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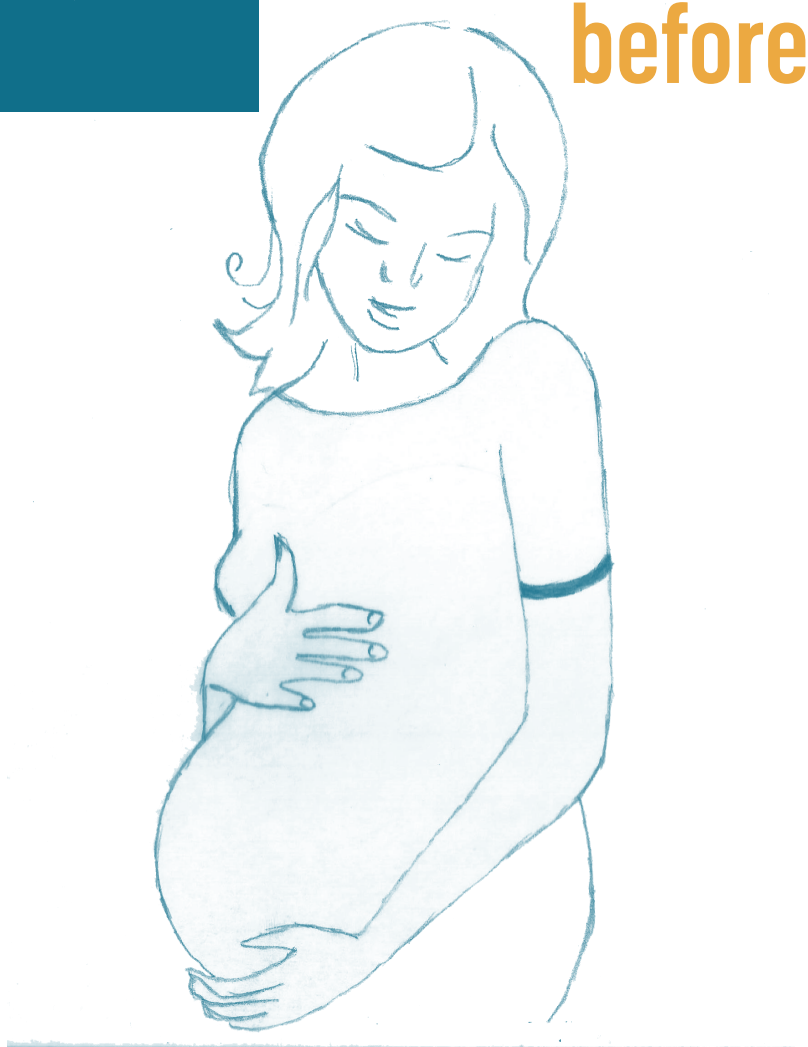
Benefit-Cost Analysis

Costs and benefits of providing skilled care before and during birth in Haiti



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Haïti Priorise
Un plan de développement alternatif

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Costs and benefits of providing skilled care before and during birth in Haiti

Haïti Priorise

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Academic Abstract

Haiti is the poorest country in the American region, with the highest rate of maternal mortality. In 2013 the maternal mortality ratio (deaths per 100,000 live births) was estimated at 380, compared to a regional average of 68 (WHO 2015a). In 2015 the maternal mortality ratio (MMR) was estimated to have reduced further to 359, and the neonatal mortality rate (deaths per 1,000 live births) was estimated at 25.4 (UN estimates). These deaths (the equivalent of 1,122 maternal deaths and 7932 newborn deaths in 2017) are to a large extent preventable.

This analysis estimates costs and benefits of expanding coverage of skilled care before and during birth in Haiti; the implementation of which will result in prevention of maternal and newborn deaths (including stillbirths). We present research conducted as part of the Haiti Priorise project, under the leadership of the Copenhagen Consensus Center.

