

Preventing Maternal Death in Haiti's Central Plateau



Emory Global Health Institute

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Disclaimer: All characters described within the case are fictional, but the background information provided in the case report reflect real-life data and events ongoing in Haiti. Teams are responsible for justifying the accuracy and validity of all data and calculations that they use in their presentations.

Introduction

A truck rolls up on a hot morning to the Cange Regional Hospital, a plume of dust trailing behind it. As usual, many people are waiting to be seen outside the hospital's emergency department. This is the only tertiary hospital within a 50km radius. It is situated in Cange, Haiti, a rural town in Haiti's Central Plateau. It was founded several decades ago by a renowned global health non-governmental organization (NGO) that invested millions of dollars to build one of the largest healthcare systems in Haiti, Alyans Sante Ayiti, which is second only to the Haiti Ministry of Health in terms of its reach and patient volume.

The truck carries Sabrina and her husband, Pierre. Pierre and Sabrina are farmers, and they have only had meager earnings lately due to poor crop growth. Despite financial hardships imposed by traveling such great distances, they have decided to spend a month's wages to pay a neighbor in the village to take Sabrina to the hospital because she has become severely ill. They travel three hours over bumpy roads that were half washed away after the last hurricane battered the countryside.

Sabrina, just 22 years old, practically falls out of the truck when it arrives at the hospital. She is clutching a swollen belly, pale, and sweating. This is her second pregnancy. Her first daughter, Rose, is turning one year old next month. Rose was born at home without complications, but the current pregnancy seems to be physically more challenging for Sabrina. Her feet have become more and more swollen since the first month. In the last four weeks, she has been having daily headaches and chest pain that have kept her from doing most of the housework. In fact, Rose has been staying with her grandmother because Sabrina has been so ill. Last night, Sabrina felt a terrible, stabbing pain in her belly when she was getting ready for bed. Pierre knew then that they needed help. He called Esther, the "matwon" or midwife, who visits the village occasionally to help women in their pregnancies. Within a couple of hours, Esther arrived. Her face was that of calm – she had supervised hundreds of births and was a seasoned healthcare provider trained in traditional Haitian medicine and Western medicine.

As Esther assessed Sabrina, Pierre sat by her bed, hoping for reassuring news. However, he saw Esther's face gradually become grimmer. "What should we do?" Pierre asked. "Go to the hospital. Your wife's condition could be very serious, and I do not think it would be safe for her to deliver at home," Esther replied. They left immediately.

And now, as a group of nurses rushes Sabrina into the hospital, Pierre wonders if everything will be alright. Sabrina had started bleeding in the car, but wasn't that normal? Didn't she bleed right before Rose came?

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Several hours later, Pierre is met in the waiting room by the doctor who attended Sabrina's delivery. The doctor is covered in sweat – the hospital operation rooms do not have temperature control, given the area has spotty electricity access. Pierre learns that Sabrina has died in childbirth. She lost too much blood, the doctor explained. He says something about "eclampsia" and "placental abruption" that Pierre is barely able to process as he tries to make sense of this new reality without Sabrina.

...

Weeks later, Esther, the matwon who visited Sabrina, hears the news of her passing. She is at Cange Regional Hospital today, meeting with members of the Maternal Health Unit to discuss the state of affairs. Here in rural Haiti, too many mothers like Sabrina die in childbirth, so matwons and doctors have formed an alliance. Out of this alliance has emerged more efforts to train matwons in aseptic techniques to minimize infection and allopathic medicine so that they can combine their age-old traditions with new ones. Esther completed advanced training with the Haiti Midwives Initiative five years ago, and yet it feels like she and her colleagues are still falling behind in the battle to save mothers' lives in rural Haiti. As the attendees of the meeting review the long list of mortalities and complicated deliveries that the unit has seen in the last month, everyone around the table knows something has to change.

An Opportunity Arises

The United Nations Population Fund (UNFPA) has just announced a Request for Proposals for a three-year pilot grant of 1,000,000 USD from its Maternal and Newborn Health Thematic Fund. The aim of this funding mechanism is to encourage the development of innovative interventions that will improve maternal health and reduce maternal mortality in low- and middle-income countries. UNFPA hopes that the results of the funded pilot project will inform the global health community's approach to reducing maternal mortality in diverse settings worldwide.

You are a team of epidemiologists, private donors, local community leaders, governmental agency representatives, non-governmental international agencies, public health officials, and health care providers employed by Alyans Sante Ayiti, the health system to which the Cange Regional Hospital belongs. Alyans Sante Ayiti is a well-known, international nonprofit NGO whose mission is to provide healthcare to the underserved communities in Haiti. This UNFPA pilot grant could save many lives in the Central Plateau and is an opportunity that you cannot pass up.

Details of the Request for Proposals

The UNFPA will highly favor proposals that fulfill all of the following criteria:

- A solution that reduces the maternal mortality ratio (MMR), measured as number of maternal deaths/100,000 live births in a year, considering the definition of maternal death to be: a death that occurs during pregnancy or within one year after delivery.
- An innovative intervention that either expands on existing initiatives or creates a new approach targeting maternal health. Consider existing hospital and community programs, to ensure the approach is either completely novel or adds new facets to existing initiatives. An intervention that is tailored to the target audience, both in terms of feasibility and cultural appropriateness.
- A program that engages a multidisciplinary approach including stakeholders from varied fields including (but not limited to): healthcare, social work, and government, recognizing how social determinants of health (SDoH) impact maternal mortality. The proposed program must consider the impact in the 5 domains of SDoH:

- Economic stability
 - Health care access and quality
 - Education access and quality
 - Neighborhood and build environment.
 - Social and community context
- A three-year project that builds local capacity and is community-based. Building local capacity means that the outcomes of the project can continue to provide benefits even after the project has ended. Examples of capacity building interventions include, but are not limited to: workforce training, development of a sustainable new technology that improves care/access to care, and increasing public awareness of signs of high-risk pregnancies. Community-based means that the intervention should leverage resources within the community, and that obtaining community members' buy-in is critical.
 - Year 1: Focuses on engaging community members and gaining buy-in for the intervention and/or its implementation.
 - Years 2 and 3: Focuses on implementation of the intervention and building capacity for sustainability after the pilot period ends.
 - A project that focuses on intervening during ONE specific time period in pregnancy, of the following options, and provide a rationale for selection of that time period: (see pages 10-13 for definitions of these time periods)
 - Preconception
 - Prenatal
 - Intrapartum, or
 - Postpartum

The scope of the UNFPA is strictly limited to maternal health, and while neonatal health is closely tied to maternal health, interventions related to neonatal health will not be considered at this time.

Case Prompt

You will submit your application in the form of a **twelve-minute PowerPoint presentation** to the panel of reviewers that UNFPA has assembled for evaluation, including members of the Haitian government, community members, and health workers. Your presentation must include the following components:

1) Descriptive Title

2) Project Narrative:

- a) Describe the problem you intend to address.
- b) Identify the period of intervention (preconception, prenatal, intrapartum, OR postpartum) and your rationale.
- c) Explain your proposed intervention.
- d) Provide supporting evidence for your specific approach, including references where appropriate. References should be formatted in APA citation style.

