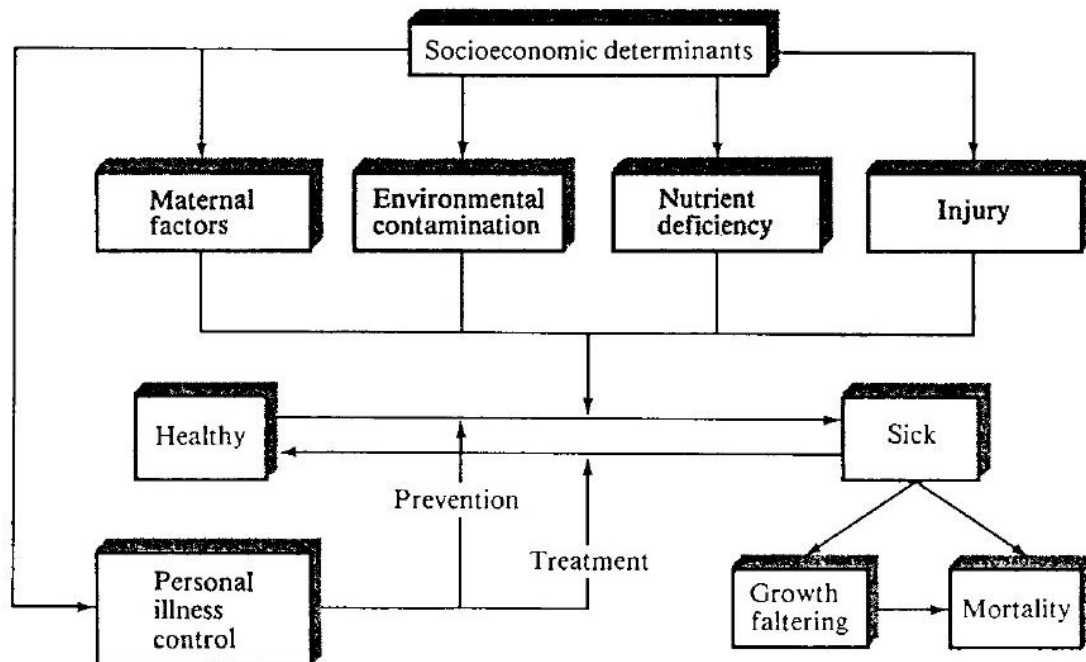


Figure 2: Mosley and Chen's conceptual framework

Sources: "An analytical framework for the study of child survival in developing countries, WHO Bulletin, 2003" (33)

### 3.3 Limitations of the Study:

The limitations of this paper are:

- Scarcity of information, the author has tailored other country findings with the same context IMR.
- The last version of the Yemen National Health and Demographic Survey – YDHS was in 2013. There is no updated data after this time. The author has relayed national and donor reports in presentation data and problem statements.

## **4. Finding:**

The author will discuss proximal and socioeconomic factors contributing to infant mortality in this chapter. The findings are derived from the 2021 MoPHP annual report, Yemen national SDG 2019, NGOs reports and websites. Due to the scarcity of research in Yemen, the link between the factors and infant health will be highlighted through other studies in similar countries' contexts.

### **4.1 Proximal Determinants:**

In proximal determinants, we will discuss early marriage under maternal factors. The environmental factors mainly focused on WASH, the main issue in Yemen. Infant and mother nutritional and conflict situations will be discussed under nutrition deficiency and injury factors. Finally, infant illness and control factors will discuss the preventive and treatment of infant diseases, infant immunisation coverage, antenatal care, post-natal care, family planning, skilled birth attendance, delivery location and type, and maternal diseases.

#### **4.4.1 Maternal factors:**

Early marriage is described as a union between a child or adolescent and a person under 18 when the bride-to-be is not yet emotionally and physically capable of becoming a mother and shouldering the responsibilities of a wife (34). Around 21% of young women worldwide marry before they are 18 years old (35). Young married women are more likely to give birth as teens, increasing their risk of pregnancy difficulties and maternal mortality. They have a higher chance of having adverse health experiences (36). Stillbirths and NB are high among women under 18 with 50% compared to women aged 20-29. Moreover, 60% of infants are at high risk of death among women under 18 (37).

In Yemen, early marriage is seen as a serious problem. To address this issue, the government did propose a law that would have set the marriage age at 18, but it was never approved. According to data from Yemen national report conducted in 2006, 2013, and 2018, early marriage is still high for girls. 10.5% of women between the ages of 20 and 24 who were married in 2006 wed before becoming 15, and 32.3% wed before turning 18. In 2013, these figures declined somewhat to 9.4% for women who married before becoming 15 and to 31.9% for those who did so before turning 18. In a report released in 2019, UNICEF provided figures for this group of women, finding that 32% of them were married before the age of 18, and 9% were married before the age of 15 (Figure 3) (20).

Among internally displaced people, early marriage was most common. It was one in five compared to one in eight in the host community next door for girls aged 10 to 19, as a mechanism to decrease family financial hazards. 16.1 years old was the average marriageable age. Overall, girls had around a five-times higher chance of marriage than guys their age. If these data are considered collectively, it may be concluded that child marriage is more likely to occur among people who live in conflict areas. Interestingly, lower probabilities of early marriage were linked to unemployment and better levels of education for the household's head. In light of the findings, it is possible that higher

education, particularly for the head of the home, protects against early marriage for both boys and girls, even in economic difficulties (38).

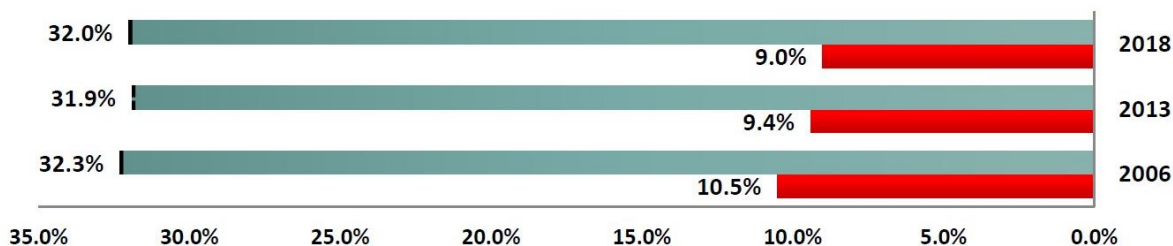


Figure 3: early marriage in Yemen. 2006, 2013, and 2018

Source: “The sustainable development indicators report in Yemen 2016-2018” (20)

#### 4.4.2 Environmental contamination factors:

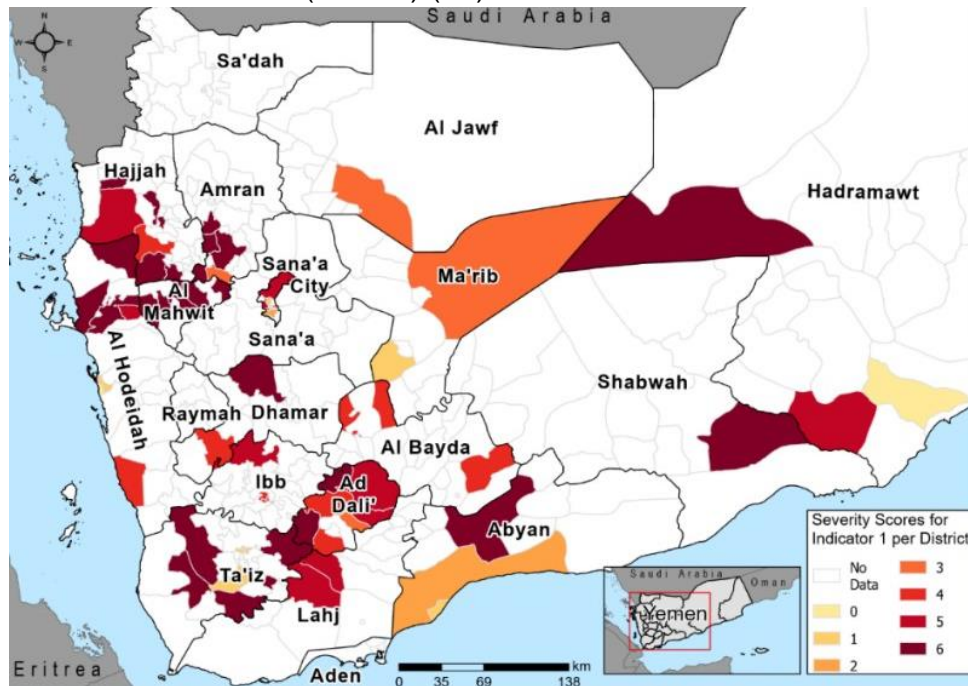
Investments in water, sanitation, and hygiene (WASH) are considered necessary for enhancing infant health (39). Children's health, nutrition, education, and learning capacities are all impacted when they lack access to clean water, which significantly negatively affects many facets of their life. Children are not only able to thrive but also get off to a healthier start in life when they have access to clean water, basic toilets, and excellent hygiene habits (40). WHO/UNICEF mentioned that poor sanitisation and access to water account for 28% of child fatalities. On the other hand, safe water and sanitation may prevent nine out of ten diarrheal infections. Other significant factors contributing to child mortality, such as pneumonia, and undernutrition, are considerably decreased by safe sanitation. According to research done in 33 African nations, there would be an approximate reduction in infant mortality of two NB deaths for every 1000 LBs if just 1% more people had access to better sanitation (41). Children who live in severely vulnerable environments are three times more likely to use open defecation practices, four times more likely to lack basic sanitation facilities, and eight times more likely to lack essential drinking water services. Infections connected to poor water quality and sanitation are more than 20 times more likely to kill children under five than physical assault (42).

Desk review for 117 WASH reports in Yemen, which covered 110 districts, showed that 63% of districts in Yemen are in acute WASH need. Most of these districts exist in the four central governorates Hajjah, Al Hodaidah, Taiz, and Amran. The same report showed that 65% of the population has acute WASH needs, and the average access to improved water sources is 30 - 40% (MAP 3). The average access to a latrine is 45-50% of Yemeni people, and 30-40% have adequate hygiene access to soap and handwashing among the population (MAP 4) (27).

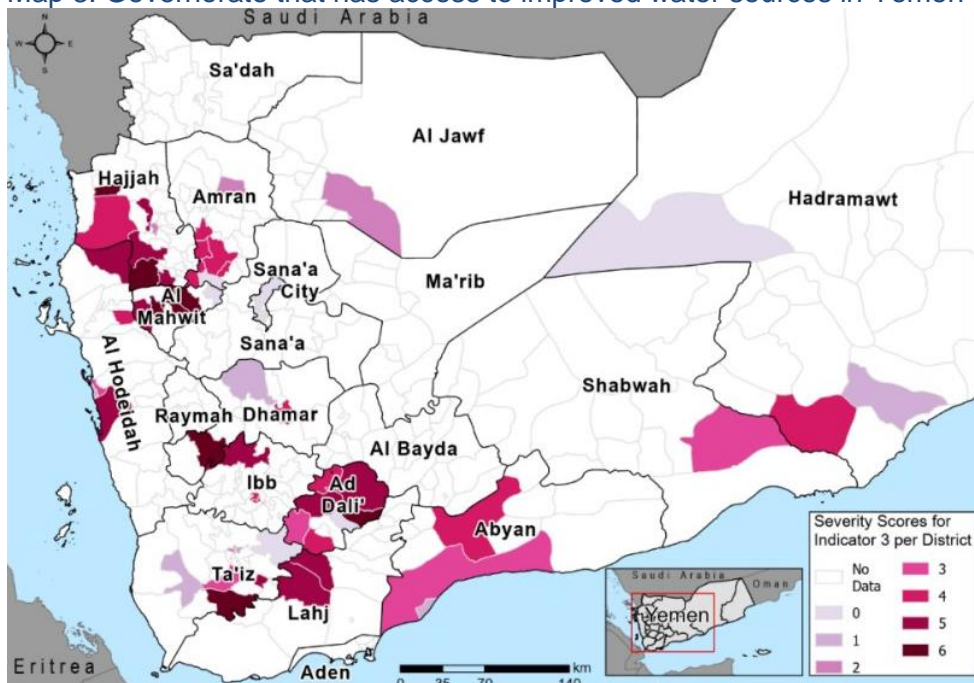
Yemen suffers from various infectious illnesses made worse by insufficient WASH infrastructure. In addition to vector-borne illnesses like malaria, dengue fever, and chikungunya, which frequently experience outbreaks, this also includes water-borne illnesses like Acute Watery Diarrhea (AWD) and cholera. The fourth quarter of 2019 saw a rise in dengue cases, with Al Hodaidah, Aden, Marib, and Lahj governorates reporting



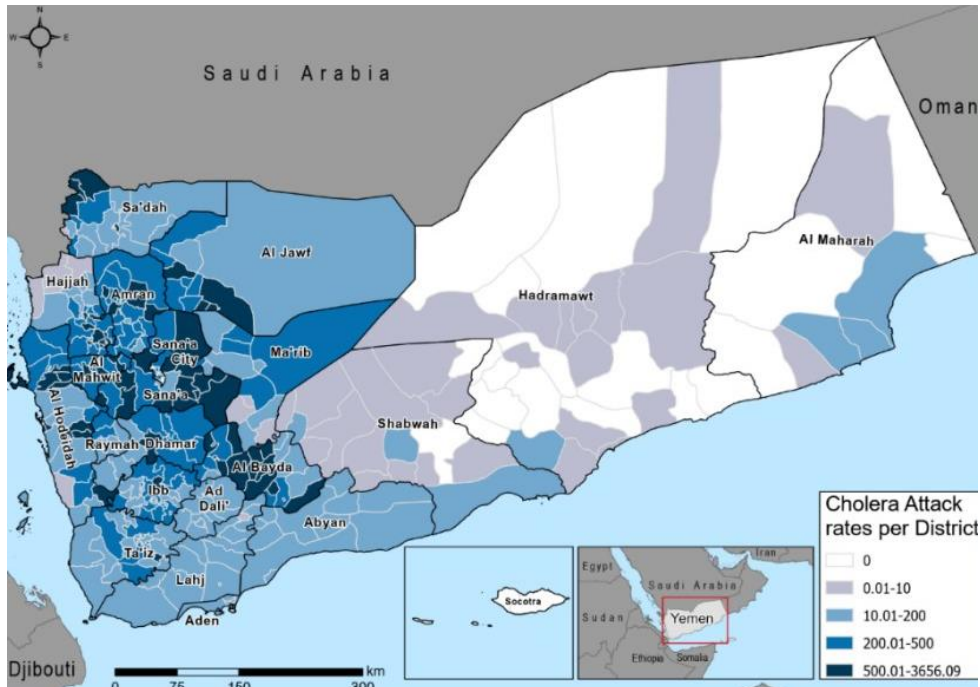
most of these cases. With 655 suspected cases per 10,000 people, Al Hodaidah has the second-highest incidence rate of cholera in 2019 after Sana'a. Utilising insufficient and unimproved water sources is an associated risk factor for developing cholera. Poor hand hygiene, a lack of access to clean, working latrines, and the presence of wastewater or sewage close to homes are additional variables linked to an elevated risk for water-borne illnesses like cholera (MAP 5) (27).