Main causes of maternal deaths in Haiti are severe bleeding, infections, hypertension during pregnancy (pre-eclampsia and eclampsia) and unsafe abortions. Main causes of newborn deaths include prematurity, asphyxia and sepsis. Our analysis considers a set of highly effective interventions provided during pregnancy through routine antenatal care visits, as well as skilled care at birth and immediate postnatal care. We model the impact of providing essential services through emergency obstretic care, which is essential to manage complications arising at birth. Furthermore, our analysis considers an expanded combination package where safe abortion and post-abortion care is part of the services provided.

We estimate costs and health impact of hypothetical scenarios where coverage would be increased from current levels to reach 80% or 95% in 2018 and with such coverage maintained until 2036. We project reductions in maternal mortality, newborn mortality and stillbirths that would follow from providing the maternity care packages. Deaths averted are translated into economic benefits and compared against the projected costs, in order to derive cost benefit ratios. Each healthy life year gained is valued at 3 times GDP per capita.

Packages for antenatal care and skilled assistance at delivery are estimated to have benefit-cost ratios ranging from 1.6 to 25 depending on the scope of the package, and the discount rate applied. When

applying a 5% discount rate, BCRs range from 4 for antenatal care to 18 for a comprehensive combined package.

In absolute numbers of deaths averted however, access to basic and comprehensive emergency obstretric care is the key to mortality reduction. Our estimates indicate that a comprehensive package for maternal health care – comprising antenatal care, skilled care at birth including management of complications, and access to safe abortion and post abortion care - would avert over 12,000 maternal deaths and close to 74,000 newborn deaths and 25,000 stillbirths during 2018-2036 if made universally available (at 95% coverage). This is equivalent to averting over 650 maternal deaths and close to 3900 newborn deaths and 1300 stillbirths per year. The maternal mortality ratio would be brought down from current 359 to reach 125 per 100,000 (a reduction by 65%) and the newborn mortality rate would drop from 25 to the Sustainable Development Goal (SDG) target level of 12 per 1,000. Such a comprehensive package (at 95% coverage) would have a benefit-cost ratio of 17 when valued at a 5% discount rate.

The projected average additional cost per year 2018-2036 is in the range of US$ 1.95 per capita, or $135 per birth. Out of these US$1.45 (73%) are estimated to be carried by the health sector, and 27% by the education sector.

Policy Abstract

Overview

Haiti is the poorest country in the American region, with the highest rate of maternal mortality. In 2013 the maternal mortality ratio (deaths per 100,000 live births) was estimated at 380, compared to a regional average for the American region of 68 and a global average of 210 (WHO 2015a). In 2015 the maternal mortality ratio (MMR) in Haiti was estimated to have decreased to 359, which is still the equivalent to a woman having a one in 90 risk of dying due to pregnancy or child birth. The neonatal mortality rate (deaths per 1,000 live births) was estimated to be around 25(24.9) in 2013, compared to a regional average of 30.5 (WHO 2015a). Applying these rates to the projected population for 2017 implies the equivalent of 1,122 maternal deaths and 7,932 newborn deaths in 2017 – or 3 mothers, and 22 newborns, dying every day. These deaths are to a large extent preventable and are caused by poor access to and utilization of quality health care.

This analysis estimates costs and benefits of expanding coverage of skilled care before and during birth in Haiti; the implementation of which will result in the prevention of maternal and newborn deaths (including stillbirths).

Rationale for Intervention

Main causes of maternal deaths in Haiti are severe bleeding, infections, hypertension during pregnancy (pre-eclampsia and eclampsia) and unsafe abortions. Main causes of newborn deaths include prematurity, asphyxia and sepsis. Only 37 per cent of women give birth under the care of a skilled birth attendant – such as a doctor, nurse or midwife – who is able to recognize and address complications. Moreover, only 36 per cent of births in Haiti take place in health facilities (EMMUS V).

Our analysis considers a set of highly effective interventions provided during pregnancy through routine antenatal care visits, as well as skilled care at birth and immediate postnatal care. We model the impact of providing essential services through emergency obstretic care, which is essential to manage complications arising at birth. Furthermore, our analysis considers an expanded combination package where safe abortion and post-abortion care is part of the services provided.