3) Timeline: A detailed timeline depicting all components of the proposed project across the 3-year grant period.

4) Budget: Describe your budget for each year. Itemize costs for personnel, supplies, etc.

5) Sustainability Justification: Describe how your project can build capacity in the local community so that your intervention can be sustainable beyond the grant period.

6) Measuring Impact: In addition to MMR, describe what maternal health measures your project targets and what data you will collect to evaluate the impact of your project in alignment with these targets. All measures for which data will be collected should be justified in relation to the project's intended goal. For example, it would be appropriate to design an intervention to expand services offered by matwons and to measure impact by counting the number of matwons served by the training program in order to understand how much capacity building was achieved. *Note: For the purposes of the case competition, you do not need to set aside a budget for impact measurements – assume the funding organization, UNFPA, will do this for you.*

Country Profile

Haiti is a country located in the Caribbean Sea on the island of Hispaniola. It is bordered by the Dominican Republic (Figure 1).

Capital: Port-au-Prince

Population (2022): 12,080,000 [1]

Official Languages: Haitian Creole and French

Religion: Predominantly Roman Catholic

Currency: Gourde

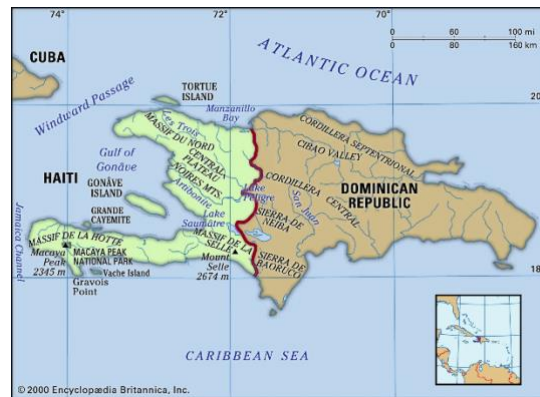


Figure 1. Haiti on the map. Image from Encyclopedia Britannica [1].

Background: Maternal Mortality

Maternal Mortality in Haiti

Haiti currently has the highest maternal mortality rate (MMR) in the Western hemisphere, with most recent data from the United Nations Children's Fund (UNICEF) reporting an MMR of 480 maternal deaths per 100,000 live births [2]. For comparison, the Dominican Republic, which neighbors Haiti, has an MMR of 95 maternal deaths per 100,000, and the MMR in the United States is 19 per 100,000 [3].

According to this same UNICEF dataset, there was a steep upward trend in Haiti's MMR from 2000, peaking in 2010 with 506 maternal deaths per 100,000 live births [2]. Maternal mortality has since declined modestly to about 480 deaths per 100,000 live births in 2017 (Figure 2). The relatively lower MMRs in the early 2000s could be due to the underestimation of maternal deaths due to inadequate data collection. While UNICEF does not record maternal mortality data from recent years, there are reasons to believe that maternal death is on the rise amidst an evolving cholera epidemic [4] [5],

and ongoing economic and political turmoil that have further weakened the already fragile healthcare system [4] [5].

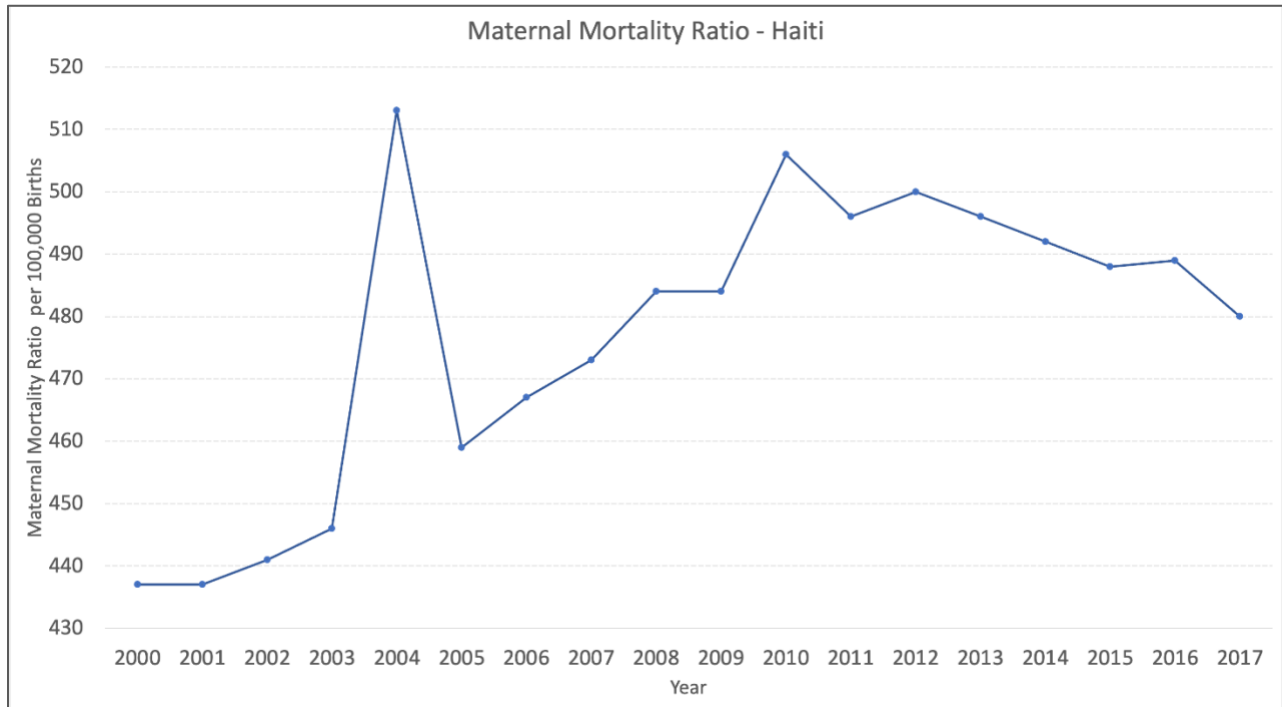


Figure 2. Haitian Maternal Mortality Ratio from 2000-2017. Data from the UNICEF Data Warehouse [2].

Other measures related to maternal health such as the percentage of mothers receiving, prenatal, antenatal, and postnatal care, as well as rates of deliveries attended by skilled birth attendants, rates of caesarean-section (c-section), and percentage of women giving birth under the age of 18 are presented in Figure 2. C-section is surgery performed to deliver the infant via incisions made in the abdomen and into the uterus. C-sections are sometimes indicated during complicated deliveries to prevent significant maternal morbidity and mortality and can only be performed in hospital settings.