Map 3: Governorate that has access to improved water sources in Yemen



Map 4: Governorate that has access to improved sanitation in Yemen



Map 5: Distribution of cholera attack rate in Yemen governorates

**Source:** “WASH assessment in Yemen, May 2020” (27)

#### 4.4.3 Nutrition deficiency factors:

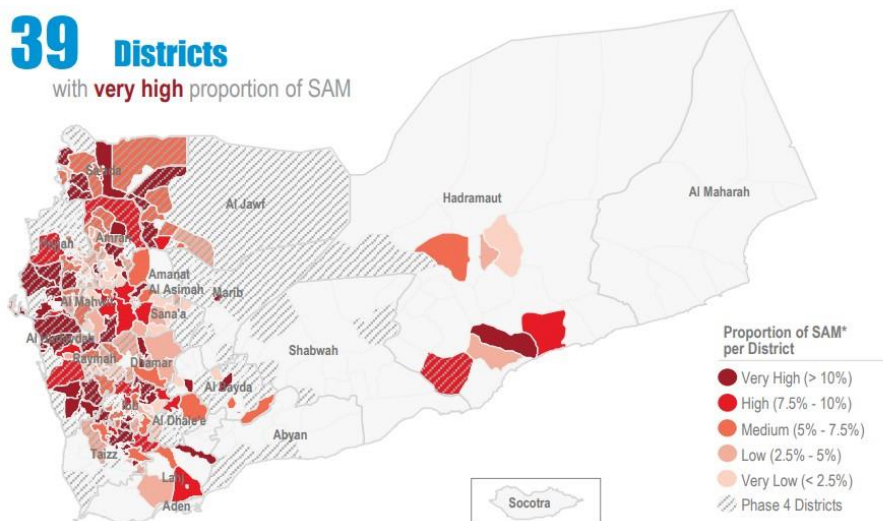
Infant malnutrition is a broad term characterised by deficiencies, excesses, or imbalances in a person's nutrient and/or energy intake (43). This section highlights the impact of undernutrition on infant health as it is one of the main issues in Yemen. Research measuring the effect of sanitation, clean water, and health spending on NB mortality in 84 developing nations revealed that a 1% increase in the depth of a food shortage raises infant death rates by 2–3%. This suggests that the NB mortality rate in the chosen emerging economies is significantly negatively impacted by low food intake (44).

Although food aid is being provided in Yemen, Global Acute Malnutrition (GAM) rates are still high nationwide. The Global Hunger Index rated Yemen 116<sup>th</sup> out of 117 countries in 2019, describing Yemen's food security as "alarming." With 45 districts already in an emergency, 69% of the districts were at risk of starvation (27).

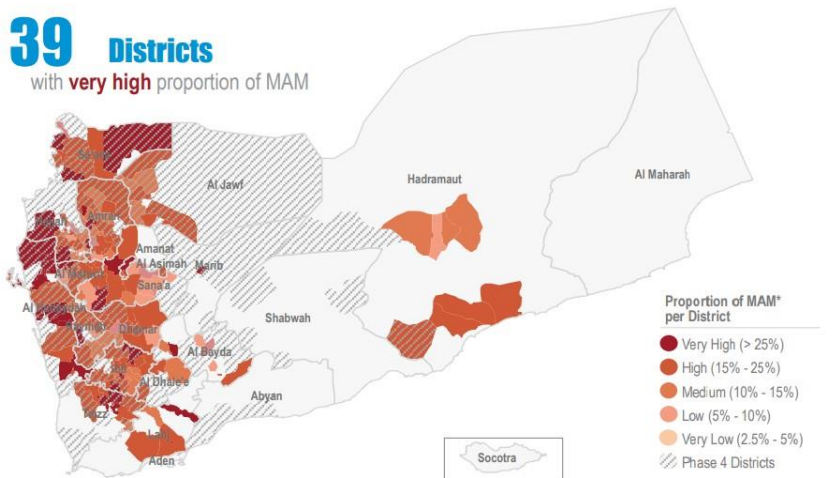
Yemen provide malnutrition treatment services through the community management of acute malnutrition program (CMAM), therapeutic feeding centres (TFC), and infant and young child feeding (IYCF) supported by WHO, UNICEF, and World Food Program (WFP). WHO TFC 2019, 2020, and 2021 annual reports showed 12,500, 14,300, 21,904 children were admitted to current 110 TFC, respectively. children under six months represented 25% of total admission. The death rate was two percent. This increase in admission is because of the consequence of war, which leave more people in need of food (45).

The economic situation and inflation rate made the Yemeni people borrow their food and change their food quality and quantities or move their children to live with their relatives as a coping mechanism for the family with their low food income (111). Moreover, increase in the number of IDPs with insecure access to enough food due to limited resources. Based on the 2022 report, there are more than 4 million IDPs in Yemen. Out of them, 1.6 million lacks access to basic need food, WASH, shelter, education, and protection (21).

WHO monthly nutrition Surveillance report showed a deterioration of child malnutrition in Yemen from January to May 2022 compared to previous years. The reports showed the GAM rate reached 27% in 2022 compared to 23% on average in previous years. This will leave 316,846 children under one year at risk of illness and death. In addition, the stunting rate is 48%, meaning 2,816,410 babies are at risk of stunting in their life (Map 6,7) (45).



Map 6: SAM proportion per district May 2022



Map 7: MAM proportion per district May 2022

Source: “Nutrition surveillance infographics report, WHO, May 2022” (45)



Breastfeeding is one of the best strategies to ensure a child's health and survival (46). A study by National Human Development Survey in India showed neonatal mortality was approximately three times more likely among moms who did not breastfeed their NB within the first hour of delivery (47). Breastmilk meets up to half or more of a child's nutritional requirements during the second half of the first year of life (46).

Over the previous few decades in Yemen, the early start of breastfeeding has progressively grown. 53% of NB were breastfeeding within an hour of birth, and 76% started breastfeeding within a day. Even though 97% of children receive breast milk at some point (48), only 11% of NB under six months old have received breast milk exclusively in 2022 (45), and 44% are fed through a bottle, which suggests significant rates of baby formula usage. Before the crisis, NB formula was generally recognised in Yemen, and various studies indicate that an infant formula is a potential option for feeding infants (48). Almost one out of ten infants exclusively breastfeed, and infants not breastfed face a higher risk of dying both directly from hunger and indirectly through a higher vulnerability to diseases (24,49).

Maternal and child health are directly correlated with malnutrition. Poor diets deficient in vital nutrients during pregnancy can result in anaemia, pre-eclampsia, bleeding, and mortality in mothers. They can also cause wasting, low birth weight, stillbirth, and delays in children's development (50). Pre-term births, postpartum bleeding, and stillbirths are all consequences of maternal malnutrition. As a result, the foetus growth would be delayed, and they would be born with low birth weight (51). Nutrition status among women and children has deteriorated since the beginning of the war (23). 1.3 million pregnant and lactating women suffer from malnutrition and acute need for treatment (26). Figures 4 and 5 showed the trend of acute malnutrition admission from 2018 to 2021 in Yemen based on Nutrition cluster annual reports (52).

It became clear that a mother's health affects infant nutrition before and throughout pregnancy. Furthermore, it is impacted by insufficient breastfeeding, poor eating habits, hazardous settings, bad cleanliness, sanitation, persistent food insecurity, and poverty (20). The infant nutrition situation is predicted to worsen until the end of September 2022 due to declining food security made worse by war, high morbidity, diarrhoea and other sickness outbreaks, inadequate infant diet quality and quantity, and a destructed health system (53).

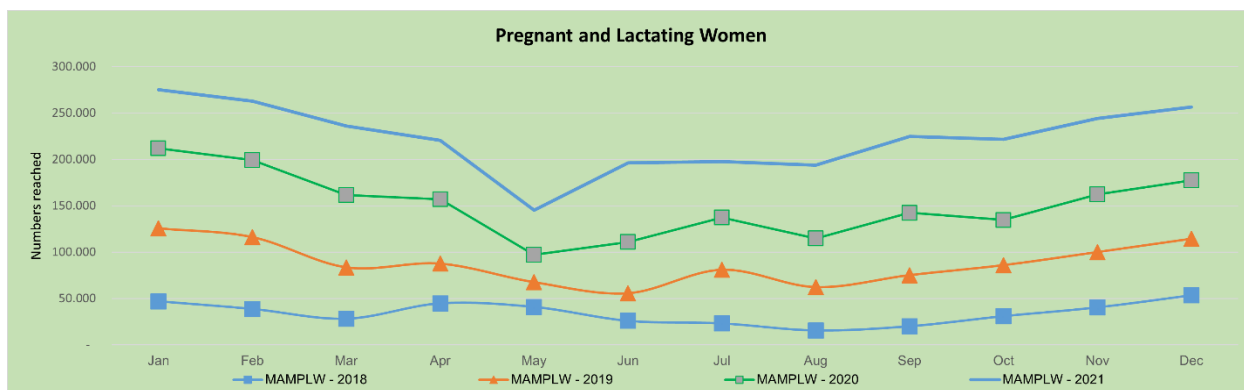


Figure 4: Maternal malnutrition reach during 2018 -2021

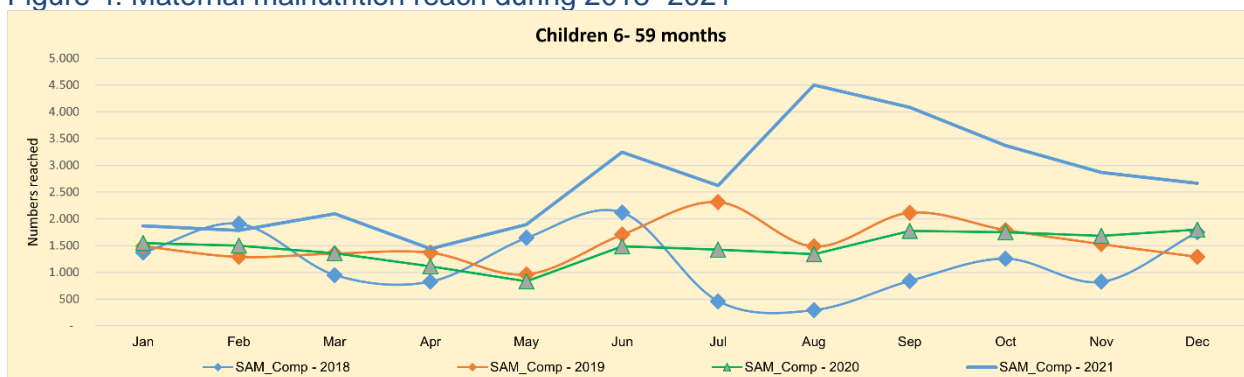


Figure 5: Severe Acute Malnutrition (SAM) with complications 2018 – 2021

**Source:** “Yemen Nutrition cluster website” (52)

#### 4.4.4 Injuries factors:

Conflicts aggravate political instability, weaken social institutions, particularly those that provide health care, disrupt water and food supplies, and worsen poverty, unemployment, and homelessness, all severely impacting pregnant women's health and young children. The average IMR was more significant in countries with conflicts 46 per 1,000 LBs than in those without conflicts 25 per 1,000 LBs. War-torn nations have the highest rates of 52 per 1,000 LBs. The number of NB fatalities per 1,000 live births increased by 2.8 during the war-related conflicts (54). Research on armed conflict in Africa showed there is a 5.2 per 1000 birth increase in the probability of a child dying before the age of one year if they are born within 50 kilometres of conflicts as opposed to when there is peace in the area. The study discovered evidence of elevated mortality risk from armed conflict up to 100 km distant and for eight years following conflicts, with an increase in NB mortality that is two to four times more over time than it is at the time of the conflict (55).

Yemen National Team for Foreign Outreach (YNTFO) has counted the direct civilian casualties of the war on Yemen during the seven years: 4,017 and 4,586 children have been killed and injured, respectively. In addition, 2,434 and 2,910 women have been killed and injured, respectively. The YNTFO report did not segregate the data by age, therefore the number here for children under five (56). According to reports on Yemenis' health, the continuous conflict contributes to worsening health conditions. These include

widespread infectious illness outbreaks, inadequate vaccination rates, and high levels of childhood malnutrition (23).

Moreover, fighting has had a direct impact on the health of the populace. It is considered the fourth significant factor in mortality in Yemen after heart diseases and NB illnesses (Figure 6). There may have been as many as 3,000 children among the 130,000 people who perished due to a lack of infrastructure, food, and healthcare. 50% of the conflict's casualties are women and children, and 45% of dying children are critically malnourished. 58% of Yemenis live in extreme poverty, up from 19% before the conflict, and the GDP has decreased by 50% because of the economy's collapse. 80% of the population needs humanitarian aid and has difficulty accessing food or medical treatment (23).

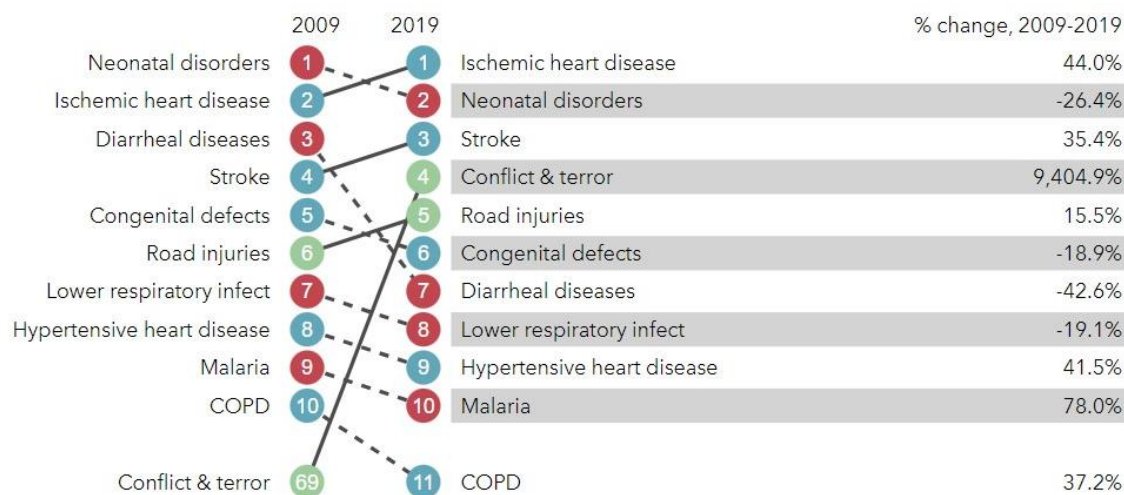


Figure 6: The top leading causes of death in Yemen 2019

Source: “Top 10 causes of deaths in Yemen, IHME 2019” (32)

#### 4.4.5 Infant illness control factors:

The infant control factors are the preventive and treatment measures that influence infant health. In this section, the review findings found that infant diseases and immunisation directly affect infant health. Other variables related to mothers before, during, and after pregnancy impact infant health. These variables are; Antenatal care (ANC) coverage, Family planning (FP) coverage, Skilled birth attendance, delivery locations, Delivery type, Postnatal care (PNC), and maternal diseases.

##### 4.4.5.1 Infant Diseases:

Half of all children die of infectious illnesses, and these fatalities are concentrated in the first two years of life. Nearly 44% of all children die in the first month of their lives. The most common infectious diseases that claim the lives of children globally are pneumonia, diarrhoea, and malaria (57,58).

The IMR in Yemen represented 46 per 1000 LBs in 2020 based on the WB report (25). Another research done in 2018 to estimate infant death in Yemen showed a mortality

rate of 52.6 per 1000 (Table 2) (59). Moreover, the annual MoPHP report in 2020 indicated that 80 babies die every day before they reach the age of 1 month. The most common causes of death are low birthweight (29%), respiratory tract infections (25%), asphyxia (23%), tetanus and congenital anomalies (8%), and diarrhoea (2%) (Figure 7) (24).

Birth weight is a crucial prognostic indicator for the health of infants since it represents the mother's nutritional and metabolic status as well as the foetal growth throughout pregnancy. WHO defines low Birth Weight (LBW) as a weight of less than 2500g (60). A prospective cohort study for 952 pregnant women in 5 districts in Sana'a city from August 1, 2015, to December 31, 2016, showed that infants with LBW had a 17.8 times higher risk of stillbirth than infants with average birth weight (61). LBW in Yemen is the leading cause of death among NB; it represents 29% of the total causes of neonatal death (24). There is an association between LBW prevalence, maternal education level, and family planning (62).