Cost estimates include recurrent costs for service provision (health worker time, commodities etc) as well as pre-service education for midwifes.

Results

Our analysis indicates that providing these services will result in benefits roughly 4 to 17 times higher than the costs incurred (estimates when valuing benefits at 3 x GDP and applying a 5% discount rate). In absolute numbers of deaths averted however, access to basic and comprehensive emergency obstretric care is the key to mortality reduction and brings the highest benefit-cost ratio. Our estimates indicate that a comprehensive package for maternal health care – comprising antenatal care, skilled care at birth including management of complications, and access to safe abortion and post abortion care - would avert over 650 maternal deaths and close to 3900 newborn deaths and 1300 stillbirths per year - if made universally available (at 95% coverage). The maternal mortality ratio would be brought down from current 359 to reach 125 per 100,000 (a reduction by 65%) and the newborn mortality rate would drop from 25 to the Sustainable Development Goal (SDG) target level of 12 per 1,000. Such a comprehensive package (at 95% coverage) would have a benefit-cost ratio of 17 when valued at a 5% discount rate.

Summary table. Benefits, Costs, and Benefit-Cost Ratios relative to expanding coverage beyond current coverage (incremental scenario), at a 5% discount rate

	Package (implemented at 95% coverage)	Benefits (NPV)	Costs (NPV)	Benefit Cost Ratio
P1	Antenatal care	25,175,075,349	6,930,109,589	3.6
P2	Skilled assistance for normal delivery	59,454,478,956	7,967,738,024	7.5
P3	Skilled delivery including referral and management of complications	177,297,676,119	10,949,315,886	16.2
P4	Combination maternal and newborn health (P1+P3	194,621,045,556	11,642,588,094	16.7
P5	Extended combination package including safe abortion and post abortion care	197,949,681,155	11,720,105,003	16.9

Benefits are valued at 3x GDP. Costs and benefits are presented in Net Present Value terms for 2018-2036; discounted at 5%. The overall quality of evidence is rated as high.

Implementation challenges

While skilled care at birth increased from 24.2% in 2000 to 37% in 2015, access remains limited and there is scarcity of trained personnel. Midwifes can play a key role for maternal and newborn health outcomes (Renfrew et al, 2014). However current outputs from midwifery training schools would need to increase by a factor of ten to fulfil the estimated need.

Annual additional costs to reach 95% coverage are estimated to range from USD 11 million for antenatal care to USD 24 million for a comprehensive package. Around 7.7% of health expenditure – or an

equivalent of USD4.7 - is estimated to currently be devoted to reproductive health (MSPP of the Republic of Haiti (2015b)). Expanding access to a comprehensive package would require at least USD 1.95 per capita – or USD135 per birth. Out of these USD 1.45 (73%) are estimated to be carried by the health sector, and 27% by the education sector. The health sector share is the equivalent of increasing the budget for reproductive health by 41%.

Advancing towards the SDG targets for maternal and newborn health thus poses real implementation challenges in a country that is struck by environmental and political crises, poverty, and volatile external funding. At the same time, benefits from investing in maternal and reproductive health have high rates of return which go beyond short-term gains; they include longer term sustainable development. Implementation will need to advance progressively, and attempts made to secure sustainable funding for strengthening the health system to expand access to quality maternal health interventions.