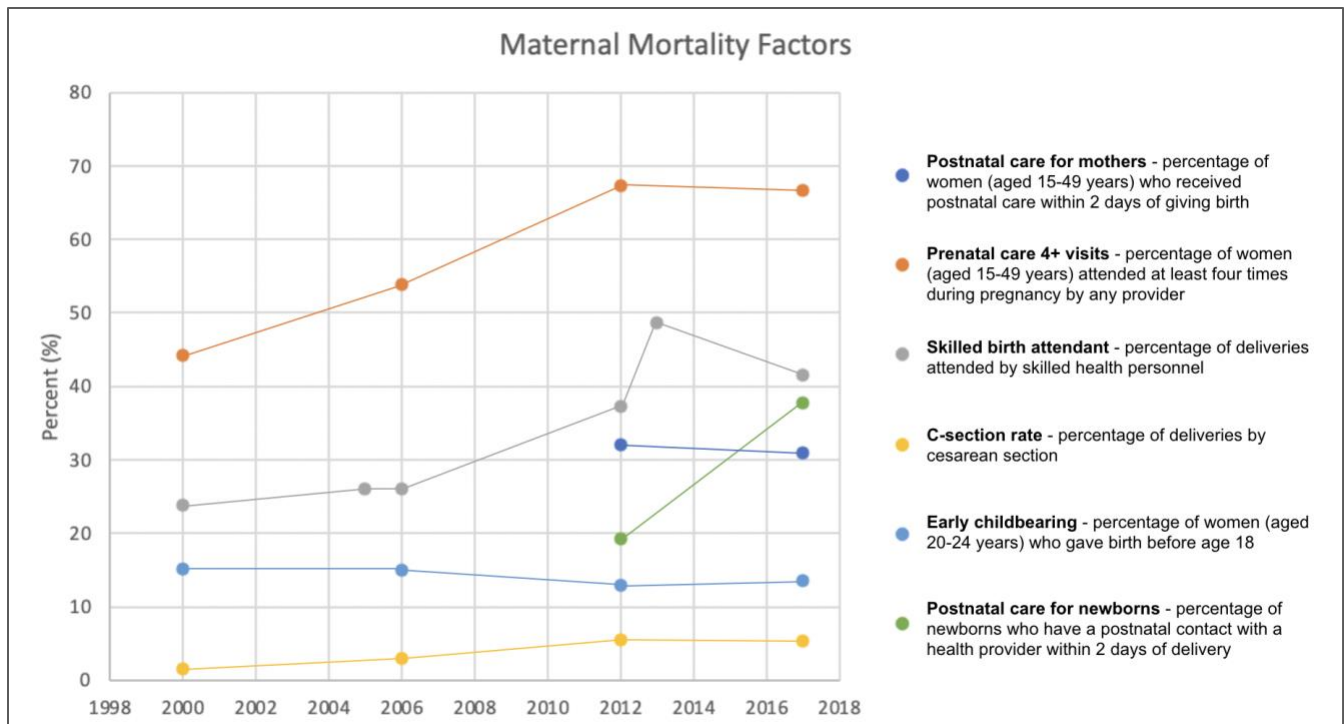


Figure 3. Risk Factors of Haitian Maternal Mortality from 1995-2020. Data from the UNICEF Data Warehouse [2].

Despite these reassuring numbers, women in Haiti continue to die from childbirth at alarming rates. According to the US Agency of International Development (USAID) Haiti report from 2008, the top causes of maternal mortality in Haiti are eclampsia (35.7%), followed by hemorrhage (22%), infection, gynecological disorders, and other causes such as anemia [9]. Eclampsia is an obstetrical emergency in which pregnant women develop seizures from pre-eclampsia. Pre-eclampsia is characterized by high blood pressure during pregnancy leading to organ damage, evidenced by symptoms such as vision change and dysfunction of the lungs, kidney, and/or liver. Risk factors for pre-eclampsia include first birth, multi-gestation pregnancy, advanced maternal age less than 18 or over 40 years, history of chronic high blood pressure, maternal obesity, and history of diabetes. If not treated, pre-eclampsia can develop into eclampsia. Mortality related to (pre)eclampsia can be prevented if blood pressures are monitored and kept within a reasonable range during pregnancy and childbirth. Screening for pre-eclampsia is an essential component of prenatal care [10].

In terms of hemorrhage, or severe bleeding related to delivery, causes can be attributed to the inability of the uterus to contract post-delivery, infections, retained foreign objects in the uterus, or trauma sustained during the delivery (e.g., lacerations to the birth canal) [10]. Interventions cannot be delayed as mothers can bleed out. Appropriate interventions include proper delivery of the placenta following delivery, surgical repair of lacerations sustained during delivery, manual massage of the uterus following delivery, and administration of certain medications to promote uterine contraction to clamp down on bleeding, to name a few. Because of transportation barriers from rural villages to

healthcare facilities, some believe that the rate of death by hemorrhage is an underestimation given that women can easily bleed out during transportation [11]. The third-leading cause of maternal death is infection. Aseptic technique - an approach to limit contamination of pathogens, for example, using sterilized instruments and proper handwashing - and access to antibiotics can help ameliorate the risk of infection [9].

While the leading causes of death have been identified and the solutions to prevent these deaths do exist, there are many economic, social, and logistical barriers that make it very difficult to implement these solutions.

Cultural Beliefs Surrounding Pregnancy and Childbirth

It is important to acknowledge that there is another healthcare network to be found outside of Haiti's hospitals and clinics. In Haiti, expectant mothers often rely on matwons, who serve as Haiti's traditional midwives and facilitate home births. Sixty percent of all Haitian births are attended by matwons [12]. This decision for women to deliver their children at home with a matwon can be accounted for by sociological and cultural factors, including preferring a female attendant at birth, and desire to follow traditional birthing practices, such as using herbs to clean the newborn or mother after birth [8]. One qualitative study surveying a small group of rural and urban women noted that while most women agreed that delivering in a hospital was preferable, especially if there were pregnancy complications, there were also good reasons for them to choose home birth instead. They shared previous negative experiences in hospitals and with medical personnel that prevented them from seeking out hospital births, noting that compared to delivering at home, in the hospitals, they were often left alone and ignored on patient beds. Some also noted that the quality of care received at the hospitals had decreased, possibly due to the hospitals having fewer resources [13]. Comparatively, when delivering at home women can have the support of family members and matwons, who are known to provide physical and emotional support to laboring mothers. The findings from this study are best captured by the voices of the women who shared [13]:

“What we need to change in the hospital is for them to welcome the laboring woman. They should give them a bed because it is possible that the person cannot continue to walk all by herself. They should give the woman a bed during the whole day she is laboring.... At the hospital, it's only when you are about to deliver that you are given a bed.”

“When I could not continue, I told them that I needed to rest, I was told no, that I have to walk and walk again... They will not let your parents in. My mother wanted to get in. I bled a lot. My mother asked the nurse to let her in to help me, but the nurse said no.”