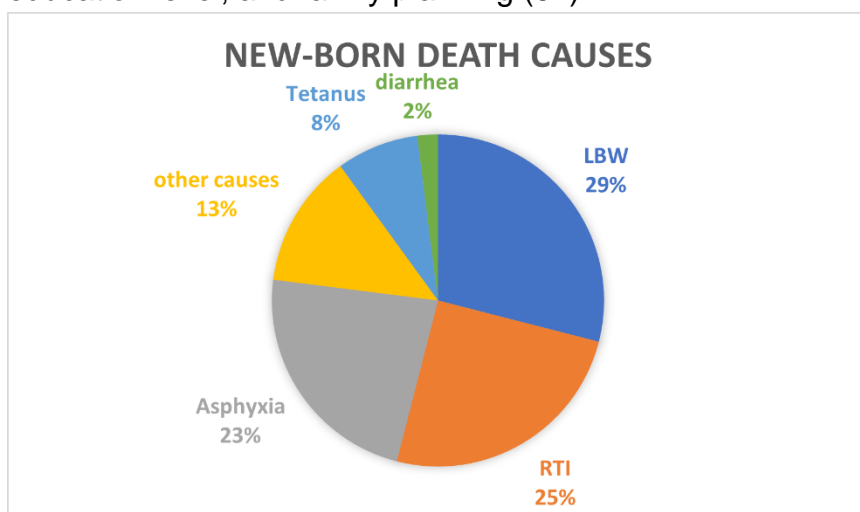


Figure 7: New-born death causes in Yemen

Source: Annual report of the MNBS 2021 (24)

Table 2: Distribution of infant mortality among rural and urban areas in Yemen

Indicators	General	Urban	Rural	Read-write	Noread-write
Probability of dying before first year of life by 1000	52.6	39.9	56.1	42.0	57.9
Probability of dying before age of five years by 1000	78.1	59.6	83.1	62.6	85.6
Life expectancy at birth	63.2	63.4	63.0	65.6	62.1

Source: "Measurement and Correlates of Child Mortality in Yemen, Romanello, M. (2018)" (59)

Males have a higher chance of contracting infectious diseases than girls, including syphilis, malaria, tetanus, and diarrheal illnesses, which helps to explain why boys have a higher mortality rate than girls. In almost every country, males are more likely than girls

to die because male babies are more exposed to complications during delivery and get infections. Additionally, they are less physically developed at birth and more likely to be delivered preterm. Boys may often have a poorer immune system, which is why this is the case (63). An analytic study in 2021 for 31,743 infants in Yemen extracted from YNDHS showed that male infant mortality represents 48% which is high compared to 45% of female infant mortality (63). WB estimates male IMR in Yemen is 50 per 1000 compared to 42 per 1000 among infant females (64,65).

#### 4.4.5.2 Infant immunisation:

An essential method to save a baby's health is immunisation. Several dangerous illnesses can be avoided with vaccinations (66). WHO defines a child as completely immunised "if they have received the BCG vaccine to prevent TB, three doses of the DPT vaccine to prevent diphtheria, pertussis, and tetanus, at least three doses of the polio vaccine, and one dose of the measles vaccine" (67). The WHO designated a coverage rate of at least 90% with vaccinations as one of the markers of the world's health condition. Moreover, its preservation in children is crucial to preventive medicine measures (20). A study in Nigeria, including 1,100 children selected randomly from 6 governorates, showed that the probability of acute respiratory infection (ARI) is lower among vaccinated children by 50% compared to non-vaccinated (68).

WHO indicators for vaccine coverage in Yemen for the years (2016-2018) showed that the average ratio of all vaccines given to children was covered by 75.11% in 2016, but that rate dropped to 73.7% in 2017 and continued to decline in 2018, reaching 71.6%. The poor vaccination coverage rates in Yemen severely impact the standard of paediatric healthcare and Yemen's high NB death rate (Figure 8). The ongoing war, the devastation of medical facilities, and the challenges associated with getting vaccinations such as the cold chain to all parts of Yemen may be the major causes of the low vaccination rates in Yemen (20).

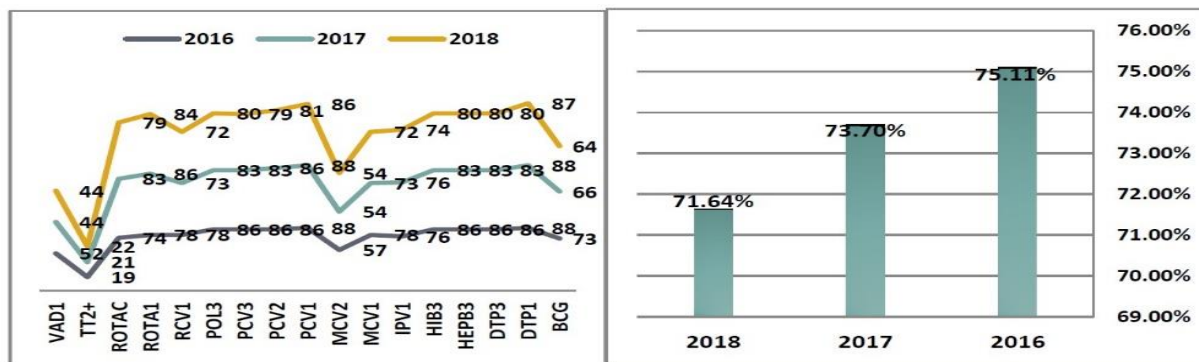


Figure 8: The percentage of vaccinated children from 2016 to 2018

Source: "The sustainable development indicators report in Yemen 2016-2018" (20)

#### 4.4.5.3 Antenatal care (ANC) coverage:

ANC offers the chance to treat present and prospective causes of mother and neonatal death and morbidity. WHO advises pregnant women to seek their first ANC services during the first trimester in addition to extra seven visits. When providing optimal treatment and health outcomes for women and children, the timing of the first ANC visit is critical (69). ANC reduces IMR. This is illustrated in a meta-analysis conducted in 18 low- and middle-income countries (LMICs) related to ANC follow-up had a substantial impact on NB mortality. They found that implementing ANC follow-up might cut NB mortality by 34% (70).

The 2021 Maternal and New-Born (MNB) analysed data in Yemen showed that the percentage of ANC coverage with four visits was 23% which is almost the same as in 2013 and decreased by 5% from 2020. On the other hand, the percentage of ANC coverage with one visit was 60% which is better than coverage in 2013 and decreased by 10% from 2020 (Figure 9) (24,67).

The increased coverage rate in 2021 compared to 2013 might be related to duplicating reporting data input. The decreased ANC coverage is related to the current conflict that impacted half of HFs, affecting accessibility issues and lack of human resources (23).

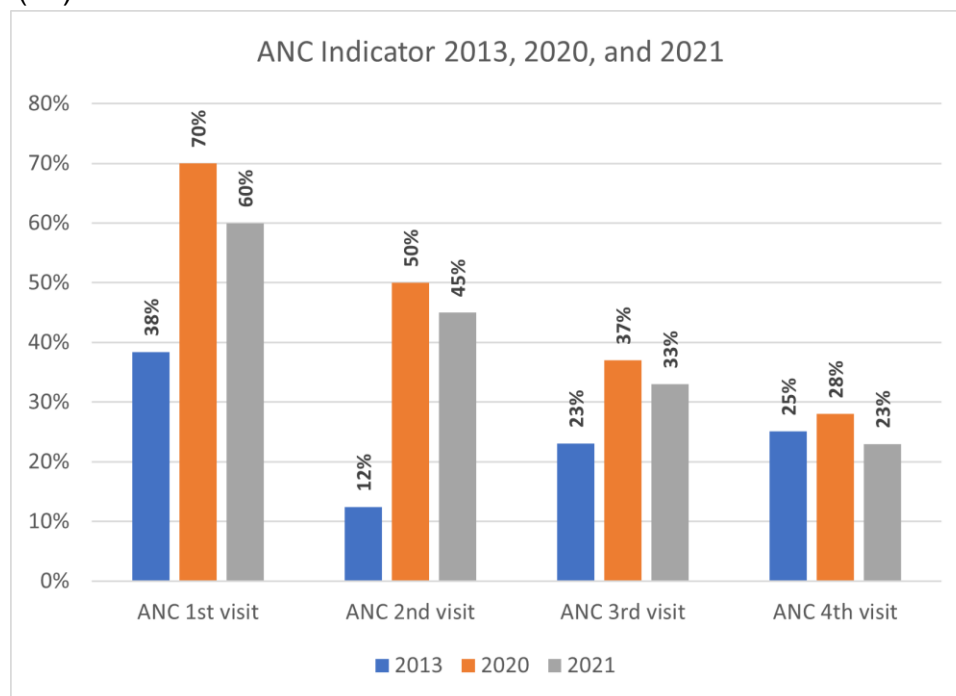


Figure 9: ANC visit indicator 2013, 2020, and 2021

Source: "Annual report of the MNBS 2021" (24)

#### 4.4.5.4 Family planning (FP) coverage:

Family planning plays a role in human rights that everyone has access to reach. Family planning is essential for empowering women and achieving gender equality. It also plays a significant role in lowering poverty. Pregnancy and delivery complications are the

most significant cause of death among teenage girls (ages 15-19) (71). FP is highly related to decreasing IMR. A meta-analysis study in Ethiopia related to FP and infant mortality found that a birth interval of at least two years decreases infant mortality by 50% (72).

Annual Yemen statistical health report 2020 showed that only 26% of women of reproductive age were seeking FP compared to 34% in 2013, and most of these women are between 20 – 34 years old, representing 21% (67,73). During the war, FP became less accepted by the communities because they were looking for food and other health services. In addition, stories of foreign agendas promoting FP serve to decline in FP usage among the community (74).

#### 4.4.5.5 Skilled birth attendance and delivery locations:

Deliveries attended by SBA improve MCH outcomes and the early identification and treatment of difficulties during pregnancy, labour, and the postpartum period. Consequently, SBA has a beneficial effect on lowering maternal and neonatal mortality and morbidity (75). SBA-assisted deliveries can avoid 66% of MMR and 43% of IMR (7).

Based on 2021, MNB data in Yemen showed that SBA coverage decreased from 48% in 2013 to 43% in 2020 and 39% in 2021. That means 4 out of 10 Yemeni women get SBA coverage services. These percentages are far from the national target of 60% of women delivered by SBA. Moreover, the percentage of women who delivered babies at HF has dropped from 30% in 2013 to 26% in 2021, which means 3 out of 10 women deliver their babies at HFs (Figure 10) (24,67). This decline is related to the current war that impacted the shortage of human resources, medical supplies, and equipment availability (23).

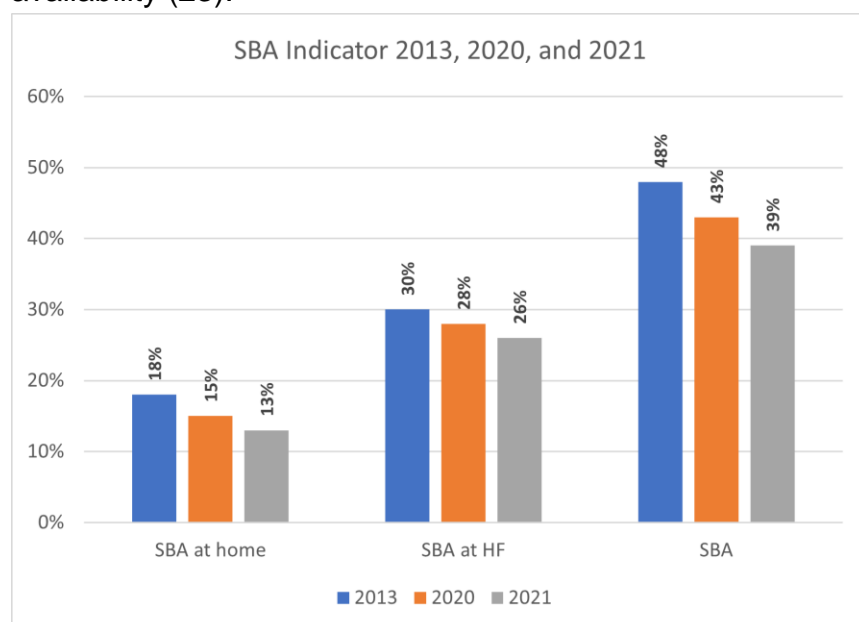


Figure 10: SBA coverage in Yemen 2013, 2020, and 2021

Source: “Annual report of the MNBS 2021” (24)



#### 4.4.5.6 Delivery type:

Ensuring access to Caesarean Delivery (CD) is a crucial step in lowering infant and mother mortality since it can save lives in cases of obstructed labour and other emergency obstetrical situations. However, given the nature of the surgery, there are potential risks for complications, and excessive usage can be a threat to both MNBs (76). WHO advised that CD rates not exceed 10 to 15 CDs per 100 LBs. Even though it is challenging to determine the ideal population-level CD rate, several nations have far greater rates of CDs (76). According to research conducted in India, CDs have a 4 to 5 times higher risk of maternal death than Vaginal Deliveries (VD), and the danger to NB is 1.7 times higher. The primary causes of increased mortality following CD are postpartum haemorrhage, anaesthesia-related problems, postpartum infections, and NB immunological and respiratory morbidity (77). In Yemen, CD rates have been stable at 5% from 2015 till now, and the rest deliveries go under VD (24).

#### 4.4.5.7 Postnatal care (PNC):

The postnatal period is described as the period that starts just after the baby is delivered and lasts up to six weeks (42 days). WHO advises four PNC visits and a minimum 24-hour stay in a medical institution following delivery (78). A meta-analysis covering 24 developing countries showed a significant association between utilising PNC and dropped infant mortality (79). In addition, a study for Bangladesh Demographic and Health Survey data indicated that Infants who got PNC had a 68% lower risk of dying in the first few days of life than infants who had not (80).

MNB data in Yemen showed that the PNC coverage has declined from 20% in 2013 to 17% in 2020 and 16% in 2021 (Figure 11) (24,67). The low coverage of PNC is related to the shortage of health workers and the unavailability of medicine and medical equipment. In addition to accessibility issues related to financial barriers and family awareness about PNC benefits (23).

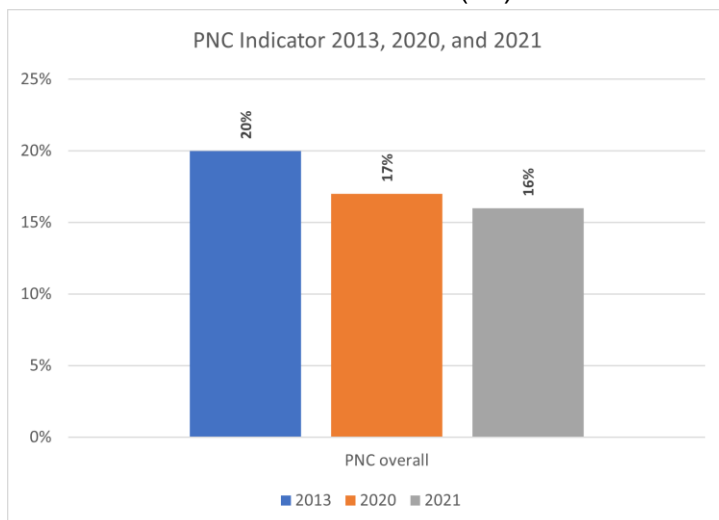


Figure 11: PNC coverage in Yemen 2013, 2020, and 2021

Source: “Annual report of the MNBS 2021” (24)



#### **4.4.5.8 Maternal Diseases:**

Maternal morbidity and mortality are any health issues or fatalities caused by pregnancy, childbirth, or both that happen during the pregnancy or within six weeks after it ends (81). Strong evidence exists for the interdependent nature of mother and neonatal health. NB health is improved because of the interventions mothers receive before pregnancy, throughout pregnancy, and after giving birth (82). A longitudinal study in Ethiopia for 25-year showed that children whose mothers died during or soon after childbirth had a roughly 50-fold higher chance of dying during the first month of life. A considerably higher risk ratio was also discovered for children born to mothers who passed away within a year after giving birth (83).