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Acronyms

BCC: Behaviour change communication

BCR: Benefit-cost ratio

CBA: Cost-benefit analysis

CBR: Cost-benefit ratio

EmOC: Emergency Obstetric Care Services

BEmOC: Basic Emergency Obstetric Care Services/Centre

CEmOC: Comprehensive Emergency Obstetric Care Services/Centre

EMMUS: Enquête Mortalité, Morbidité et Utilisation des Services

GCEA: General Cost Effectiveness Analysis

GDP: Gross Domestic Product

HLY: Healthy Life Year

HTG: Haitian Gourde

LiST: Lives Saved Tool for child and maternal health

MMR: Maternal Mortality Ratio (maternal deaths per 100,000 live births)

NMR: Neonatal mortality rate (deaths per 1,000 live births)

MSPP: Ministère de la santé publique et de la population

NPV: Net Present Value

ObGyn: Obstetrics and Gynecology

PNS: Politique Nationale de Santé

pPRoM : preterm premature rupture of membranes

SBA: skilled birth attendance

SDG: Sustainable development goal

USD: US dollar

Contents

1. Introduction

This paper presents an analysis to estimate the benefit-cost ratio of expanding coverage of skilled care before and during birth in Haiti, as part of a broader priority setting exercise. We project an increase in antenatal care coverage, skilled assistance at birth, as well as access to safe abortion and post abortion care. We present the estimated costs and benefits in terms of prevented maternal deaths, newborn deaths and stillbirths.

This paper is structured as follows: the Introduction section of the report describes the current situation of maternal health in Haiti. The Theory section explains how the cost-benefit analysis was conducted, including data sources and assumptions for information on costs and health benefits, and how health benefits were valued in economic terms. Outcomes are presented and discussed in the Results section. Finally, a Conclusion section summarises the main findings.

1.1 Development policy in the Haitian context

Haiti is the poorest country in the American region and is also considered a "fragile state" because of the low performance on human development indicators, low scores on governance due to chronic political instability and weak institutions. Moreover, the country has a high risk for emergencies caused by various natural disasters. Environmental, economic and political crises occur frequently.

Economic growth is limited. The country suffers from high currency depreciation, high inflation (14% in 2016) and a high trade deficit (Haiti imports three times more than it exports). Almost a quarter of GDP comes from the Diaspora (US $ 2.1 billion in 2015, source: World Bank). With 50% of the population below 23 years of age, the population is growing faster than the economy. Thus, gross domestic product (GDP) per capita is now lower than that of 20 years ago, and around two-thirds of the current population (11 million) are estimated to live in poverty. The

drought in 2015 and Cyclone Matthew in 2016 have seriously affected the country[1] especially the agricultural sector, which accounts for one-fifth of GDP mainly for the poor. Inequalities are high and increasing with a Gini coefficient of 0.66 in 2012 vs. 0.61 in 2010 (UNDP, 2014).

Despite these challenges, overall population health has improved in recent years. For example, under-five mortality dropped by 50% from 146 per 1,000 births in 1990 to reach 69 in 2015 (WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division (2015)). HIV/AIDS prevalence is now at 1.35% vs 1.86% in 2001 (WHO 2015a), and overall life expectancy has increased from 54 years in 1990 to reach 63 years in 2013 (WHO 2016a). However when compared to other countries in the region, overall mortality levels and morbidity from both communicable and infectious diseases remains high, as do nutritional deficiencies. Haiti's health indicators are at the level of economically comparable (low-income) countries, thus child and maternal mortality rates are four and five higher than the average rates in the Latin America and Caribbean region. The supply of health services remains limited and fragmented, with problems of accessibility and inequalities. The cycle of malnutrition and infectious and parasitic diseases fueled by chronic food insecurity has increased since 2010 with the emergence of cholera.[2]

Current total health expenditure per capita is US$ 61.5 (in 2014 at average exchange rate)[3]. Reports indicate that resources may not be effectively used. One of the challenges is the existence of vertical programs and the multiplicity of projects which poses challenges for the Ministry of Health (MSPP) to lead overall health sector governance processes. The share of public expenditure on health is less than 10% of total health expenditure. For the current fiscal year (2016/2017), the share of the public health budget, which has been continuously decreasing for 20 years, represented less than 5% of the national budget despite a 15% target set in the national health policy (2012). External funding is volatile with large fluctuations over time in response to various health crises (the peak being the post-earthquake 2010 period), resulting in limited sustainability of funding to strengthen the foundations of the health system.