“Well, when the [midwife] arrived, she looked at me and she touched my belly, and she told me that I had contractions and could push. She massaged my belly when the pains came time and again, and I would feel a little better, and then I gave birth.”

The first two quotes shed insight on the negative experiences that women had in the hospital setting. Contrast this with the third quote, which describes the comfort and respect one woman experienced when delivering at home with a matwon.

Using the Three Delays Framework to Understand the Root Causes of Maternal Mortality

A useful framework to understand the contributing factors to maternal mortality is the “Three Delays” model pioneered by Thaddeus and Maine. These three delays are 1) delay in seeking care, 2) delay in reaching care, and 3) delay in receiving adequate, appropriate care (Figure 5) [14].

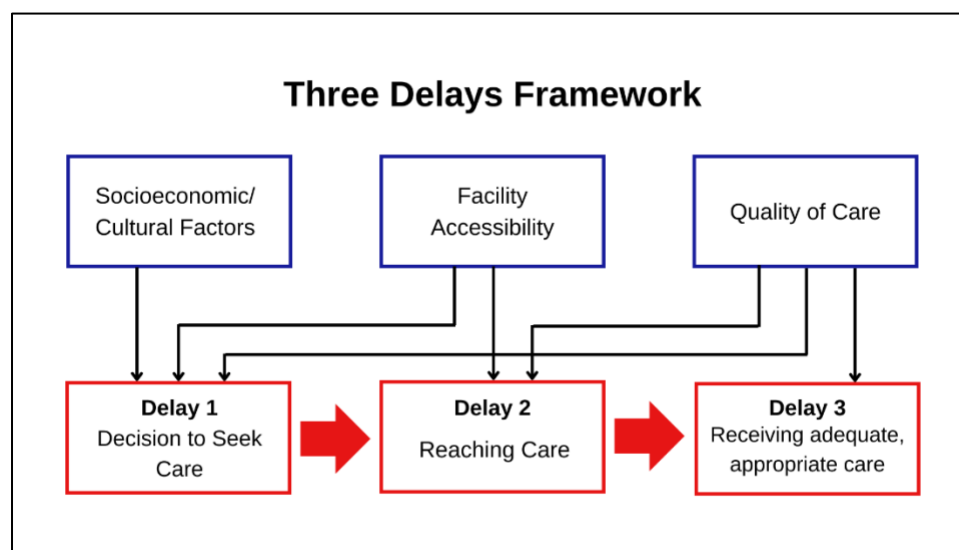


Figure 4. Factors contributing to the three delays. Diagram based on Thaddeus and Maine’s framework [14].

A delay in seeking care is often due to socioeconomic and cultural factors affecting decision-making at a personal level, such as financial burden and medical mistrust. **Delay in reaching care** and a **delay in receiving adequate, appropriate care** are both accounted for by issues with infrastructure. The concentration of healthcare facilities in urban areas coupled with a lack of accessible or adequate transportation infrastructure, such as paved roads, also contributes to **delay in reaching care**. Furthermore, poor healthcare infrastructure and declining numbers of trained healthcare workers are both causing **delays in receiving adequate, appropriate care**. “Brain drain”, a phenomenon that occurs when skilled workers leave for other countries in pursuit of better opportunities, contributes to this [15]. Haiti has long experienced an exodus of doctors who leave the country in search of better residency training and better pay. Natural disasters have also caused delays in training of healthcare professions from midwives to doctors.

Periods to Intervene and Improve Maternal Health

The following section provides definitions for the discrete time periods affecting maternal health. As stated previously in the prompt, teams will create an intervention focusing on one of these periods.

I. Preconception

Women in Haiti enter the period of preconception during the time of their reproductive years, which. For most women in Haiti, the period of menarche (the first occurrence of menstruation) begins at around the age of 15 years old. Preconception follows this period, and it refers to the time of a woman's life before she becomes pregnant---during her reproductive years [16].

For women in Haiti, health and pregnancy outcomes can be influenced by several factors. These include socioeconomic status, urban vs. rural residency, and education level. Poverty may prevent access to safe, adequate care for most women, especially considering that more than 70% of the population live below the poverty line as of 2022. Women living in rural residences face barriers that make it difficult to access primary care, let alone hospital care.

Barriers to primary and hospital care can affect pregnancies for women with chronic conditions. Conditions such as hypertension and diabetes can affect maternal health, especially if gone undiagnosed. More specifically, hypertension has higher rates of prevalence in Haiti compared to nearby countries [17]. The two conditions: diabetes, and hypertension, can both increase risks of cerebral hemorrhage and pre-eclampsia during pregnancy. Left untreated, pre-eclampsia can lead to serious (even fatal) complications for both the woman and the child [18].

Lower educational attainment is associated with a higher likelihood of adolescent pregnancy for women in Haiti [19]. This can further lead to increased risks of complications, including the aforementioned condition, pre-eclampsia [19]. Anecdotes of cultural stigma around sex and the use of contraceptives are common in Haiti [20]. Interventions have aimed to combat this issue through accurate sex education and family planning. One such intervention that was implemented through PIH focused their efforts of family planning in the maternity ward rather than after the woman has left the hospital. They also expanded implant contraceptive eligibility through this initiative. To de-stigmatize the use of contraceptives and family planning, PIH leaned on older women that are oftentimes more influential in the community to facilitate discussions. Many of the women leave the hospitals following education on family planning having a greater sense of control and empowerment [21].

II. Prenatal

The prenatal period describes the time between conception and the start of labor. It lasts about nine months and is divided into three, twelve-week trimesters. Prenatal care usually consists of regular doctor's visits throughout the pregnancy, during which both the mother and the fetus's health can be monitored.

Haitian mothers may face risks due to low frequency of visits. This is an important period to detect early warning signs of birth complications. High blood pressure, gestational diabetes, genital and urinary tract infections, and other conditions should ideally be detected and treated during the prenatal period. If they are not, this could contribute to maternal mortality and delay access to high-risk obstetrical care for women who have multiple risk factors. Additionally, delayed prenatal care increases risk for premature rupture of membranes, which is when the "breaking of water" occurs before labor begins. This risk is increased by 13-27% and can subsequently increase the risk for infection. Lastly, if women are given late prenatal care, they may also be postnatally underweight by 25-33% under the average. [22][23]

Interventions to ease access to prenatal care or encourage expecting mothers to seek it out can be considered. Not surprisingly, women in rural Haiti are significantly less likely to use prenatal care compared to mothers in urban areas. A significant predictor of prenatal care use is the education levels of both the mothers and their partners. Barriers to repeated prenatal visits include longer travel times and greater distances in rural areas, hence why mothers in rural areas make, on average, 3.78 prenatal care visits, whereas mothers in urban areas make, on average, 5.06 visits [23]. These factors must be taken into consideration to decide the management of health care services for mothers in Haiti.