In Yemen, MMR became a tragedy becoming 500 deaths per 100,000 LBs in 2019 compared to 385 deaths per 100,000 LBs in 2015. Sixteen mothers die every day as a complication of pregnancy and delivery (24), which is far from the SDG target to decrease MMR to less than 70 per 100,000 LBs (84). Most of these deaths occur from preventable complications. In Yemen, for example, these complications are pre-eclampsia 36%, vaginal bleeding 11%, infection and pre-term labour 7% for each, and other pregnancy complications represent 39% of the total causes of maternal death (Figure 12) (24). The MMR was related to accessibility issues to healthcare services where the conflicts destroyed almost half of the health facilities and affected medical supplies, equipment, and human resources availability. In addition, the financial barriers play a role along with the inflation rate leaving families without sufficient income to seek essential MCH services (23).

Maternal mental health plays a role in infant health outcomes. For instance, depression alone affects up to 25% of pregnancies, and it appears to be linked to a mild increase in the risk of stillbirth and infant death. Meta-analyses revealed that the two leading causes of perinatal mortality—preterm delivery and low birth weight—were associated with a 40–80% increased risk in mothers with depression and anxiety disorders. Moreover, mothers with mental illnesses are more prone to have poor nutrition, which can significantly impact the development of the foetus (85).

In Yemen, a study issued in 2018 by the Family Counselling and Development Foundation (FCDF) showed that the incidence of mental problems among the Yemen population impacted by the conflict was 19.5% in 2018, up from 15.7% in 2007. Anxiety disorders, depressive disorders, traumatic stress disorder-related diseases, schizophrenia spectrum disorders, and other psychotic disorders are the most common mental illnesses. Females were more to have problems and stress than males. The prevalence rate was 81.4% for women and 18.6% for men, among the 75,910 cases in this study. It was more common in unmarried people 52% than in married people 48% (86).

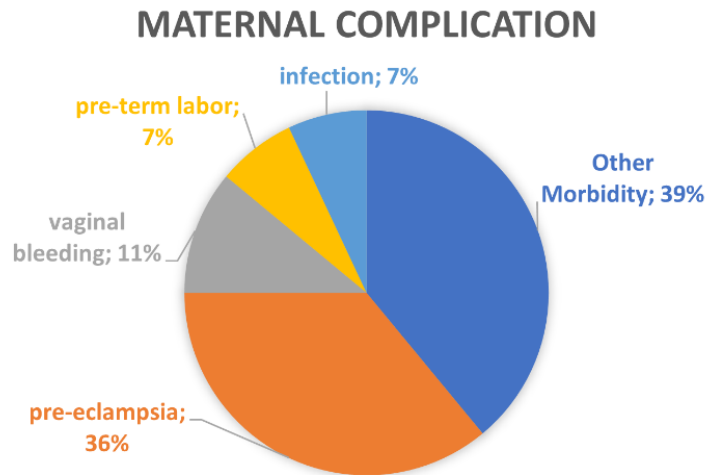


Figure 12: Maternal complications in Yemen  
**Source:** Annual report of the MNBS 2021 (24)

## 4.2 Socioeconomic Determinants

Socioeconomic determinants will identify the factors that impact infant health by interacting with the proximal factors. These factors are parent education level, productivity, gender, and traditional behaviours "chewing Khat" (individual-level variables). In addition, residency, household income and economic situation, health system, and ecological "climate change" (household and community level variables).

### 4.2.1 parent education level, productivity, and gender:

Parental education has been related to long-lasting increases in children's health, life expectancy, and economic status. Higher maternal education has been linked to a reduction in child mortality. Even though father education is linked to higher infant survival rates, this relationship is critically understudied (87). A study that covered over three million live births and comprised over 300 research from 92 different nations showed that the protective impact of parental education became more pronounced as a child's age grew. However, it was still significant for all age groups under five years. For NB 0–27 days old, every extra year of maternal education decreased death risk by 1.5%. The risk was decreased by 1.1% every year of father education. Every year of maternal education decreased the mortality risk for infants between 1 and 11 months by 3.7%. The risk was lowered by 1.8% every year of paternal education. For a child aged 1-4 years, maternal education lowered mortality risk by 4.4% every year. The risk was decreased by 2.2% every year of paternal education (88).

The literacy rate in Yemen for those above the age of 15 dropped from 22.5% in 2016 to 21.5% in 2017 to 21.3% in 2018. A delay, diminution, or cancellation of literacy programmes because of the war and the economy undoubtedly causes these drops (Figure 13). From 2016 to 2018, there was a consistent fall in the enrolment rate for secondary education for students aged 15 to 18. The average of people enrolled in 2016 was 31% and fell to 28% in 2017, with the downward trend continuing to 25% in 2018. Regarding the ratio of students enrolled in universities aged 19 to 24, the average of students enrolled in 2016 reached 9% and fell to 8% in 2017, with the decline continuing to 7% in 2018 (Figure 14) (20).

The unemployment rate in Yemen is among the highest in the world. In 2016, 32.9% of men and 43.5% of women were unemployed, with the overall unemployment rate falling from 33.8% to 31.9% and 29.9% during the next two years. Because of the violence that started in 2015, which resulted in many employees losing their jobs, the unemployment rate in 2016 was higher than in 2014. It has been observed that the unemployment rate for women in Yemen is significantly higher than for men, including the fact that women in Yemen have lower levels of education than men and are subject to a variety of pressures regarding where and when they can work (Figure 15) (20).

Gender affects who has access to social power and how resources are distributed, and it is entwined with many cultural notions of what is appropriate for male and female behaviour. Therefore, gender is linked to many good and bad health outcomes. These

can be direct for instance, the fact that women experience domestic violence more frequently, or indirect affecting other socioeconomic determinants of health like poverty (89).

The 2016 Global Gender Gap Index ranked Yemen last among 144 nations. Women and girls in Yemen were often marginalised and discriminated against even before the crisis began. The dispute has made decision-making at the community level even more male-dominated. Due to the high illiteracy rates, women find it difficult to seek support. Malnutrition levels have grown, they've had trouble getting an education, there has been more risk because of poor access to water and sanitation, and they have had difficulty getting medical treatment, particularly for mothers. Significantly impacted is women's access to maternity healthcare. More than 2.2 million Yemeni women and girls of reproductive age are in danger of their health and safety. Around 500,000 pregnant women may be unable to get secure and reasonably priced medical care. Women and girls' already restricted movement has been further delayed by conflict parties and gender norms, which has decreased their access to services (90)

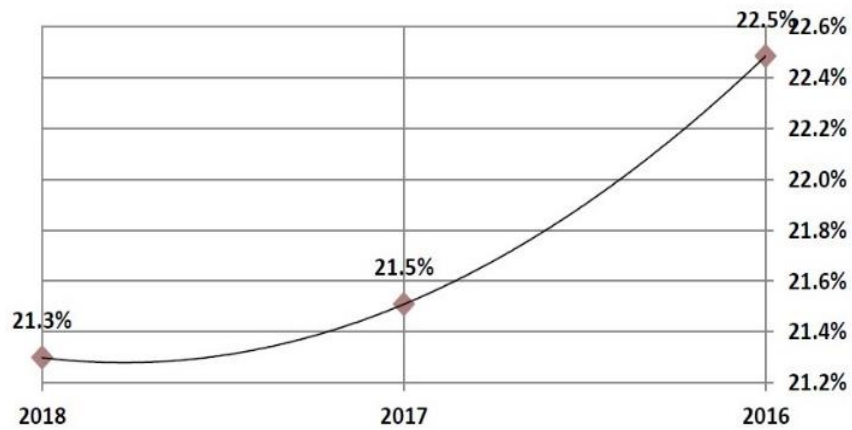


Figure 13: literacy rate from 15 in 2016 to 2018

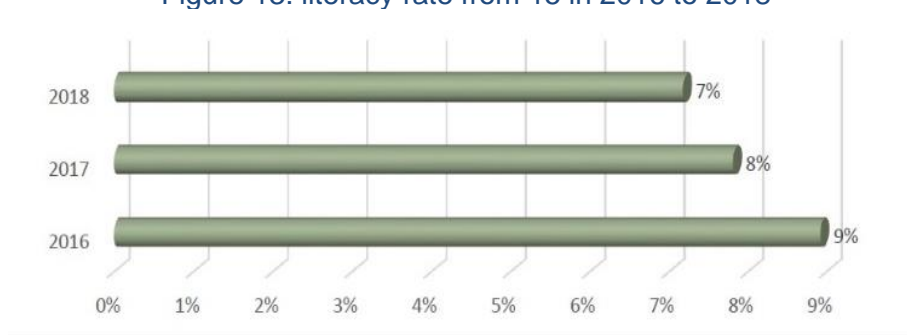


Figure 14: University enrolment rate from 2016 to 2018

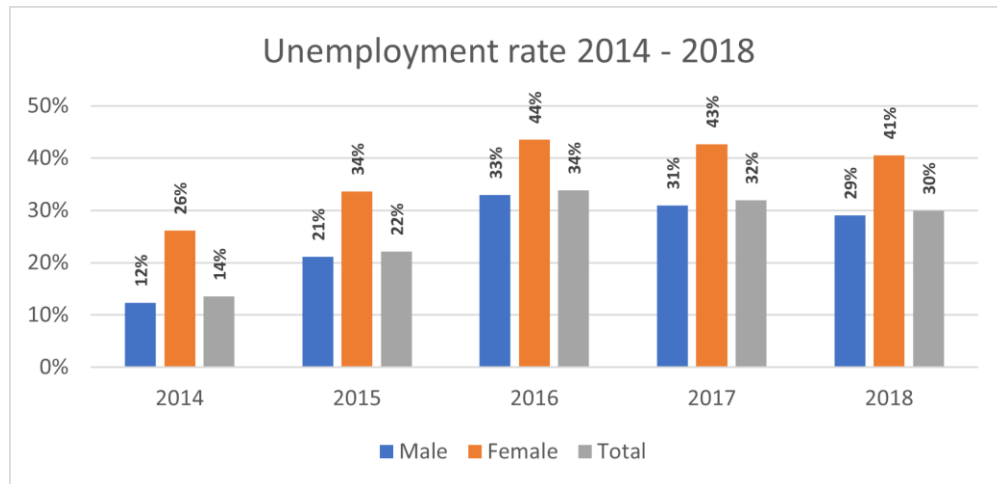


Figure 15: The unemployment rate in Yemen 2014 - 2018

Source: “The sustainable development indicators report in Yemen 2016-2018” (20)

#### 4.2.2 Traditional behaviours - Chewing Khat:

The plant known as Khat (*Catha edulis*) grows naturally in nations surrounding the Red Sea and contains active compounds with broader physiological effects. Khat chewing is widespread throughout Yemen and Africa, with rates as high as 15% in Ethiopia and 90% in Yemen. According to a national demographic census in Ethiopia, only 10% of Ethiopian women chew Khat, compared to 50% in Yemen. According to other research, just 26% of pregnant Ethiopian women consume Khat, compared to 41% of Yemeni women (91). Studies on the side effects of chewing Khat include anxiety, anorexia, constipation, and a decrease in breastfeeding. Studies have revealed that Khat reduced the amount of breast milk produced and that its active ingredients were transferred to the baby through breastfeeding. According to different research, pregnant women who chew Khat four times per week throughout their pregnancy are twice as likely to experience infant mortality as those who do not. Compared to non-chewers, mothers who chewed Khat daily during pregnancy were shown to have four times higher risk of infant mortality (91).

#### 4.2.3 Residency:

Rural areas across the world struggle to get the necessary healthcare. Most of the population in LMICs reside in isolated, rural areas with inadequate resources. These problems are most likely caused by less access to and use of healthcare, lower levels of education, poorer living conditions, and inadequate water and energy infrastructure at the community level (92,93).

The rural population in Yemen shows a decline from 65.22% in 2015 to 61.45% of the total population in 2021 (12). According to research done to determine IMR and demonstrate various household characteristics in Yemen, rural mortality is significantly higher than in urban areas, with 56.1% and 39.9%, respectively (Table 2) (59).

#### **4.2.4 Household income and economic situation:**

Recent research established those economic recessions negatively influence infant mortality, with the impact being three times worse in LMICs than in those with more robust economic indices. If households struggle to make ends meet, they may move to less sanitary, crowded housing and change their diets to exclude expensive sources of protein and micronutrients. Economic downturns have indirect effects on health because they have an impact on factors that directly affect health, such as access to and the quality of food, water, and shelter, and because they also have an impact on the amount of money that can be spent on healthcare (94). A meta-analysis of 23 studies, which study the relationship between income and mortality showed that IMR in a nation with 50 deaths per 1000 LBs would be predicted to drop to 45 deaths per 1000 LBs if the Gross domestic product (GDP) per capita increased by 10% (95).

Yemen's economy has collapsed since 2015 GDP falling by 50%. 58% of Yemenis live in extreme poverty, compared to 19% before the conflict. Yemen's health system mostly depends on outside financing to provide essential services, making it unstable (23). The national Yemen economy continued to contract from 2016 to 2018. The annual growth rate of GDP per capita declined over that time was estimated to be around 25.3%, with negative growth rates estimated to have ranged from -14.61% in 2016 to -9.96% in 2017 to -1.35% in 2018 (20).

Consumer price inflation is one of the most important metrics for assessing macroeconomic success and economic stability. It is defined as a constant increase in consumer goods and services prices. Yemen's consumer price inflation increased from 2016 to 2018. Yemen's inflation rate peaked at 30% in 2016 and increased steadily over the following years, reaching 40% in 2017 and 48% in 2018 (Figure 16). The average annual per capita income was calculated using the rate of consumer price inflation. It was found to be about 143 thousand riyals in 2018, down from 153 thousand riyals in 2016 and 148 thousand riyals in 2017 (Figure 17) (20).

Yemen has retained its status as the sixth-lowest income country in the World Bank categorization since 2016. Due to the start of the conflict and the partial or complete suspension of government employee wages, annual income has decreased. Moreover, with the interruption of air, land, and sea outlets and the suspension of output in other economic sectors, it is anticipated that the national economy will continue to suffer losses, and the inflation rate will continue to increase (20).

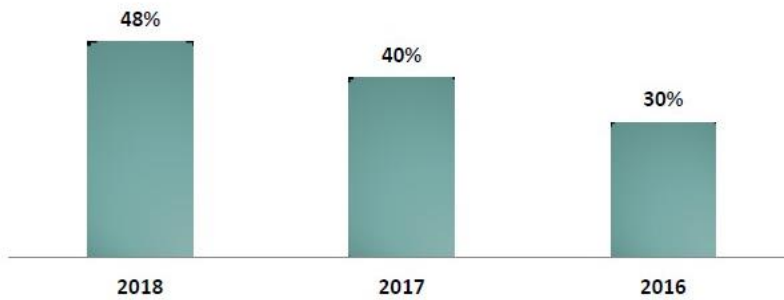


Figure 16: Price inflation rate in Yemen 2016-2018

Source: “The sustainable development indicators report in Yemen 2016-2018” (20)

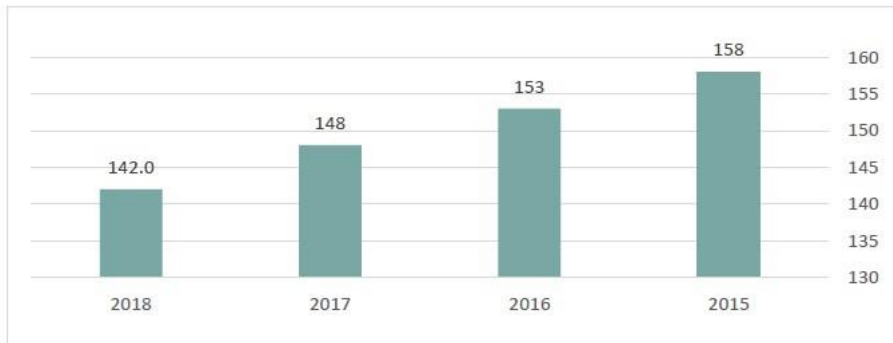


Figure 17: Yemen annual income 2015 - 2018 (1000 YR)

Source: “The sustainable development indicators report in Yemen 2016-2018” (20)

#### 4.2.5 Health system:

WHO emphasises the value of an effective healthcare system in lowering avoidable death through early intervention. A key component of early intervention is making sure that moms and children have access to affordable, accessible, and available health care systems (96). Various variables cause the underutilisation of efficient health services in LMIC. Children may face unique challenges since they frequently rely on a parent or caregiver for healthcare services (97).