[1] The damage caused by cyclone Matthew has been estimated at 32% of GDP [Gouvernement de la République d'Haïti/Système des nations Unies/Banque interaméricaine de développement/Banque Mondiale (2017). Evaluation des besoins post catastrophe pour le cyclone Matthew - Haïti. Port-au-Prince, Haïti p.100].

[2] Cf. Rapports / Profil statistique Cholera de http://mspp.gouv.ht/newsite/

[3] http://apps.who.int/gho/data/view.main.HEALTHEXPCAPHTI?lang=en

External funds tend to focus on the short term, do not address priority health needs and are not aligned with national priorities.[4] Moreover, the majority of external funds bypass the government, thereby limiting the strengthening of public institutions. Total per capita health spending has been on an upward trend because of a rise in private health expenditure, with direct out of pocket payments generally accounting for more than 50% of health expenditure.[5]

With the post-2015 Sustainable Development Goals (SDGs), countries are taking on a broad development agenda, where the Health Goal (SDG3) plays a key role for sustainable development. SDG3 includes a number of specific targets for maternal and reproductive health, where target 3.1 is to by 2030, reduce the global maternal mortality ratio to less than 70 per 100 000 live births, and by 2030, to end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1000 live births and under-5 mortality to at least as low as 25 per 1000 live births. Moreover, target 3.7 is to ensure universal access to sexual and reproductive healthcare services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes.

Given the limited resources available in low-income countries such as Haiti, decisions need to be made carefully with regards to how to best invest available funding. This document presents the results of a Cost-Benefit analysis (CBA) for providing skilled care before and during birth in Haiti. Benefit-Cost ratios (BCR) indicate the value of benefits obtained for every dollar (or Haitian Gourde) invested; and provide one type of evidence that can be used to inform policy discussions around priority setting. It should however not be the only evidence used, since other criteria such as equity, feasibility, financial sustainability and acceptability will also carry important weight to inform decisions around resource allocation.

[4] MSPP de la République d'Haïti (2012). Politique nationale de santé. MSPP, Port-au-Prince. p.56.

[5] During post-crisis periods, external funding for health care plays an important role by reducing the need for household expenditure.

1.2 Maternal and newborn health in Haiti

In 2015 the maternal mortality ratio in Haiti was estimated at 359, which is the equivalent to a woman having a one in 90 risk of dying due to pregnancy or child birth.[6] The neonatal mortality rate was estimated at 25.4 deaths per 1,000 live births (Table 1). Applying these rates to the projected population for 2017 implies the equivalent of 1,122 maternal deaths and 7,932 newborn deaths in 2017 – or 3 mothers, and 22 newborns, dying every day. These deaths are to a large extent preventable and are caused by poor access to and utilization of quality health care.

According to the most recent Demographic and Health Survey (DHS) - EMMUS V - 37 per cent of women gave birth under the care of a skilled birth attendant – such as a doctor, nurse or midwife – who is able to recognize and address complications. Skilled assistance at birth is one of the indicators for the Sustainable Development Goal on health, for which it is recommended that countries achieve at least 80% coverage (WHO 2015b).

Table 1. Maternal and newborn mortality in Haiti

	Estimates from demographic surveys	UN inter-agency estimates [7,8]
Maternal mortality ratio (deaths per 100,000 live births)	• 457 in the early 1990s [EMMUS II] • 523/100,000 in 1994-1995 [EMMUS III] • 630/100,000 in 2005 [EMMUS IV].	620 in 1990 550 in 1995 460 in 2000 410 in 2005 350 in 2010 359 in 2015
Newborn mortality (deaths per 1,000 live births)	• 45.5 / 1,000 in period 1985-1990 [EMMUS II] • Around 30 to 33 in period betweeen 1997 and 2007 [EMMUS V]. • 31 in 2007-2012 [EMMUS V].	39.2 in 1990 29.9 in 2010 25.4 in 2015

[6] World Bank. World Development Indicators http://databank.worldbank.org/ Estimate for 2015.
[7] WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division (2015). Trends in maternal mortality: 1990 to 2015. http://www.who.int/reproductivehealth/publications/monitoring/maternal-mortality-2015/en/
[8] Estimates developed by the UN Inter-Agency Group for Child Mortality Estimation (median estimate) (http://www.childmortality.org/).