III. Intrapartum

Intrapartum refers to the time period from the onset of labor through the delivery of the placenta. Labor onset is usually marked by the beginning of regular contractions or a gush of fluid leaking from the vagina [24]

There are three stages of labor. In the first stage, the cervix of a mother begins to efface and dilate until it reaches 10cm, a process defined as ripening. There are medications, such as oxytocin or prostaglandins, as well as physical maneuvers that can accelerate this stage. While the cervix is ripening, the mother typically also experiences strong and regular contractions every three to five minutes. The second stage begins promptly after the first stage, from full cervical dilation to the completion of the delivery of the neonate. While the cervix is ripening in the first stage, the fetus is descending pass the pelvic bone. After full cervical dilation, the fetus reaches the vaginal canal and is ready to be expelled with maternal pushes. This stage typically lasts less than three to four hours. The second stage is typically shorter for mothers who have delivered in the past. During both the first and second stages, prolonged labor may be an indication for advanced techniques including changing the positioning of the patient, vacuum suction, and even

c-section. The third stage quickly follows and concludes with the delivery of the placenta. Typically, after the delivery of the neonate, much bleeding occurs. The bleeding in addition to the lengthening of the umbilical cord and a palpable uterine fundus signifies the separation of the placenta. Gentle traction is then applied to the umbilical cord for safe delivery of the placenta [24].

During this intrapartum period, hemorrhage remains at high risk and contributes significantly to maternal mortality. The top reasons for hemorrhage during childbirth includes failed clotting, birth trauma, the failure of the uterus to contract down after delivery and retained placental pieces or foreign objects used to facilitate delivery. Furthermore, an increased risk of infection can also contribute to maternal mortality. Some factors that can lead to increased infection risk include prolonged labor, retained objects in uterus or early membrane rupture. Interventions to increase access to life-saving medications, tools, and techniques, either within the hospital or at home, can be considered to improve outcomes in the intrapartum period [24].

IV. Postpartum

The postpartum period refers to the time after the neonate is delivered and is separated into three distinct phases: acute, subacute, and delayed.

The acute phase is the first six to twelve hours after birth; this phase is characterized by rapid change and the potential for immediate crises. This can include postpartum hemorrhage, uterine inversion, amniotic fluid embolism, and eclampsia [25]. Traumatic medical emergencies resulting from the delivery can impact both the physical and mental health of the woman during the postpartum period and may result in adverse health outcomes for the child as well. During this time, the mother may have significant pain. The mother may also experience hormonal changes leading to mood swings: estrogen and progesterone levels would decrease, and prolactin and oxytocin levels would fluctuate throughout the day while the baby feeds [26].

The subacute postpartum phase lasts two to six weeks after birth, with major changes occurring to the body. From the second week onward, it is common to face the “baby blues” or postpartum depression. The mother may feel sad, anxious, and have difficulty eating and sleeping [26].

The last phase, the delayed postpartum phase, can last up to six months, during which gradual changes can occur. This is the time of restoration of muscle tone and connective tissue to the pre-pregnant state [27].

Worldwide, most maternal deaths occur in the postpartum period [28]. The leading culprits can be presumed to be the same as the overall leading causes of death in Haiti: hemorrhage, eclampsia, sepsis [9]. Interventions to enhance access to postpartum care or promote early detection of postpartum complications can be considered to improve outcomes in this period.

Haiti's Economic Development

Haiti is the poorest country in the Latin America/Caribbean (LAC) region and among the poorest in the world. Over half the population of Haiti lives under the low- and middle-income country (LMIC) poverty line of 3.20 USD/day. The portion of Haitians under the poverty line has been growing over the past few years, increasing in just one year from 51% in 2020 to 52.3% in 2021 [2].

Haiti's Socioeconomic Markers Compared to the Latin America/Caribbean Region

<i>Marker</i>	<i>Haiti</i>	<i>LAC</i>
Global Food Security Index	37.8	60.91
Youth Literacy Rate	82.99 %	97.61 %
Access to Electricity	46.93 %	96.63 %
Mobile Connectivity Index	32.81	60.75
Participation in Labor Force	64.69 %	61.47 %
Employment in Agriculture	29.03 %	15.42 %

Table 1. Socioeconomic Markers in Haiti vs. Latin America/Caribbean Region. Data from the USAID International Data and Economic Analysis database [27].

Haiti's economic development is deeply impacted by a long history of slavery and colonialism. Haitians today are descendants of Africans who were enslaved by the French in the late 17th century. These same ancestors were worked under brutal conditions in agricultural fields to make Haiti the richest French colony by the mid 18th century. In the period between 1791-1804, the enslaved people began to stage revolts against the French colonizers and ultimately won their freedom and declared independence in 1804 [1]. However, this freedom came with a price; in 1825, French warships arrived in Haiti threatening retaliation unless Haiti agreed to pay "reparations" to former slave- and plantation-owners at the price of 150 million francs. Haiti agreed to this ultimatum in order to avoid violence, and because the newly formed country did not have the means to pay this fee, they were encouraged by the French monarchy to take out large loans from French banks. Thus began a cycle of indebtedness that resulted in Haiti paying billions of dollars to France over the centuries, with estimates ranging anywhere from 21-115 billion USD [29]. These startling figures beg the question of what Haiti would look like today had it been able to invest these dollars at home rather than turn them over to their former colonizers.

Challenges throughout the Years

Haiti has weathered several natural disasters, epidemics, and episodes of political unrest over the years (Figure 4). These events have worsened the country's economic condition and infrastructure, further driving home the importance of building capacity through investments in sustainable health infrastructure. Major efforts from the international community to provide aid have taken place, but today, many Haitians view foreign aid warily. The 2010 cholera epidemic, for example, was brought to Haiti by United Nations Peacekeepers and resulted in thousands of deaths. There have also been multiple instances of foreign powers, namely the United States, sending military operations to Haiti to intervene in domestic affairs during periods of political upheaval in the 1990s and early 2000s. Perhaps not surprisingly, these interventions have done little to improve the root problems that hamper Haiti's economic development, and today Haitians largely view them as "humiliations" [30] [31].

In 2021, Haitian President Jovenal Moïse was assassinated by political rivals [30], leaving behind a power vacuum that has been filled by several gangs that now control the capital, Port-au-Prince. While the international community is considering intervention due to ongoing violence in the country, Haitians are taking to the streets to protest foreign aid [31].