In Yemen, the health system is fragmented into two health ministries, one in DFA in Sana'a and the other in the IRG area in Aden. Both saw themselves as accountable authorities for the organisation and planning of health care. Some Sana'a City officials in charge of MCH services criticised the design of their programmes as being short-term and occasionally dependent on the uninformed objectives of DFA decision-makers or their political agendas. Aden's MoPHP is underdeveloped and cannot manage and assist the health offices. The staff of humanitarian organisations and community-based healthcare providers in the governorates of Sana'a, Aden, and Taiz noted that women traditionally preferred to give birth at home. That is because of the difficulty in getting care in urban and rural areas. They tend to seek care only when complications occur (74).

Furthermore, it was revealed through key informant interviews that none of these three governorates had a formal referral mechanism for women needing urgent obstetric treatment (74). WB stated in the 2021 policy note that Yemen's HS heavily depends on



fund aid from other countries, and local and international organisations mainly provide health services. External health funding has descended recently, leaving Yemen's health sector vulnerable to future health deterioration (23). As a result of the economic hardship brought on by the war, the quality-of-service delivery has declined. In 2014, the government spent 43.91% of overall government expenditures on health, education, and social protection. In 2018, that percentage dropped to 5.38% (Figure 18) (20).

According to WB, 30% of the population resided more than 30 minutes away from an efficient primary care facility, while more than 42% resided more than an hour away from a hospital. Most patients, 82%, walk to the closest primary care facility, while over half of the population lives more than a 30-minute walk from these facilities. According to a study focused on access to vital services, 30% of the population resided more than an hour away from the closest prenatal care facility, posing a considerable risk to MNB health outcomes (Table 3) (23).

Only 51% of healthcare institutions are entirely operational, and two-thirds of the population cannot access treatment. During the war, 274 medical institutions were destroyed, and 120 medical professionals were assaulted. Only three physicians and seven hospital beds are present in Yemen for every 10,000 residents. This ratio is far lower than the WHO estimates to be required to provide essential health coverage, which is a minimum of 22 health workers per 10,000 people. Most health workers have not received pay in more than two years, which has led to a significant brain drain. 18% of the districts nationwide lack doctors. Despite incentive payments from donors, they are not routinely made, and as a result, the health staff continues to be a substantial barrier to service delivery (23).

The prolonged battle has almost stopped access to public services, leading to inadequate access to healthcare, food, and water resources. This already dire scenario will worsen because of the fighting in Ukraine. Yemen imports most of its food, with Ukraine accounting for 30% of its wheat imports. The price of food will inevitably rise owing to the high rise in wheat prices brought on by the situation in making it more expensive and limiting access for those who need it most (98).

Table 3: The average distance to the nearest health facilities in Yemen

Travel time	Nearest PHC with vehicle access	Nearest PHC by foot	Nearest Hospital with vehicle	Nearest hospital by foot
< 30 minutes	69.4%	55%	37.4%	17%
< 60 minutes	90.9%	82%	57.6%	32%
< 120 minutes	98.4%	97%	80.5%	52%

Source: "World Bank Yemen Emergency Health and Nutrition Project (EHNP), 2020" (23)





Figure 18: Total Yemen spending on essential services 2014 – 2018

Source: “The sustainable development indicators report in Yemen 2016-2018” (20)

#### 4.2.6 Climate change:

The previous decade saw the hottest time on record, and the planet is already 1.2°C warmer than before the industrial revolution. Climate change harms maternal and infant health because of unmet dietary demands, infections, and underlying chronic illnesses like diabetes and obesity. These appear because of floods or droughts, which cause harvests to fail, cattle to die, and people to be displaced. In low- and middle-income nations, women of reproductive age and children are most at risk for nutritional deficiency. Internal displacement patterns brought on by climate change and climate-related calamities are a growing source of worry. Infants are one of the vulnerable groups that are impacted by the outcome of climate change. Changes in disease patterns and an increase in vector-borne illnesses like dengue fever and malaria are possible additional indirect effects of climate change (Figure 19) (99).

Yemen is highly vulnerable to the effects of climate change, including drought, intense flooding, pests, abrupt disease outbreaks, altered rainfall patterns, more frequent and more severe storms, and sea-level rise. Yemen has designated water resources, agriculture, and coastal zones as its three most susceptible sectors to climate change (100). At least 28,000 people were impacted by flash floods in 2021. Additionally, illnesses like cholera and malaria are more contagious when flooding occurs. Cholera cases increase a few weeks following the start of the rainy season because of an accumulation of contaminated water and the growth of cholera germs (101).

The ongoing armed war that started in 2014 contributes to climate change in Yemen (102). Yemen's severe food insecurity problem is made worse by deforestation and desertification, which destroy agricultural land and diminish clean water supplies. People and companies have been compelled to clear trees for firewood because of severe fuel shortages. Since 2018, more than 5 million trees have been destroyed, with more than 889,000 used as fuel for bakeries and restaurants in Sana'a's capital. Deforestation has risen because of the rising demand for wood, with disastrous long-term consequences for Yemen's growth. Because of the demand and the high unemployment

rate, some former farmers whose land is no longer arable have turned to logs to survive (103).

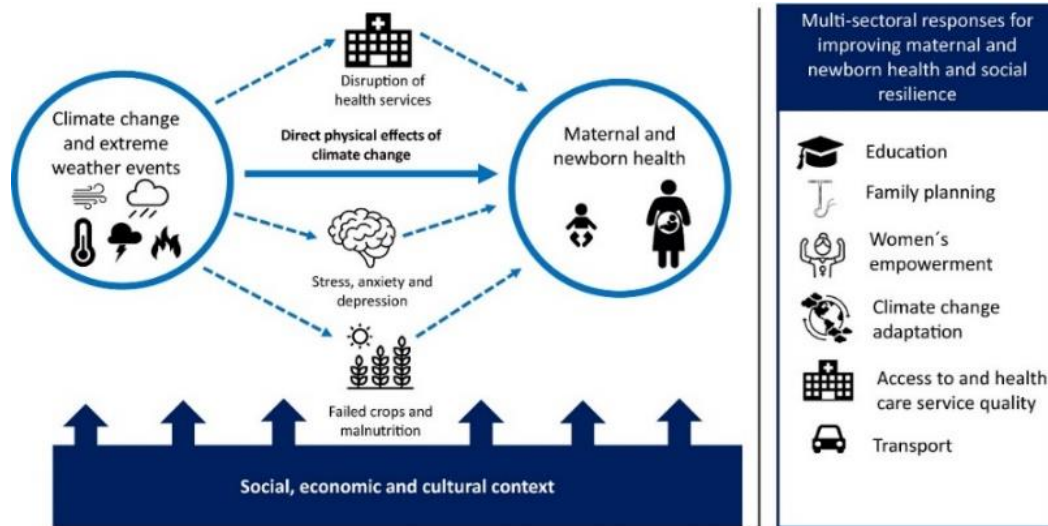


Figure 19: The impact of climate change on maternal and neonatal health

**Source:** “Maternal and new-born health risks of climate change: A call for awareness and global action, Acta Obstetricia et Gynecologica Scandinavica (AOGS) 2021” (99)

## **5. Evidence-based practice and interventions:**

The findings showed deterioration in infant mortality due to different proximal and socioeconomic factors in Yemen, which are interrelated. To reduce infant mortality, comprehensive and integrated approaches must be considered. This chapter will discuss Minimum Initial Service Package, New-born Education for midwives, and community-based interventions as three possible interventions to reduce IMR. These interventions were implemented and evaluated in similar conflict and low-resource countries, such as Afghanistan, Pakistan, Nigeria, and Sudan.

### **5.1 Minimum Initial Service Package (MISP):**

MISP is an integrated package for MCH that ensures the availability, accessibility, acceptability, and quality of services in a conflict setting. Preventing excessive morbidity and death among pregnant women and NB is one of MISP's goals. MISP interventions concentrate on the time of birth, during labour, delivery, and the first weeks after giving birth. MISP components are illustrated in figure 20 (104,105). Implementing MISP will encourage intersectoral collaborations, outreach health services, and enhances skilled midwives to improve access to care and referrals. This will ensure the improvement in child survival (28). In Yemen, during the current war, the MCH is managed by an Inter-agency working group on reproductive health (RH-IAWG) in crisis, supported by UNFPA, UNICEF, WHO, and partners from NGOs (106). UNFPA is one of the MISP program implementers in Yemen, and the program has shown great outcomes (104). Based on the 2022 report, UNFPA has supported 127 HFs, reached 1.6 million people with MCH services, and provided 151,115 safe deliveries in 2021 (107).

A study conducted in 24 conflict areas, including Afghanistan, Pakistan, and Sudan, evaluated the effectiveness of RH, including MISP. The study showed improvement in utilised FP in Afghanistan from 16% to 26% on 13 governorates within two years. The same study showed a decline in NB mortality from 25 to 20.7 per 1000 LBs and MMR from 291 to 102 per 100,000 LBs in Pakistan during seven years of program implementation. In Sudan, there was an improvement in SBA coverage from 35.7% to 52.7%. In addition, ANC and PNC coverage showed good coverage due to the education campaigns of the MISP (108).

### **5.2 New-born Education for midwives:**

Infant deaths in low-resource settings may be avoided with widely accessible and efficient treatment techniques. WHO and other organisations have created programs to enhance the capacities of community midwives, aiming to decrease infant mortality. These consist of the "WHO Essential New-born Care (ENC) program, the American Academy of Paediatrics Neonatal Resuscitation Program (NRP), and the Helping Babies Breathe (HBB)". These programs have successfully enhanced fundamental knowledge of infant resuscitation techniques.

According to research conducted in 80 low-resource countries such as Nigeria, Tanzania, and Kenya, the introduction of the ENC reduced early infant mortality from 36.2 to 25.1 deaths per 1,000 LBs, while the streamlined NRP reduced infant mortality to 15.9 deaths per 1,000 LBs. Stillbirths have been consistently and significantly decreased because of the HBB programme, which has been adopted in more than 80 countries (28).

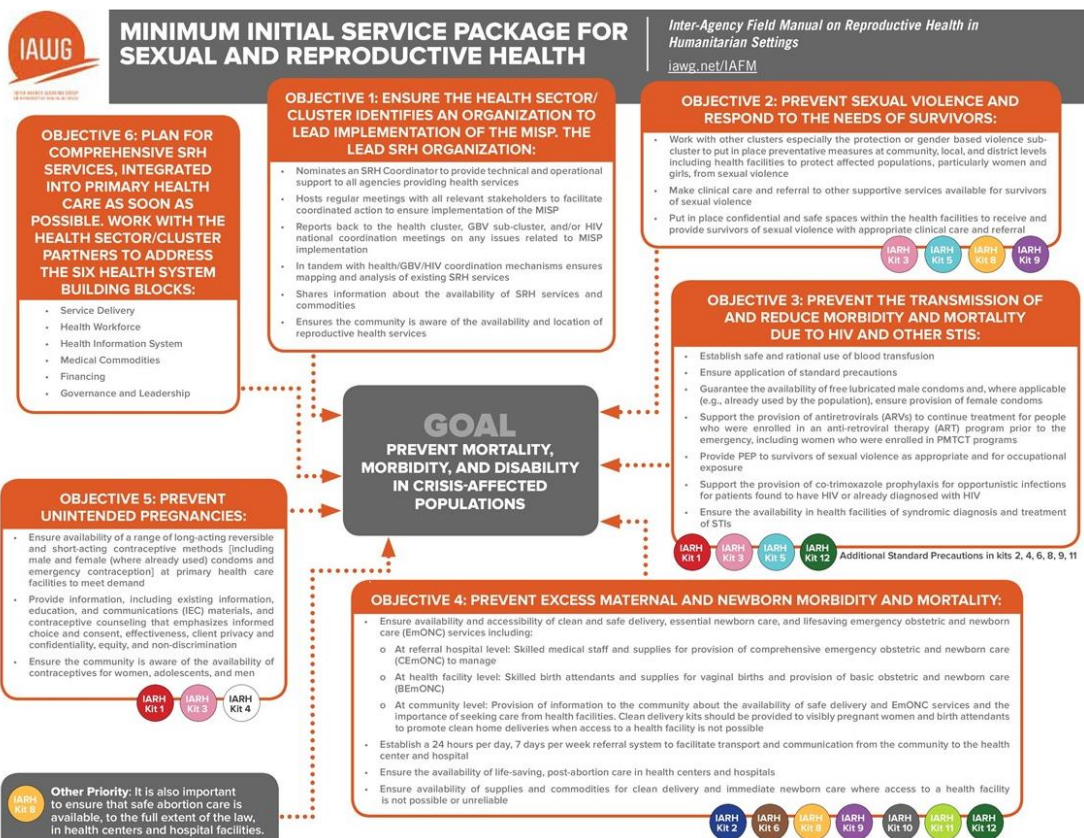


Figure 20: MISP package components

Source: "MISP in Crisis Situations, UNFPA 2020" (109)

### 5.3 Community-Based Interventions:

Developing countries have made investments in community-based intervention programmes to promote MCH interventions. Antenatal, intrapartum, postpartum, and neonatal care are all components of the "Birth Preparedness and Complication Readiness programme (BPCRP)" (28). BPCRP engages the families in awareness about pregnancy danger signs, preparedness for birth delivery, coordination with SBA, and sound money estimation and saving for pregnancy, transportation, and emergencies (110) The BPCRP can potentially improve knowledge and health outcomes among the communities, including family behaviours change and utilising the MCH medical services. The government can execute the BPCRP with little support, but it needs to be integrated with other MCH programmes (111).

A meta-analysis conducted through 14 randomized studies showed a significant reduction of 18% in the chance of IMR by implementing BPCR in developing countries such as Pakistan, Nepal, and Ghana (112). Unfortunately, there are no studies on the application of BPCR in Yemen. Including this program in MCH activities in Yemen will benefit the communities and decrease IMR.

## **6. Discussion**

This literature review is about infant mortality (IM) in Yemen. IMR in Yemen showed good progress from 88 per 1000 in 1990 to 45 per 1000 in 2015. Since the war in 2015, this rate increased to 46 per 1000 LBs in 2020, which is relatively high and without any prediction of improvement in the current context. This percentage is too high compared to the average rate in the Middle East & North Africa (MENA) region, which is 18 per 1000 LBs in 2020 (113). Different factors explain this deterioration, like problems in the health system, maternal and new-born, nutrition, communicable diseases, and war.

The findings showed discrepancies in IMR among WB data, studies, and MoPHP reports. The available data is based on an estimation approach of YDHS data in 2013. they did not show the actual statistics of IMR that we can rely on to describe the current situation and predict HS and the country's future.