Planning and accountability for improving maternal health requires accurate measures of maternal mortality. Haiti is one of many low-income countries that still lack a comprehensive system for capturing vital events data (civil registration system), which poses a major challenge to accuracy of estimates around maternal mortality ratios. Table 1 summarizes maternal mortality ratio estimates for Haiti between 1990 and 2010. According to the UN estimates, maternal mortality ratio declined from 620 in 1990 to 359 in 2015.

Although the decline was significant, it was not sufficient to reach MDG 5 in 2015, which aimed for a three-quarter decline from 1990 to 2015. Maternal mortality remains at much higher levels than other countries in the region (67 / 100,000 in the Latin American region; see WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division (2015).). While newborn mortality rate is estimated to have decreased by one-third from 39.2 to 25.4 since 1990,[9] newborn deaths between the age of 0-1 months represent 52% of infant mortality and more than one third of deaths of children aged 0-5 years.

The main causes of maternal deaths are severe bleeding, infections, hypertension during pregnancy (pre-eclampsia and eclampsia) and unsafe abortions. Main causes of newborn deaths are prematurity, asphyxia and sepsis/infection (Say L et al (2014); MSPP (2015); FNUAP/ ONUSIDA/OPS-OMS/ UNICEF (2017)). These conditions can be prevented and managed, by providing antenatal care to detect and manage complications, access to family planning and comprehensive care for unplanned births; and quality care to manage complications arising during labour. A continuum of care is required from primary level to referral level.

There are significant inequalities across different demographic groups in Haiti. Rural women give birth to an average of 1.9 children more than those living in urban areas [EMMUS V], and unmet need for family planning remains high. Similar inequalities exist in terms of maternal health outcomes. Neonatal and postnatal mortality rates were estimated at 32 / 1,000 and 30 respectively per 1,000 live births for the poorest quintile of the population compared with 27 / 1,000 and 24 / 1,000 for the richest quintile [EMMUS V].

Prenatal Care

According to EMMUS V (2012), 90% of women that gave birth in the previous five years had

[9] Because of the poor civil registration system for births and deaths in Haiti, we maintain the UN estimate of 359 for MMR and 25.4 for NMR in our analysis.

received antenatal care by a trained health professional for the most recent birth, and 67% had at least four antenatal visits [EMMUS V].

Skilled assistance at birth

According to the latest DHS in 2012, only 37% of women benefited from skilled attendance at delivery by a doctor, nurse or midwife [EMMUS V]. Nevertheless this was a substantial increase in access to skilled attendance at birth from 24.2% in 2000 [EMMUS III] and 26.1% in 2005-2006 [EMMUS IV] (the equivalent share of births delivered in facilities was 23% and 25%). In 2013, only 43% of health facilities offered delivery services and 10% carried out caesarean section [Institut Haïtien de l'Enfance (IHE) et ICF International. 2014.]. Currently 89% of institutional deliveries take place in institutions offering comprehensive obstetric and neonatal emergency care (CEmOC) and 11% in institutions providing basic obstetric and neonatal emergency care (BEmOC) (PAHO 2017).

The large share of deliveries not attended by skilled personnel is the reason for high levels of maternal and newborn mortality. 80% of maternal deaths are due to severe bleeding, infections, hypertension during pregnancy (pre-eclampsia and eclampsia) and unsafe abortions. 97% of non-institutional births are delivered by traditional birth attendants ("matronnes") who play a large role in the communities to which they belong (MSPP Statistics (2014). Statistics 2013 and / or 2014].