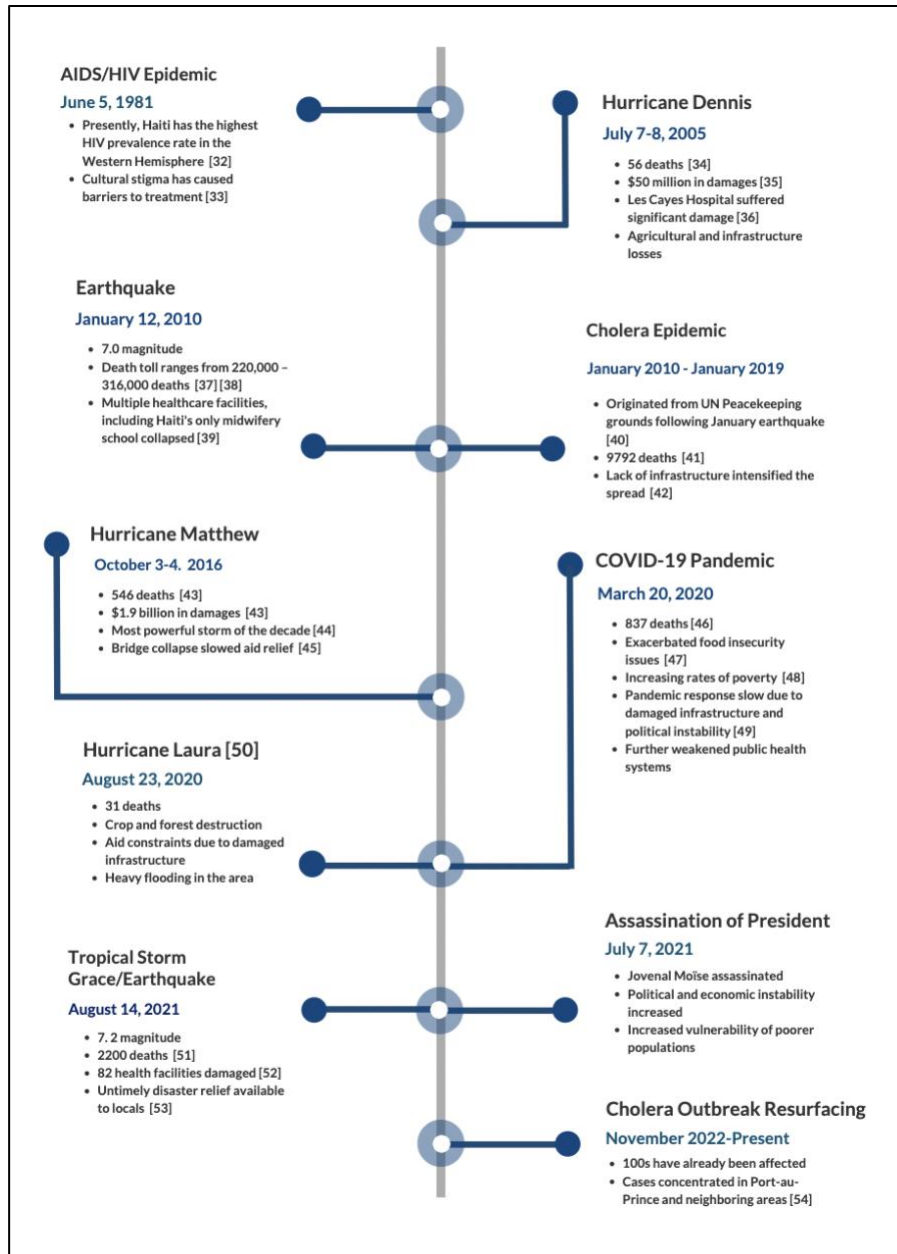


Figure 5. Timeline of natural disasters, health epidemics, and political events in Haiti from 1980s-Present. Select events included to convey the many threats the country has withstood over the decades [32-54].

Infrastructure and Resources in Cange and Haiti

Haiti's population is almost evenly split between rural and urban areas, with 48% living in cities and 52% living in rural areas. However, the resource distribution is much less evenly distributed, with 70% of the rural population considered “chronically poor” compared to only 20% of those in cities [55]. Access to resources also widely differs with 11% in rural areas having access to energy, compared to 63% of those in cities, and 16% having access to sanitation compared to 48% in cities [56]. Other infrastructure such as roads have been affected by the earthquakes and hurricanes and, despite efforts to rebuild these, remain in poor condition [57].

These infrastructure issues affect access to healthcare; lack of energy and proper sanitation impacts provision of hospital resources such as imaging modalities and clean equipment, and the lack of roads impacts the populations' ability to get to hospitals [58]. The healthcare system has been devastated by natural disasters and inadequate funding and competes with the stronghold that traditional medicine practices have in the community. An effort to bridge these practices to “Western” medicine has been made through community health workers (CHWs). CHWs conduct health literacy sessions on maternal and child health, while understanding and addressing local practices and beliefs [59]. One prominent nonprofit group working in Haiti, Partners in Health, employs over 1,000 CHWs and collaborates with the Haiti Ministry of Health to expand CHW training and recruitment [60]. The use of CHWs to accompany clients to clinics, assist in obtaining services, getting medications, and providing health education, has been shown to increase usage of the healthcare system [61]. Nevertheless, CHWs are not able to overcome persistent challenges such as access to transportation, lack of resources at hospitals, and decreased interest among Haitians to seek care at hospitals.

References

1. Encyclopædia Britannica (n.d.). Haiti - Early period. Encyclopædia Britannica. Retrieved December 9, 2022, from <https://www.britannica.com/place/Haiti/Early-period>
2. WHO, UNICEF, UNFPA, World Bank Group, and the United Nations Population Division. (2019). Maternal mortality ratio (modeled estimate, per 100,000 live births) - Haiti. Retrieved December 9, 2022, from <https://data.worldbank.org/indicator/SH.STA.MMRT?locations=HT>
3. Data Warehouse. UNICEF DATA. (2021, March 29). Retrieved December 20, 2022, from https://data.unicef.org/resources/data_explorer/unicef_f/?ag=UNICEF&df=GLOBA L_DATAFLOW&ver=1.0&dq=HTI.MNCH_MMR.&startPeriod=1970&endPeriod=2022
4. United Nations. (2022, October 13). Haiti: 'bearers of hope', saving newborn lives, amid growing turmoil | UN news. United Nations News. Retrieved December 20, 2022, from <https://news.un.org/en/story/2022/10/1129527>
5. Sanon, E. (2022, October 29). Cholera cases, deaths spike in Haiti amid fuel and water crisis. PBS. Retrieved December 20, 2022, from <https://www.pbs.org/newshour/world/cholera-cases-deaths-spike-in-haiti-amid-fuel-and-water-crisis>
6. UNICEF. (2020, February 6). Haiti (HTI) - demographics, Health & Infant Mortality. UNICEF DATA. Retrieved December 9, 2022, from <https://data.unicef.org/country/hti/>
7. Karrar SA, Hong PL. Preeclampsia. [Updated 2022 Jun 9]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK570611/>
8. Prins, A., Kone, A., Nolan, N., & Thatte, N. (2008, September). USAID/Haiti Maternal and Child Health and Family Planning Portfolio Review and Assessment. US AID. Retrieved September 20, 2022, from https://pdf.usaid.gov/pdf_docs/PDACP887.pdf
9. Norwitz, E. R. (n.d.). Eclampsia. UpToDate. Retrieved December 9, 2022, from https://www.uptodate.com/contents/eclampsia?search=eclampsia&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1#H20
10. Wormer, K., Jamil, R., & Bryant, S. (2022, October 25). Acute Postpartum Hemorrhage. National Center for Biotechnology Information. Retrieved December 6, 2022, from <https://pubmed.ncbi.nlm.nih.gov/29763164/>
11. MacDonald T, Jackson S, Charles MC, Periel M, Jean-Baptiste MV, Salomon A, Premilus É. The fourth delay and community-driven solutions to reduce maternal mortality in rural Haiti: a community-based action research study. *BMC Pregnancy*