This chapter will discuss the findings and has been divided into proximal and socioeconomic factors based on the main dominant findings.

### **6.1 Proximal factors:**

The findings showed a deterioration in the utilisation of MCH, nutrition deficiency, environmental contamination, especially WASH, and infant preventive and treatment factors that are mostly affected by the current war.

#### **6.1.1. Nutrition and WASH**

The nutrition status and food security are considered one of the leading causes of infant death in Yemen. All reports and studies showed a dramatic deterioration of nutrition status in Yemen during the war. Integration Food Security Phase Classification (IPC) 2022 report in Tigray and neighbouring zones of Afar and Amhara in Ethiopia showed a similar impact of conflict on nutrition status among the population. 5.5 million people in these areas face high levels of acute food insecurity compared to 17.4 million in Yemen. In addition, the UNICEF situation report in March 2022 stated that the average GAM rate in Ethiopia is 17% compared to the average GAM rate of 23% in Yemen. Ethiopia has similar causes of malnutrition to Yemen as conflict and displaced population, economic and inflation rate, deteriorated infrastructure, and the recent impact of the Ukraine crisis on the food globally (114–116).

The findings showed that WASH is one factor that aggravates Yemen's nutrition and diarrhoea situations. The WASH impact pathogen exposure and health behaviours. Furthermore, it influences nutritional status, morbidity, and death. In LMICs, WASH is closely linked to women's and children's nutritional health (117). In 2019 Yemen experienced a high incidence of cholera which affected mainly children. In addition, weak coordination among the Yemen government regarding WASH services and deterioration of WASH infrastructure increased the burden of diseases among children.

### **6.1.2. Pregnancy-related (health) services impacting on IMR**

ANC is important as it assesses the maternal status by taking a complete history and monitoring health and nutrition conditions during pregnancy. Even after delivery, during PNC, pregnant women can be advised about the proper family planning and methods, breastfeeding, danger signs, and health education after delivery. Despite that ANC has decreased IMR by 34%, service coverage is still low in Yemen 60% compared to the average coverage of ANC in Sub-Saharan Africa (SSA) at 82% and 75% in fragile and conflict-affected situations (118). The studies showed that the leading cause of low ANC coverage is related to accessibility to health services (70).

This review showed that the coverage of FP is 26%, SBA is 39%, and maternal death is 500 per 100,000 in Yemen, which is low compared to Ethiopia's 41.4% for FP and 48% for SBA, and high for MMR for Ethiopia 412 per 100,000 maternal mortalities. For immunisation, Yemen showed 71.6%, a good coverage indicator compared to 38.3% in Ethiopia, but both are still far from 90% of the WHO immunisation 2030 targets (119–122). In Yemen, many families do not take their children for vaccination as they are afraid about the quality and proper storage of vaccination, along with the limited availability of electricity and fuel, the primary power source. In addition, as preventive health services' advantages are more intangible than food aid and emergency medical care, many families are losing interest in vaccinating their children. Rumours that foreign governments are pressing for family planning and vaccinations only increase resistance (74).

The main barriers to low coverage of the services are related to access issues, level of education, economic situation, lack of staff, health workers' skills and knowledge, low women empowerment which is more dependent on their husbands, and cultural norms (116,119–122). Based on the Ethiopian studies, Yemen has the same barriers related to HS deterioration that impact infant health.

Family planning is still challenging in Yemen. FP concept is still linked to birth control among most communities rather than planning, organising, and preparing the environment for the coming family member. Family planning was neglected during the war; it was not seen as a priority or urgent need compared to disease outbreaks. Taiz GHO indicated that service is weakly provided due to the lack of supplies. GHO manager mentioned they only provide oral contraceptive pills. IUD and other family planning tools are also weakly provided due to the lack of supplies and difficulty in sending them to the directorate and transferring them to health centres (74).

Mental health is not less important than other factors, particularly in the war context of Yemen, the prevalence will increase, and another burden will be added to HS. Mental health data and studies are scarce in Yemen.



## **6.2 Socioeconomic factors:**

War is still the main factor that affects all findings in this review. In addition, findings showed that education and productivity of parents, household income and economic situation, and health system are the most dominant socioeconomic factors impacting infant health.

Yemen's literacy rate is too low 21.8%, compared to 63% in fragile and conflict-affected situations and 52% in Ethiopia (123). This rate continues to decrease during the current war. The finding showed a decline in enrolment in education institutions in Yemen. This decline is associated with the direct effects of the war and blockade on Yemen's educational process, where many educational facilities were subjected to bombings or accommodations by refugees. Low income for the family and teachers' absence due to their non-receipt of salaries. In addition, the students leaving their university to look for other types of work to support their families and the inability to pay for their education all contributed to decreasing the education level in Yemen.

The findings showed a continued contracted economic situation accompanied by an unemployment rate increase. More spending on war leaves less budget for health like providing medicines and supplies, HF's maintenance, HW's salaries, and population income that affects their access to healthcare. Since 2014, Yemen's poverty rate has sharply grown, from 47% of the population in 2014 to 75% in 2019. This number is much higher than the 35% in unstable and conflict-affected areas. If the conflict lasts until 2022, Yemen will be the most impoverished nation in the world, with 79% of the people will live below the poverty line (124,125).

In summary, the proximal and Socioeconomic factors are interlinked and impact infant health. Parents' education level and economic situation influenced the utilisation of services mentioned in proximal factors. Most families suffer from low income and prioritise food and acute diseases, which impact infant health. Another aspect of socioeconomic factors is a wrong coping mechanism with the current conflict, such as the drop in education enrolment, minimising their food quality and quantities, early marriage, and selling the family asset. Moreover, the financial barriers led to access issues to health care services and increased infant morbidity and mortality hazards. These factors are also influenced by the current destructed public infrastructures, political situation, multi-governments representatives, diminished government spending on health, and the communities' dependence on humanitarian assistance instead of development is increasing rising IMR.

Addressing the MISP, NB education program, and community-based interventions in the current context of Yemen will predict a positive impact on infant health. Integrating these interventions with PHC services will increase access to MCH services. MISP will ensure coverage of the ANC, FP, and SBA services and address MNB complications. Promoting the level of midwife education is another strategic intervention for saving infants in the first hours of their life. Addressing the point of community-based intervention

will ensure that the community is aware of pregnancy danger signs, well prepared for birth delivery, makes a financial plan for transportation and emergency, and safe delivery through regular ANC visits and skilled birth attendance.

### **6.3 Study strengths and limitations:**

To the author's knowledge, this is the first study to analyse the determinants of infant mortality in Yemen in a war context. Mosley and Chen's framework comprehensively covered biological and social factors of infant health and would be good to use this framework for infant health. The author covered all factors in the framework to show the gap in each factor for further interventions that strengthen HIS for research in the future.

**Limitations:** Due to the war since 2015, there were no updated data. Most available data are annual MoPHP, national SDG, and donor reports. Even these reports mainly showed discrepancies among donors and MoPHP reports, which might be there are biases in reports data. The most recent available data were YDHS in 2013. The available article resources on infant mortality during the war are limited, and studies have limited data. Most recent articles are analysing YDHS 2013, which is beyond the scope of the study due to the demographic and country context change since 2015. Finally, the thesis is constrained by limited words, a challenge for such a literature review.

## **7. Conclusion and Recommendations:**

This paper found that infant mortality is affected by the current conflicts. In addition, the deterioration of infant health is linked to the fragile health system in Yemen even before the war began. Socioeconomic and proximal factors are interlinked and increase the infant mortality rate. Because of that, stakeholders need to respond to these factors and strengthen the health system in Yemen. Enhancing the health information system and prioritising maternal and child health will reduce infant deaths. The current conflict significantly affects infant health because of access to health services, medical supplies and equipment shortages, and lack of human resources. Moreover, governance weakness, destruction of public infrastructures, humanitarian dependence, and absence of developmental programs affect infants' health.

Promoting the maternal and infant's nutrition status and good access to WASH services will ensure saving more infant life. Enhance access to pregnancy-related health services such as ANC, FP, and SBA will mitigate the burden of IMR. Increasing the level of education and the economic situation among the communities will raise the accessibility and affordability of MCH services. Adopting interventions from similar fragile and conflict settings is an excellent strategy to alleviate the risk of infant death in the conflict situation in Yemen.

There is a need to give attention to infant health, promoting national health and future outcomes. To reach that, the recommendations are as follows:

### **At National Level:**

1. Prioritise maternal and child health programs and review the current national policies and guidelines.
2. Strengthen the health information system by activating studies, research, and surveys on maternal and child health.
3. Strengthen integrated project approaches (health, nutrition, food security, WASH, protection, and emergency response) to cover most maternal and child health services.
4. Strengthen the multisectoral and integrated partnership between MoPHP and other ministries and Civil Society Organization (SCO) to improve community coordination. Donors to harmonise donor funding, and Private Sectors (PS) to work with MoPHP to reduce negative interventions and participate in maternal and child health through funding support.

### **At Health Facility Level:**

5. A scale-up of the Minimum Initial Service Package (MISP) program, integration with primary health services, and the inclusion of a psychological services program in maternal and child health services.
6. Include new-born education programs in the community midwives' workers (CMWs) curriculum in educational institutions in Yemen with frequent on-job training and supportive supervision.

7. Activating the surveillance system and response to maternal and child health services, medical commodities, and maternal and child health indicators in all health facilities.

**At Community Level:**

8. Invest in the people-centric approach and encourage them to participate in decision-making related to maternal and child health in their communities and strengthen the communication between the community and the health system.

## References

1. National Academy of Sciences. *Overview of Family Planning in the United States - A Review of the HHS Family Planning Program: Mission, Management, and Measurement of Results*. National Academies Press (US), Washington (DC); 2009.  
[https://www.ncbi.nlm.nih.gov/books/NBK215219/#\\_NBK215219\\_pubdet](https://www.ncbi.nlm.nih.gov/books/NBK215219/#_NBK215219_pubdet) [Accessed 3rd August 2022].
2. Food Security Cluster. *FSC Indicators Handbook, Proxy Global Acute Malnutrition by MUAC*. Food Security Cluster. [https://fscluster.org/handbook/Section\\_three\\_proxy.html](https://fscluster.org/handbook/Section_three_proxy.html) [Accessed 2nd August 2022].
3. Centers for Disease Control and Prevention. *Infant Mortality*. Centers for Disease Control and Prevention. <https://www.cdc.gov/reproductivehealth/maternalinfanthealth/infantmortality.htm> [Accessed 29th July 2022].
4. World Health Organization. *Infant mortality rate (deaths per 1000 live births)*. World Health Organization. [https://www.who.int/data/gho/data/indicators/indicator-details/GHO/hem-infant-mortality-rate-\(deaths-per-1000-live-births\)](https://www.who.int/data/gho/data/indicators/indicator-details/GHO/hem-infant-mortality-rate-(deaths-per-1000-live-births)) [Accessed 3rd August 2022].
5. World Health Organization. *Maternal deaths*. World Health Organization. <https://www.who.int/data/gho/indicator-metadata-registry/imr-details/4622> [Accessed 3rd August 2022].
6. S.W. Wen, R X. Maternal Mortality. *Reference Module in Biomedical Sciences, Elsevier*. 2014; <https://doi.org/10.1016/B978-0-12-801238-3.00263-4>.
7. Damian DJ, Tibelerwa JY, John B, Philemon R, Mahande MJ, Msuya SE. Factors influencing utilization of skilled birth attendant during childbirth in the Southern highlands, Tanzania: A multilevel analysis. *BMC Pregnancy and Childbirth*. 2020;20(1): 1–11.  
<https://doi.org/10.1186/s12884-020-03110-8>.
8. ACAPS. *Yemen: Outlook for April-September 2020*. ACAPS Maps & Infographics. <https://www.acaps.org/what-we-do/maps-and-infographics?page=1> [Accessed 23rd July 2022].
9. ACAPS. *ACAPS Country Profile: Yemen*. ACAPS . 2015 Jul [Accessed 23rd July 2022].  
<https://reliefweb.int/report/yemen/acaps-country-profile-yemen-july-2015> [Accessed 23rd July 2022].
10. Yemen National Information Center. *An overview of Yemen*. Yemen Government. <https://yemen-nic.info/yemen/> [Accessed 23rd July 2022].
11. United Nations Statistics Division. *Yemen Undata*. UNData app.  
<http://data.un.org/en/iso/ye.html> [Accessed 23rd July 2022].

12. The Global Economy. *Yemen economic indicators*. The Global Economy. <https://www.theglobaleconomy.com/Yemen/> [Accessed 23rd July 2022].
13. Population Pyramids of the World. *Population Pyramid of Yemen 2021*. Population Pyramids of the World. <https://www.populationpyramid.net/yemen/2021/> [Accessed 23rd July 2022].
14. Sharp JM. *Yemen: Civil War and Regional Intervention*. Congressional Research Service. 2021 Nov [Accessed 23rd July 2022]. <https://crsreports.congress.gov/product/pdf/R/R43960> [Accessed 23rd July 2022].
15. ACAPS. *Yemen Social impact monitoring report: July - September 2021*. 2021 Jul [Accessed 23rd July 2022]. [https://www.acaps.org/sites/acaps/files/products/files/20211105\\_acaps\\_yah\\_simp\\_july\\_to\\_september\\_0.pdf](https://www.acaps.org/sites/acaps/files/products/files/20211105_acaps_yah_simp_july_to_september_0.pdf) [Accessed 23rd July 2022].
16. al-Sakani Ali. *Yemen inaugurates new presidential council*. Al Jazeera. <https://www.aljazeera.com/news/2022/4/19/yemen-inaugurates-new-presidential-council> [Accessed 23rd July 2022].
17. Fragile States Index. *Measuring Fragility, Risk and Vulnerability in 179 Countries*. Fragile States Index. <https://fragilestatesindex.org/> [Accessed 23rd July 2022].
18. Mele G, al Akkaoui MK, Saki Handley, Geoff Davies, Fiona Malvina. *Yemen Economic Monitor : Clearing Skies Over Yemen?*. 2022 [Accessed 3rd August 2022]. <http://documents.worldbank.org/curated/en/099445406102232164/IDU02c5915390fb9604bd10ae55053ca415f59f9> [Accessed 3rd August 2022].
19. World Bank. *The World Bank In Yemen*. World Bank. <https://www.worldbank.org/en/country/yemen/overview> [Accessed 23rd July 2022].
20. UNFPA Yemen and Central Statistics Organization. *THE SUSTAINABLE DEVELOPMENT INDICATORS REPORT IN YEMEN 2016-2018*. 2020 Apr [Accessed 3rd August 2022]. <https://yemen.unfpa.org/en/publications/sustainable-development-goals-indicator-report-yemen-2016-2018> [Accessed 3rd August 2022].
21. OCHA. *Yemen Humanitarian Response Plan 2022 (April 2022)*. 2022 Apr [Accessed 3rd August 2022]. [https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/documents/files/yemen\\_hrp\\_2022\\_english.pdf](https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/documents/files/yemen_hrp_2022_english.pdf) [Accessed 3rd August 2022].
22. DTM Yemen I. *Yemen — Annual Rapid Displacement Tracking Report (2021)*. 2022 Apr [Accessed 24th July 2022]. [https://displacement.iom.int/sites/default/files/public/reports/20220315\\_DTM\\_RDT\\_2021\\_Annual\\_Report.01.pdf](https://displacement.iom.int/sites/default/files/public/reports/20220315_DTM_RDT_2021_Annual_Report.01.pdf) [Accessed 24th July 2022].