- Childbirth. 2018 Jun 20;18(1):254. doi: 10.1186/s12884-018-1881-3. PMID: 29925327; PMCID: PMC6011389.
12. Matwon program. The Haiti Plunge. (2021). Retrieved September 20, 2022, from <https://www.thehaitiplunge.org/matwon-program>
 13. Dev, A., Kivland, C., Faustin, M., Turnier, O., Bell, T., & Leger, M. D. (2019, December 27). Perceptions of isolation during facility births in Haiti - a qualitative study - reproductive health. BioMed Central. Retrieved December 9, 2022, from <https://reproductive-health-journal.biomedcentral.com/articles/10.1186/s12978-019-0843-1>
 14. Thaddeus S, Maine D. Too far to walk: maternal mortality in context. *Soc Sci Med.* 1994 Apr;38(8):1091-110. From <https://pubmed.ncbi.nlm.nih.gov/8042057/>
 15. Morse, M. (2013, October 15). Young Haitian Doctors Begin Medical Residencies at University Hospital. Partners In Health. Retrieved December 9, 2022, from <https://www.pih.org/article/young-haitian-doctors-begin-medical-residencies-at-university-hospital>
 16. CDC. (2022, September 20). Preconception Health and health care is important for all. Centers for Disease Control and Prevention. Retrieved December 20, 2022, from <https://www.cdc.gov/preconception/overview.html>
 17. Jean-Charles, R. R. (2014, February). Challenges in hypertension: The Haiti Experience. *Journal of clinical hypertension (Greenwich, Conn.)*. Retrieved December 20, 2022, from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4237537/>
 18. Bertelsmann Stiftung. (n.d.). BTI 2022 Haiti country report. BTI 2022. Retrieved December 20, 2022, from <https://bti-project.org/en/reports/country-report/HTI>
 19. Mohr, R., Carbajal, J., & Sharma, B. B. (2019). Review - ScholarWorks | Walden University Research. Scholarworks. Retrieved December 9, 2022, from <https://scholarworks.waldenu.edu/cgi/viewcontent.cgi?article=1021&context=jswgc>
 20. Rahill, G. J., Joshi, M., Zlotnick, C., Lamour, S., Beech, H., Sutton, A., ... & Paul, P. (2020). "Give me proof": A covert but coercive form of non-partner sexual violence contributing to teen pregnancy in Haiti and opportunities for biopsychosocial intervention. *Journal of Aggression, Maltreatment & Trauma*, 29(7), 835-855.
 21. Jean-Baptiste, M. C., Louis, S., Millien, C., Jeune, E. D., Sainterant, O., & Joseph, J. P. (2018). Postpartum quality improvement strategy for increasing long-acting contraception uptake at a University Hospital in Haiti. *BMJ Open Quality*, 7(4), e000204.
 22. Cianelli, R., Mitchell, E., Albuja, L., Wilkinson, C., Anglade, D., Chery, M., & Peragallo, N. (2014). Maternal - Child Health Needs Assessment in Haiti. *International journal of applied science and technology*, 4(5), 30-38.
 23. Jacobs, L. D., Judd, T. M., & Bhutta, Z. A. (2016). Addressing the Child and Maternal Mortality Crisis in Haiti through a Central Referral Hospital Providing Countrywide Care. *The Permanente journal*, 20(2), 59-70.

24. Alexandre, P. K., Saint-Jean, G., Crandall, L., & Fevrin, E. (2005). Prenatal care utilization in rural areas and urban areas of Haiti. *Revista Panamericana de Salud Pública*, 18(2), 84-92.
25. Hutchison, J. (2022, September 12). Stages of Labor. Retrieved December 20, 2022, from <https://www.ncbi.nlm.nih.gov/books/NBK544290/>
26. Romano, M., Cacciatore, A., Giordano, R., & Rosa, B. L. (2010). Postpartum period: three distinct but continuous phases. *Journal of Prenatal Medicine*, 4(2), 22-25. <https://doi.org/https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3279173/>
27. Rohini Radhakrishnan, E. N. T. (2021, June 4). How long is the postpartum period? recovery timeline. Retrieved December 20, 2022, from https://www.medicinenet.com/how_long_is_the_postpartum_period/article.htm
28. Kassebaum, N. J., Bertozzi-Villa, A., Coggeshall, M. S., Shackelford, K. A., Steiner, C., Heuton, K. R., Gonzalez-Medina, D., Barber, R., Huynh, C., Dicker, D., Templin, T., Wolock, T. M., Ozgoren, A. A., Abd-Allah, F., Abera, S. F., Abubakar, I., Achoki, T., Adelekan, A., Ademi, Z., Adou, A. K., ... Lozano, R. (2014). Global, regional, and national levels and causes of maternal mortality during 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet (London, England)*, 384(9947), 980–1004. [https://doi.org/10.1016/S0140-6736\(14\)60696-6](https://doi.org/10.1016/S0140-6736(14)60696-6)
29. US Agency for International Development. (n.d.). International Data and Economic Analysis. IDEA. Retrieved December 27, 2022, from <https://idea.usaid.gov/>
30. Barbaro, M., Zadié, M., Szytko, R., Reid, W., & Krupke, E. (2022, June 3). The cost of Haiti's freedom. *The New York Times*. Retrieved December 9, 2022, from <https://www.nytimes.com/2022/06/03/podcasts/the-daily/haiti-revolt-france-payments.html>
31. Peralta, E. (2022, November 4). Reporter's notebook: Haiti's at a breaking point but few want foreign intervention. NPR. Retrieved December 20, 2022, from <https://www.npr.org/2022/11/04/1131254613/haiti-sanctions-foreign-intervention-protests-gangs-cholera>
32. “Mac AIDS Fund and Fighting HIV/AIDS in Southern Haiti.” *Health Equity International*, 30 Jan. 2018, <https://healthequityintl.org/news/mac-aids-fund-and-fighting-hiv-aids-southern-haiti>.
33. Dévieux, J.G., Vertovec, J., Jean-Gilles, M. et al (2022). Patterns of sexual and HIV-related stigma among men who have sex with men and women living with HIV in Haiti. *Sci Rep* 12, 7511. <https://doi.org/10.1038/s41598-022-11647-1>
34. International Federation of Red Cross and Red Crescent Societies (2005). Caribbean: hurricanes Dennis & Emily: focus on Haiti and Jamaica. Retrieved February 26, 2023 from <http://www.ifrc.org/docs/appeals/05/05EA01403.pdf>.
35. Wikipedia. Effects of hurricane Dennis in Haiti. Retrieved February 26, 2023 from https://en.wikipedia.org/wiki/Effects_of_Hurricane_Dennis_in_Haiti.