23. World Bank. *Health Sector in Yemen – Policy Note*. World Bank. 2021 Nov [Accessed 2nd July 2022]. <https://thedocs.worldbank.org/en/doc/8aca65c4db5338cd3a408c0d4a147123-0280012021/original/Yemen-Health-Policy-Note-Sep2021.pdf> [Accessed 2nd July 2022].
24. Maternal and child health unit M. *Maternal and newborn health annual report MoPHP*. 2021.
25. World Bank. *Mortality rate, infant (per 1,000 live births) - Yemen, rep*. World Bank. <https://data.worldbank.org/indicator/SP.DYN.IMRT.IN?locations=YE> [Accessed 27th March 2022].
26. Integrated Food Security Phase Classification (IPC). *YEMEN: Food Security and Nutrition Snapshot*. IPC. 2022 Jan [Accessed 25th July 2022]. <https://www.unicef.org/mena/media/15801/file/YEMEN:%20Food%20Security%20&%20Nutrition%20Snapshot.pdf> [Accessed 25th July 2022].
27. Yemen WASH cluster. *Secondary Desk Review on WASH assessment in Yemen, full report*. 2020 May [Accessed 15th July 2022]. [https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/documents/files/reach\\_yem\\_report\\_wash\\_secondary\\_desk\\_review\\_may\\_2020.pdf](https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/documents/files/reach_yem_report_wash_secondary_desk_review_may_2020.pdf) [Accessed 15th July 2022].
28. Mwinga K, Mwinga N, Nomaguchi T. *Global Infant Health*. Springer, Cham. 2021; 1–37. [https://doi.org/10.1007/978-3-030-05325-3\\_44-1](https://doi.org/10.1007/978-3-030-05325-3_44-1).
29. Hug L, Lee S, Liu Y, Mishra A, Sharrow D, You D, et al. *Levels & Trends in Child Mortality, Estimates developed by the UN Inter-agency Group for Child Mortality Estimation Report 2020*. 2020 [Accessed 3rd August 2022]. <https://www.unicef.org/media/79371/file/UN-IGME-child-mortality-report-2020.pdf.pdf> [Accessed 3rd August 2022].
30. UNICEF. *Yemen Appeal: Humanitarian Action for Children*. 2021 Dec [Accessed 3rd August 2022]. <https://www.unicef.org/media/112406/file/2022-HAC-Yemen.pdf> [Accessed 3rd August 2022].
31. Obadi MA, Taher R, Qayad M, Khader YS. Risk factors of stillbirth in Yemen. *Journal of Neonatal-Perinatal Medicine*. 2018;11(2): 131–136. <https://doi.org/10.3233/NPM-181746>.
32. Institute for Health Metrics and Evaluation (IHME). *Yemen*. Institute for Health Metrics and Evaluation (IHME). <https://www.healthdata.org/yemen> [Accessed 31st May 2022].
33. Mosley WH, Chen L c. An analytical framework for study of child survival in developing countries. *Bulletin of the World Health Organization*. 2003;81(2): 140–145. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2572391/pdf/12756980.pdf>
34. Bezie M, Addisu D. Determinants of early marriage among married women in Injibara town, north West Ethiopia: Community-based cross-sectional study. *BMC Women’s Health*. 2019;19(1): 1–6. <https://doi.org/https://doi.org/10.1186/s12905-019-0832-0>.



35. UNICEF. *Child marriage around the world*. UNICEF. <https://www.unicef.org/stories/child-marriage-around-world> [Accessed 3rd July 2022].
36. Hunersen K, Attal B, Jeffery A, Metzler J, Alkibsi T, Elnakib S, et al. Child Marriage in Yemen: A Mixed Methods Study in Ongoing Conflict and Displacement. *Journal of Refugee Studies*. 2021;34(4): 4551–4571. <https://doi.org/10.1093/JRS/FEAA144>.
37. Burniske Andrea, Silva Elizabeth Romanoff. *Why a Mother’s Age is Important to Newborn Survival – Healthy Newborn Network*. Save the Children. <https://www.healthynewbornnetwork.org/blog/why-a-mothers-age-is-important-to-newborn-survival/> [Accessed 4th August 2022].
38. Commission R. *CHILD MARRIAGE IN HUMANITARIAN SETTINGS IN THE ARAB STATES REGION STUDY RESULTS FROM DJIBOUTI, EGYPT, KURDISTAN REGION OF IRAQ AND YEMEN Synthesis Report*. 2020 Dec [Accessed 1st August 2022]. <https://www.womensrefugeecommission.org/wp-content/uploads/2020/12/Child-marriage-Arab-states-synthesis-report-FINAL.pdf> [Accessed 1st August 2022].
39. Headey D, Palloni G. Water, Sanitation, and Child Health: Evidence From Subnational Panel Data in 59 Countries. *Demography*. 2019;56(2): 752. <https://doi.org/10.1007/S13524-019-00760-Y>.
40. United Nations Children’s Fund (UNICEF). *Water, Sanitation and Hygiene (WASH); afe water, toilets and good hygiene keep children alive and healthy*. United Nations Children’s Fund (UNICEF). <https://www.unicef.org/wash> [Accessed 6th August 2022].
41. Alemu AM. To what extent does access to improved sanitation explain the observed differences in infant mortality in Africa? *African Journal of Primary Health Care & Family Medicine*. 2017;9(1): 1–9. <https://doi.org/https://doi.org/10.4102/phcfm.v9i1.1370>.
42. UNICEF. *Fast facts: WASH in conflict*. <https://www.unicef.org/stories/fast-facts-water-sanitation-hygiene-conflict> [Accessed 15th July 2022].
43. World Health Organization. *Fact sheets - Malnutrition*. World Health Organization. <https://www.who.int/news-room/fact-sheets/detail/malnutrition> [Accessed 3rd July 2022].
44. Lu Z, Bandara JS, Paramati SR. Impact of sanitation, safe drinking water and health expenditure on infant mortality rate in developing economies. *Australian Economic Papers*. 2020;59(1): 13–33. <https://doi.org/10.1111/1467-8454.12167>.
45. World Health Organization (WHO). *WHO EMRO, Nutrition, Priority areas, Yemen site*. World Health Organization (WHO). <http://www.emro.who.int/yemen/priority-areas/therapeutic-feeding-centres.html>, [Accessed 4th August 2022].
46. World Health Organization. *Breastfeeding*. World Health Organization. [https://www.who.int/health-topics/breastfeeding#tab=tab\\_1](https://www.who.int/health-topics/breastfeeding#tab=tab_1) [Accessed 3rd July 2022].

47. Phukan D, Ranjan M, Dwivedi LK. Impact of timing of breastfeeding initiation on neonatal mortality in India. *International Breastfeeding Journal*. 2018;13(1): 1–10.  
<https://doi.org/https://doi.org/10.1186/s13006-018-0162-0>.
48. Busquet E, Sacher A. *YEMEN NATIONAL STRATEGY FOR SOCIAL AND BEHAVIOR CHANGE IN NUTRITION 2018-2021*. 2018 [Accessed 29th July 2022].  
[https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/2019/11/National-Strategy-for-SBC-for-Nutrition\\_Yemen%28English-version%29.pdf](https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/2019/11/National-Strategy-for-SBC-for-Nutrition_Yemen%28English-version%29.pdf) [Accessed 29th July 2022].
49. UNICEF Yemen. *Exclusive breastfeeding, a simple practice that saves lives*. UNICEF.  
<https://www.unicef.org/yemen/stories/exclusive-breastfeeding-simple-practice-saves-lives> [Accessed 3rd July 2022].
50. UNICEF. *Maternal nutrition*. UNICEF. <https://www.unicef.org/nutrition/maternal> [Accessed 28th July 2022].
51. Khalid N, Aslam Z, Kausar F, Irshad H, Anwer P. Maternal Malnutrition and Its Kick on Child Growth: An Alarming Trim for Pakistan. *Journal of Food, Nutrition and Population Health*. 2017;1(3): 1–7. [www.imedpub.com](http://www.imedpub.com)
52. UNICEF, Nutrition Cluster. *Yemen Nutrition Cluster Monthly update*. 2021 [Accessed 25th July 2022].  
<https://www.humanitarianresponse.info/en/operations/yemen/documents?search=Nutrition+Cluster+Monthly> [Accessed 25th July 2022].
53. Integrated Food Security Phase Classification (IPC). *IPC Yemen Food Security and Nutrition 2022 / HumanitarianResponse*. Integrated Food Security Phase Classification (IPC). 2022 Aug [Accessed 5th August 2022].  
[https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/documents/files/7.ipc\\_yemen\\_food\\_security\\_nutrition\\_2022june\\_report\\_english.pdf](https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/documents/files/7.ipc_yemen_food_security_nutrition_2022june_report_english.pdf) [Accessed 5th August 2022].
54. Jawad M, Hone T, Vamos EP, Cetorelli V, Millett C. Implications of armed conflict for maternal and child health: A regression analysis of data from 181 countries for 2000–2019. *PLoS Medicine*. 2021;18(9). <https://doi.org/10.1371/journal.pmed.1003810>.
55. Wagner Z, Heft-Neal S, Bhutta ZA, Black RE, Burke M, Bendavid E. Armed conflict and child mortality in Africa: a geospatial analysis. *The Lancet*. 2018;392(10150): 857–865.  
[https://doi.org/10.1016/S0140-6736\(18\)31437-5](https://doi.org/10.1016/S0140-6736(18)31437-5).
56. The National Team For Foreign Outreach (NTFO). *The Annual Report on the General Situation in the Republic of Yemen*. Republic of Yemen. 2022 Mar [Accessed 26th July 2022].  
<https://ntfo.org.ye/wp->

[content/uploads/reports/2022/March%202022/EN%20Annual%20Report%202022%20-%20NTFO.pdf](#) [Accessed 26th July 2022].

57. D. Frenkel L. Infectious diseases as a cause of global childhood mortality and morbidity: Progress in recognition, prevention, and treatment. *Advances in Pediatric Research*. 2018; 1–11. <https://doi.org/10.24105/APR.2018.5.14>.
58. Walker CLF, Black RE. Commentary: What is the role of co-morbidity in child mortality? *International Journal of Epidemiology*. 2009;38(3): 772–774. <https://doi.org/10.1093/IJE/DYP170>.
59. Romanello M. Measurement and Correlates of Child Mortality in Yemen. *Open Access Library Journal*. 2018;5(10): 1–15. <https://doi.org/10.4236/oalib.1104905>.
60. Vilanova CS, Hirakata VN, de Souza Buriol VC, Nunes M, Goldani MZ, da Silva CH. The relationship between the different low birth weight strata of newborns with infant mortality and the influence of the main health determinants in the extreme south of Brazil. *Population Health Metrics*. 2019;17(1): 1–12. <https://doi.org/https://doi.org/10.1186/s12963-019-0195-7>.
61. Al-Shahethi AH, Zaki RA, Al-Serouri AA, Mahmud AB. Maternal, Foetal and Service-Related Risk Factors for Stillbirths During Conflict Situation, Yemen, 2015-2016. *Research Square*. 2020; 1–34. <https://doi.org/https://doi.org/10.21203/rs.3.rs-58907/v1>.
62. Idris I, Sheryan M, Ghazali Q, Nawi A. Reproductive and behavioural risk factors of low birth weight among newborns in Al Thawra Hospital, Sana'a, Yemen. *Eastern Mediterranean Health Journal*. 2020;26(11): 1415–1419. <https://doi.org/10.26719/emhj.20.061>.
63. Zegeye B, Shibire G, Haidar J, Lemma G. Socioeconomic, urban-rural and sex-based inequality in infant mortality rate: evidence from 2013 Yemen demographic and health survey. *Archives of Public Health*. 2021;79(1). <https://doi.org/10.1186/s13690-021-00589-1>.
64. World Bank. *Mortality rate, infant, female (per 1,000 live births) - Yemen, Rep.* World Bank. [https://data.worldbank.org/indicator/SP.DYN.IMRT.FE.IN?name\\_desc=true&locations=YE](https://data.worldbank.org/indicator/SP.DYN.IMRT.FE.IN?name_desc=true&locations=YE) [Accessed 15th July 2022].
65. World Bank. *Mortality rate, infant, male (per 1,000 live births) - Yemen, Rep.* World Bank. [https://data.worldbank.org/indicator/SP.DYN.IMRT.MA.IN?name\\_desc=true&locations=YE](https://data.worldbank.org/indicator/SP.DYN.IMRT.MA.IN?name_desc=true&locations=YE) [Accessed 15th July 2022].
66. National Institute of Child Health and Human Development. *For parents: Vaccines for your children*. Centers for Disease Control and Prevention. <https://www.nichd.nih.gov/health/topics/infantcare/conditioninfo/immunization#f1> [Accessed 24th June 2022].
67. Ministry of Public Health & Population, Central Statistical Organization, Pan Arab Program for Family Health, ICF International. *Yemen National Health and Demographic Survey 2013*. 2013

- [Accessed 3rd August 2022]. <https://dhsprogram.com/pubs/pdf/FR296/FR296.pdf> [Accessed 3rd August 2022].
68. As I, Dozie I, Abanobi OC, Amadi AN, Iwuoha G, Nwufu CR, et al. Immunization Status in the Pattern and Risk of Acute Respiratory Infection among Infants in Rivers State, Nigeria. *ACTA SCIENTIFIC PAEDIATRICALS*. 2019;2: 1–10. <https://doi.org/10.31080/ASPE.2019.02.0117>.
  69. Moller AB, Petzold M, Chou D, Say L. Early antenatal care visit: a systematic analysis of regional and global levels and trends of coverage from 1990 to 2013. *The Lancet Global Health*. 2017;5(10): e977–e983. [https://doi.org/10.1016/S2214-109X\(17\)30325-X](https://doi.org/10.1016/S2214-109X(17)30325-X).
  70. Wondemagegn AT, Alebel A, Tesema C, Abie W. The effect of antenatal care follow-up on neonatal health outcomes: A systematic review and meta-analysis. *Public Health Reviews*. 2018;39(1): 1–11. <https://doi.org/https://doi.org/10.1186/s40985-018-0110-y>.
  71. United Nations Population Fund (UNFPA). *Family planning*. UNFPA. <https://www.unfpa.org/family-planning> [Accessed 25th July 2022].
  72. Dadi AF. A systematic review and meta-analysis of the effect of short birth interval on infant mortality in Ethiopia. *PLoS ONE*. 2015;10(5). <https://doi.org/10.1371/journal.pone.0126759>.
  73. Planning and Development Sector, General Administration of Health Information and Research. *annual statistical health report 2020*. 2020 [Accessed 20th June 2022]. [https://moh.gov.ye/sec\\_files.aspx?id=3](https://moh.gov.ye/sec_files.aspx?id=3) [Accessed 20th June 2022].
  74. Tappis H, Elaraby S, Elnakib S, Alshawafi NAA, Basaleem H, Al-Gawfi IAS, et al. Reproductive, maternal, newborn and child health service delivery during conflict in Yemen: A case study. *Conflict and Health*. 2020;14(1). <https://doi.org/10.1186/s13031-020-00269-x>.
  75. Ayele GS, Melku AT, Belda SS. Utilization of skilled birth attendant at birth and associated factors among women who gave birth in the last 24 months preceding the survey in Gura Dhamole Woreda, Bale zone, southeast Ethiopia. *BMC Public Health*. 2019;19(1): 1–14. <https://doi.org/https://doi.org/10.1186/s12889-019-7818-6>.
  76. Molina G, Weiser TG, Lipsitz SR, Esquivel MM, Uribe-Leitz T, Azad T, et al. Relationship Between Cesarean Delivery Rate and Maternal and Neonatal Mortality. *JAMA*. 2015;314(21): 2263–2270. <https://doi.org/10.1001/JAMA.2015.15553>.
  77. Gupta Mamta, Saini Vandana. Caesarean Section: Mortality and Morbidity. *Journal of Clinical and Diagnostic Research*. 2018;12(9): 1–6. <https://doi.org/10.7860/JCDR/2018/37034.11994>.
  78. World Health Organization. *WHO recommendations on maternal and newborn care for a positive postnatal experience..* 2022nd ed. World Health Organization. Geneva: World Health Organization; 2022. <https://www.who.int/publications/i/item/9789240045989> [Accessed 26th June 2022].