36. International Federation of Red Cross and Red Crescent Societies (2005). Caribbean: hurricane Dennis. Retrieved February 26, 2023, from <https://www.ifrc.org/docs/appeals/rpts05/carhu04.pdf>.
37. United Nations (2022). UN marks anniversary of devastating 2010 Haiti earthquake. UN News. Retrieved February 26, 2023, from <https://news.un.org/en/story/2022/01/1109632>.
38. National Centers for Environmental Information (n.d.). Significant earthquake information. Retrieved February 26, 2023, from <https://www.ngdc.noaa.gov/hazel/view/hazards/earthquake/event-more-info/8732>.
39. United National Population Fund (2010). Midwifery and nursing schools destroyed by Haiti earthquake. UNFPA.org. Retrieved February 26, 2023, from <https://www.unfpa.org/news/midwifery-and-nursing-schools-destroyed-haiti-earthquake>.
40. Mineo, L. (2020). Forcing the UN to do right by Haitian cholera victims. The Harvard Gazette. Retrieved February 26, 2023, from <https://news.harvard.edu/gazette/story/2020/10/a-decade-of-seeking-justice-for-haitian-cholera-victims>.
41. World Health Organization. (2022). Cholera – Haiti. WHO.int. Retrieved February 26, 2023, from <https://www.who.int/emergencies/disease-outbreak-news/item/2022-DON415>.
42. Fisher, M. and Kramer, A. (2012). An Epidemic after an Earthquake: The Cholera Outbreak in Haiti, Part 1. CSIS.org. Retrieved February 26, 2023, from <https://www.csis.org/blogs/smart-global-health/epidemic-after-earthquake-cholera-outbreak-haiti-part-1>.
43. Reid, K. (2018). 2016 Hurricane Matthew: facts, FAQs, and how to help. Worldvision.org. Retrieved February 26, 2023, from <https://www.worldvision.org/disaster-relief-news-stories/2016-hurricane-matthew-facts>.
44. US National Aeronautics and Space Administration. (n.d.). Hurricane Matthew soaks Haiti. Earthobservatory.nasa.gov. Retrieved February 26, 2023 from <https://earthobservatory.nasa.gov/images/88893/hurricane-matthew-soaks-haiti>.
45. Danticat, E. (2016). Hurricane Matthew’s devastating toll in Haiti. The New Yorker. Retrieved February 26, 2023 from <https://www.newyorker.com/news/news-desk/facing-hurricane-matthew>.
46. Reuters. (2022). COVID-19 Tracker: Haiti. Reuters.com. Retrieved February 26, 2023, from <https://www.reuters.com/graphics/world-coronavirus-tracker-and-maps/countries-and-territories/haiti/>.
47. Bardwell, H. (2020). Crisis in Haiti intensifies amid pandemic. Visionofhumanity.org. Retrieved February, 26, 2023 from <https://www.visionofhumanity.org/etr-2020-the-pandemics-toll-on-food-insecurity-and-undernourishment-in-haiti>.
48. Gilliard, J. (2021). The impact of COVID-19 on Poverty in Haiti. Borgenproject.org. Retrieved February 26, 2023 from <https://borgenproject.org/impact-of-covid-19-on-poverty-in-haiti/>.

49. Buechner, M. (2021). COVID-19 vaccines have arrived in Haiti now comes the hard part. Unicefusa.org. Retrieved February 26, 2023 from <https://www.unicefusa.org/stories/covid-19-vaccines-have-arrived-haiti-now-comes-hard-part/38810>.
50. Relief Web. (2020). Haiti: tropical storm Laura - situation report No. 4. Reliefweb.int. Retrieved February 26, 2023 from <https://reliefweb.int/report/haiti/haiti-tropical-storm-laura-situation-report-no-4-28-august-2020-1600>.
51. Center for Disaster Philanthropy. (2021). 2021 Haiti earthquake and tropical storm Grace. Disasterphilanthropy.org. Retrieved February 26, 2023 from <https://disasterphilanthropy.org/disasters/2021-haiti-earthquake-and-tropical-storm-grace/>.
52. Crickz, J. (2021). Securing health in Haiti when the earthquake ruined hospitals. Unicef.org. Retrieved February 26, 2023 from <https://www.unicef.org/lac/en/stories/securing-health-haiti-when-earthquake-ruined-hospitals>.
53. Beaubien, J. and Balaban, S. (2021). A tropical storm is adding to Haiti's misery following a devastating earthquake. Npr.org. Retrieved February 26, 2023 from <https://www.npr.org/2021/08/17/1028542819/earthquake-recovery-efforts-in-haiti-hindered-by-downpours-from-tropical-storm-g>.
54. Severe, K., Alcenat, N., and Rouzier, V. (2022). Correspondence: resurgence of cholera in Haiti amidst humanitarian crises. *New England Journal of Medicine*. 387:2389-2391. DOI: 10.1056/NEJMc2213782.
55. Bunyan, R. (2019). How operation uphold democracy still affects life in Haiti. TIME. Retrieved December 20, 2022, from <https://time.com/5682135/haiti-military-anniversary/>
56. Verner, D. (2016). Making poor Haitians count - poverty in rural and Urban Haiti based on the first household survey for Haiti. SSRN. Retrieved December 20, 2022, from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1149074
57. Living conditions in Haiti's capital improve, but rural communities remain very poor. World Bank. (n.d.). Retrieved December 20, 2022, from <https://www.worldbank.org/en/news/feature/2014/07/11/while-living-conditions-in-port-au-prince-are-improving-haiti-countryside-remains-very-poor#:~:text=The%20gap%20between%20the%20urban,to%20basic%20goods%20and%20services>
58. World Bank Group. (2021). Enhancing Haiti's center and Artibonite Loop Region: All-weather roads for connectivity, logistics, and Resilience. World Bank. Retrieved December 20, 2022, from <https://www.worldbank.org/en/results/2021/05/03/enhancing-haiti-s-center-and-artibonite-loop-region-all-weather-roads-for-connectivity-logistics-and-resilience>

59. Information about countries of the world, United Nations, and world leaders. Encyclopedia of the Nations. (2022). Retrieved December 20, 2022, from <https://www.nationsencyclopedia.com/>
60. Knettel, B., Slifko, S., Inman, A., & Silova, I. (2015). Training Community Health Workers: An Evaluation of effectiveness, sustainable continuity, and cultural humility in an educational program in rural Haiti. Taylor & Francis. Retrieved December 20, 2022, from <https://www.tandfonline.com/doi/abs/10.1080/14635240.2017.1284014?journalCode=rhp>
e20
61. Zanmi Lasante. (2021). Assessing the performance of community health workers in Haiti: key findings from a mixed-methods study. Population Council. Retrieved December 20, 2022, from https://www.popcouncil.org/uploads/pdfs/2021RH_FrontlineHealth_HaitiCHWbrief.pdf