79. Islam MA, Tabassum T. Does antenatal and post-natal program reduce infant mortality? A meta-analytical review on 24 developing countries based on Demographic and Health Survey data. *Sexual & Reproductive Healthcare*. 2021;28: 100616. <https://doi.org/10.1016/J.SRHC.2021.100616>.
80. Ijdi RE, Tumlinson K, Curtis SL. Exploring association between place of delivery and newborn care with early-neonatal mortality in Bangladesh. *PLOS ONE*. 2022;17(1): e0262408. <https://doi.org/10.1371/JOURNAL.PONE.0262408>.
81. National Institute of Child Health and Human Development. *Maternal Morbidity and Mortality*. National Institute of Child Health and Human Development. <https://www.nichd.nih.gov/health/topics/maternal-morbidity-mortality> [Accessed 22nd June 2022].
82. Lassi ZS, Majeed A, Rashid S, Yakoob MY, Bhutta ZA. The interconnections between maternal and newborn health – evidence and implications for policy. *The Journal of Maternal-Fetal & Neonatal Medicine*. 2013;26(SUP1): 3–53. <https://doi.org/10.3109/14767058.2013.784737>.
83. Moucheraud C, Worku A, Molla M, Finlay JE, Leaning J, Yamin AE. Consequences of maternal mortality on infant and child survival: a 25-year longitudinal analysis in Butajira Ethiopia (1987-2011). *Reproductive Health*. 2015;12(1). <https://doi.org/10.1186/1742-4755-12-S1-S4>.
84. United Nations Statistics Division’s Open SDG Data Hub. *3.1.1 Maternal Mortality Ratio*. SDG Data Hub. <https://sdg.tracking-progress.org/indicator/3-1-1-maternal-mortality-ratio-2/> [Accessed 26th June 2022].
85. Adane AA, Bailey HD, Morgan VA, Galbally M, Farrant BM, Marriott R, et al. The impact of maternal prenatal mental health disorders on stillbirth and infant mortality: a systematic review and meta-analysis. *Archives of Women’s Mental Health*. 2021;24: 543–555. <https://doi.org/https://doi.org/10.1007/s00737-020-01099-9>.
86. The Family Counseling and Development Foundation. *Estimated Prevalence of Mental Disorders: Among War-Affected Population In Yemen*. The Family Counseling and Development Foundation. 2018 [Accessed 10th July 2022]. p. 1–44. [https://moh.gov.ye/sec\\_files.aspx?id=1](https://moh.gov.ye/sec_files.aspx?id=1) [Accessed 10th July 2022].
87. Balaj M, York HW, Sripada K, Besnier E, Vonen HD, Aravkin A, et al. Parental education and inequalities in child mortality: a global systematic review and meta-analysis. *The Lancet*. 2021;398(10300): 608–620. [https://doi.org/DOI: https://doi.org/10.1016/S0140-6736\(21\)00534-1](https://doi.org/DOI:https://doi.org/10.1016/S0140-6736(21)00534-1).
88. Balaj MYHWSKBVHDAAFJGMJMRMTMECSSRS et. all. *Parental education brings large benefits for child survival, researchers find*. Institute for Health Metrics and Evaluation (IHME). [https://doi.org/https://doi.org/10.1016/S0140-6736\(21\)00534-1](https://doi.org/https://doi.org/10.1016/S0140-6736(21)00534-1). [Accessed 5th July 2022].

89. Iqbal N, Gkiouleka A, Milner A, Montag D, Gallo V. Girls' hidden penalty: analysis of gender inequality in child mortality with data from 195 countries. *BMJ Global Health*. 2018;3(5): e001028. <https://doi.org/10.1136/BMJGH-2018-001028>.
90. Brigitte Rohwerder. *Conflict and gender dynamics in Yemen*. 2017 [Accessed 9th August 2022]. [https://assets.publishing.service.gov.uk/media/5ba3772be5274a55e18d2ba0/K4D\\_HDR\\_Conflict\\_and\\_Gender\\_dynamics\\_in\\_Yemen.pdf](https://assets.publishing.service.gov.uk/media/5ba3772be5274a55e18d2ba0/K4D_HDR_Conflict_and_Gender_dynamics_in_Yemen.pdf) [Accessed 9th August 2022].
91. Hassen K. Khat ( Catha Edulis ) Chewing as a Risk Factor of Low Birth Weight among Full Term Newborns : A Systematic Review. *World Family Medicine Journal/Middle East Journal of Family Medicine*. 2015;13(7): 10–14. <https://doi.org/10.5742/MEWFM.2015.92740>.
92. Norris M, Klabbers G, Pembe AB, Hanson C, Baker U, Aung K, et al. A growing disadvantage of being born in an urban area? Analysing urban–rural disparities in neonatal mortality in 21 African countries with a focus on Tanzania. *BMJ Global Health*. 2022;7(1): e007544. <https://doi.org/10.1136/BMJGH-2021-007544>.
93. O'Sullivan BG, Couper I, Kumar P, McGrail MR. *Editorial: Effective Strategies to Develop Rural Health Workforce in Low and Middle-Income Countries (LMICs)*. *Frontiers in Public Health*. 2021. <https://doi.org/10.3389/fpubh.2021.702362>.
94. Cardona M, Millward J, Gemmill A, Yoo KJ, Bishai DM. Estimated impact of the 2020 economic downturn on under-5 mortality for 129 countries. *PLOS ONE*. 2022;17(2): e0263245. <https://doi.org/10.1371/JOURNAL.PONE.0263245>.
95. O'hare B, Chiwaula L, Bar-Zeev N. Income and child mortality in developing countries: a systematic review and meta-analysis. *The Royal Society of Medicine*. 2013;106(10): 408–414. <https://doi.org/10.1177/0141076813489680>.
96. Asantewaa P, Id O, Asumadu S, Id S, Pedersen A. Relationship between mortality and health care expenditure: Sustainable assessment of health care system. *PLoS ONE*. 2021;16(2). <https://doi.org/10.1371/journal.pone.0247413>.
97. Bright T, Felix L, Kuper H, Polack S. A systematic review of strategies to increase access to health services among children in low and middle income countries. *BMC Health Services Research*. 2017;17(1): 1–19. <https://doi.org/https://doi.org/10.1186/s12913-017-2180-9>.
98. Action Against Hunger. *The world must not shift attention away from Yemen as hunger and malnutrition rise*. Reliefweb. <https://reliefweb.int/report/yemen/world-must-not-shift-attention-away-yemen-hunger-and-malnutrition-rise> [Accessed 3rd July 2022].
99. Roos N, Kovats S, Hajat S, Filippi V, Chersich M, Luchters S, et al. Maternal and newborn health risks of climate change: A call for awareness and global action. *Acta Obstetrica et Gynecologica Scandinavica*. 2021;100(4): 566–570. <https://doi.org/10.1111/AOGS.14124>.

100. UNDP. *Yemen | UNDP Climate Change Adaptation*. UNDP. <https://www.adaptation-undp.org/explore/arab-states/yemen> [Accessed 10th July 2022].
101. Oxfam. *Video News Release on impacts of climate change in Yemen*. Reliefweb. <https://reliefweb.int/report/yemen/video-news-release-impacts-climate-change-yemen> [Accessed 10th July 2022].
102. USAID. *Climate Risk Profile: Yemen*. 2016 Nov [Accessed 10th July 2022]. [https://www.climatelinks.org/sites/default/files/asset/document/2016\\_USAID%20GCC%20Office\\_Climate%20Risk%20Profile\\_Yemen.pdf](https://www.climatelinks.org/sites/default/files/asset/document/2016_USAID%20GCC%20Office_Climate%20Risk%20Profile_Yemen.pdf) [Accessed 10th July 2022].
103. Islamic Relief. *Yemen's climate crisis is threatening lives, livelihoods and culture*. Reliefweb. <https://reliefweb.int/report/yemen/yemen-s-climate-crisis-threatening-lives-livelihoods-and-culture> [Accessed 10th July 2022].
104. Tran NT, Greer A, Kini B, Abdi H, Rajeh K, Cortier H, et al. Integrating sexual and reproductive health into health system strengthening in humanitarian settings: a planning workshop toolkit to transition from minimum to comprehensive services in the Democratic Republic of Congo, Bangladesh, and Yemen. *Conflict and Health*. 2020;14(1): 1–12. <https://doi.org/https://doi.org/10.1186/s13031-020-00326-5>.
105. Inter-Agency Working Group on Reproductive Health in Crisis - RH-IAWG. *CHAPTER 3: Minimum Initial Service Package (MISP)*. Inter-Agency Working Group on Reproductive Health in Crisis - RH-IAWG; 2018. <https://iawg.wpengine.com/wp-content/uploads/2019/07/IAFM-3-MISP.pdf> [Accessed 5th August 2022].
106. Cluster H. *Yemen Health Cluster Annual Report - 2020*. 2020 [Accessed 2nd August 2022]. <https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/documents/files/yemen-health-cluster-annual-report-2020-1.pdf> [Accessed 2nd August 2022].
107. UNFPA. UNFPA HUMANITARIAN RESPONSE IN YEMEN 2022. *UNFPA*. 2022; 1–24. [https://www.unfpa.org/sites/default/files/resource-pdf/2022\\_unfpa\\_humanitarian\\_response\\_yemen.pdf](https://www.unfpa.org/sites/default/files/resource-pdf/2022_unfpa_humanitarian_response_yemen.pdf)
108. Singh NS, Smith J, Aryasinghe S, Khosla R, Say L, Blanchet K. Evaluating the effectiveness of sexual and reproductive health services during humanitarian crises: A systematic review. *PLOS ONE*. 2018;13(7): e0199300. <https://doi.org/10.1371/JOURNAL.PONE.0199300>.
109. UNFPA. *Minimum Initial Service Package (MISP) for SRH in Crisis Situations*. p. 1–2. <https://www.unfpa.org/resources/minimum-initial-service-package-misp-srh-crisis-situations> [Accessed 2nd August 2022].
110. Moran Allisyn C, Sangli Gabriel, Dineen Rebecca, Rawlins Barbara, Yaméogo Mathias, Baya Banza. Birth-preparedness for maternal health: findings from Koupéla District, Burkina Faso -



- PubMed. *Journal of health, population, and nutrition*. 2006;24(4): 489–497.  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3001153/pdf/jhpn0024-0489.pdf>
111. McPherson Robert A, Khadka Neena, Moore Judith M, Sharma Meena. Are birth-preparedness programmes effective? Results from a field trial in Siraha district, Nepal - PubMed. *Journal of health, population, and nutrition*. 2006;24(4): 479–488.  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3001152/pdf/jhpn0024-0479.pdf>
  112. Soubeiga D, Gauvin L, Hatem MA, Johri M. Birth Preparedness and Complication Readiness (BPCR) interventions to reduce maternal and neonatal mortality in developing countries: Systematic review and meta-analysis. *BMC Pregnancy and Childbirth*. 2014;14(1): 1–11.  
<https://doi.org/https://doi.org/10.1186/1471-2393-14-129>.
  113. World Bank. *Mortality rate, infant (per 1,000 live births) - Middle East & North Africa*. World Bank. <https://data.worldbank.org/indicator/SP.DYN.IMRT.IN?locations=ZQ> [Accessed 29th July 2022].
  114. UNICEF. *UNICEF Ethiopia Humanitarian Situation Report No. 3, March 2022*. Reliefweb. 2022 May [Accessed 26th July 2022]. <https://www.unicef.org/media/119511/file/Ethiopia-Humanitarian-SitRep-March-2022.pdf> [Accessed 26th July 2022].
  115. Integrated Food Security Phase Classification (IPC). *Ethiopia: Acute Food Insecurity Situation May - June 2021 and Projection for July - September 2021*. IPC Global Platform. 2021 Jun [Accessed 26th July 2022].  
[https://www.ipcinfo.org/fileadmin/user\\_upload/ipcinfo/docs/IPC\\_Ethiopia\\_Acute\\_Food\\_Insecurity\\_2021MaySept\\_Snapshot.pdf](https://www.ipcinfo.org/fileadmin/user_upload/ipcinfo/docs/IPC_Ethiopia_Acute_Food_Insecurity_2021MaySept_Snapshot.pdf) [Accessed 26th July 2022].
  116. Integrated Food Security Phase Classification (IPC). *IPC\_Yemen\_Food\_Security\_Nutrition\_2022March\_Snapshot\_English*. IPC. 2022 May [Accessed 29th July 2022]. <https://www.ipcinfo.org/ipc-country-analysis/details-map/es/c/1155480/?iso3=YEM> [Accessed 29th July 2022].
  117. Zavala E, King SE, Sawadogo-Lewis T, Robertson T. Leveraging water, sanitation and hygiene for nutrition in low- and middle-income countries: A conceptual framework. *Maternal and Child Nutrition*. 2021;17(3): 1–15. <https://doi.org/10.1111/MCN.13202>.
  118. World Bank. *Pregnant women receiving prenatal care (%) - Fragile and conflict affected situations*. World Bank Data. <https://data.worldbank.org/indicator/SH.STA.ANVC.ZS> [Accessed 26th July 2022].
  119. Immunization Agenda (IA 2030) W. *IMPLEMENTING THE IMMUNIZATION AGENDA 2030*. 2021 Jan [Accessed 27th July 2022]. [https://cdn.who.int/media/docs/default-source/immunization/strategy/ia2030/ia2030\\_frameworkforactionv04.pdf?sfvrsn=e5374082\\_1&download=true](https://cdn.who.int/media/docs/default-source/immunization/strategy/ia2030/ia2030_frameworkforactionv04.pdf?sfvrsn=e5374082_1&download=true) [Accessed 27th July 2022].

120. Tamirat KS, Sisay MM. Full immunization coverage and its associated factors among children aged 12-23 months in Ethiopia: further analysis from the 2016 Ethiopia demographic and health survey. *BMC Public Health*. 2019;19(1): 1–7. <https://doi.org/10.1186/s12889-019-7356-2>.
121. Shiferaw BB, Modiba LM. Why do women not use skilled birth attendance service? An explorative qualitative study in north West Ethiopia. *BMC Pregnancy and Childbirth*. 2020;20(1): 1–14. <https://doi.org/https://doi.org/10.1186/s12884-020-03312-0>.
122. Bekele D, Surur F, Nigatu B, Teklu A, Getinet T, Kassa M, et al. Contraceptive prevalence rate and associated factors among reproductive age women in four emerging regions of Ethiopia: a mixed method study. *Contraception and Reproductive Medicine* 2021 6:1. 2021;6(1): 1–13. <https://doi.org/10.1186/S40834-021-00162-9>.
123. World Bank. *Literacy rate, adult total (% of people ages 15 and above) - Fragile and conflict affected situations*. World Bank. <https://data.worldbank.org/indicator/SE.ADT.LITR.ZS?locations=F1> [Accessed 30th July 2022].
124. United Nations Development Programme (UNDP). *Prolonged conflict would make Yemen the poorest country in the world, UNDP study says | United Nations Development Programme*. UNDP. <https://www.undp.org/press-releases/prolonged-conflict-would-make-yemen-poorest-country-world-undp-study-says> [Accessed 30th July 2022].
125. World Bank. *Poverty headcount ratio at \$1.90 a day (2011 PPP) (% of population) - Fragile and conflict affected situations*. World Bank. [https://data.worldbank.org/indicator/SI.POV.DDAY?locations=F1&most\\_recent\\_year\\_desc=true](https://data.worldbank.org/indicator/SI.POV.DDAY?locations=F1&most_recent_year_desc=true) [Accessed 30th July 2022].