Postnatal care

Just over six in ten women (61%) received no postnatal care within the recommended timeframe which is 2 days after birth. Barely one in five newborns (19%) received postnatal care in the first two days after birth, when the risk of neonatal mortality is high (EMMUS V).

Inequalities in service delivery

Access to essential health services before, during and after birth varies within the population. There are significant differences in access to skilled health care providers during childbirth, estimated at 61% for women with at least secondary education vs. 14% for women with no

education; 78% for women in the highest quintile vs. 10% for those in the lowest quintile and 60% for residents of the metropolitan area of Port-au-Prince, 56% for those living in other cities and only 23% for those residing in rural areas. While social determinants drive these inequalities, they are also linked to deficits in the health system (organization, infrastructure, human resources, etc.).

1.3 Policy and Health System

The national health policy (PNS) was defined in 2012 for a forward looking period of twenty-five years 2012-2037 [MSPP de la République d'Haïti (2012a).]. It aims to reduce the morbidity and mortality associated with the main health problems identified, based on an adequate, efficient, accessible and universal health care system. It is operationalized by the 2012-2022 Health Plan (PDS) [MSPP de la République d'Haïti (2012b)]. The health of women and mothers is one of the focal areas of the Health Services and Health Services component of the PDS. For maternal health, the objectives are: (i) to reduce the maternal mortality rate by 50 per cent from the baseline by 2022, to reach 250 per 100,000 live births; and (ii) to ensure the reproductive health of girls and women (p.97).

Standards for reproductive health services and family planning exist as national documents. Reproductive health policy is conducted by the Family Health Directorate (DSF) of the MSPP. The previous National Strategic Plan for Reproductive Health and Family Planning 2013-2016 included specific commitments and targets such as to reduce maternal mortality (to 400 per 100,000 live births) and neonatal mortality (to 20 per 1,000 live births) through the provision of basic obstetric and neonatal services. A new national strategic plan for 2017-2022 is being drafted.

According to the latest published national health accounts (2012/2013), 7.7% of current health expenditure was devoted to reproductive health (MSPP of the Republic of Haiti (2015b)). The 2013-2016 national strategy benefited from externally funded projects including: (i) the Canada-funded PAHO / WHO Manman Ak Timounan Sante (MATS) project, the Free Obstetric

Care (SOG) project; (ii) the USAID Community Health Project; and (iii) UNFPA / UNICEF / UNV Joint Maternity Project (Basic Emergency Neonatal Obstetric Care).

According to the national health policy (PNS 2012) Haiti has an average of 5.9 doctors or nurses and 6.5 health professionals per 10,000 inhabitants and is therefore well below the standard of 45 physicians and nurse/midwifes per 10,000 inhabitants recommended by WHO (WHO 2016b). The deployment of nurse/midwives (infirmières /sage femmes) has been limited and has not corresponded to population needs. Only 217 nurse-midwives were employed at the national level, which corresponds to 12% of estimated needs.[10]

Nurse-midwifery training is conducted at the Faculty of Medicine of the State University of Haiti and is organized over 6.5 years (three years of training as a nurse, one year of social work, then 18 months of specialization and again one year of social work). The school was destroyed during the 2010 earthquake but was rebuilt with the support of Canada and UNFPA. Since 2013 the school has become a national higher education institute for midwifes and conducts a second "direct" midwifery training program (three years of study and one year of social service) and with these two courses about 80 graduates are trained per cycle (78 in 2016; of which 39 nurse-midwives and 39 midwives). There are ongoing discussions with respect to expanding traning institutions in additional provinces to respond more quickly to needs. However, funding remains an issue, and moreover there is a risk that trained health professionals might migrate abroad unless incentives are put in place to ensure retention.

There is inadequate availability of obstetric care (EmOC) services, and those that are available have insufficient equipment and inputs to provide quality care.

1.4 Cost-effective interventions for maternal and newborn care

Maternal and newborn care interventions are generally acknowledged to be cost-effective. A review by Adam T et al in 2005 demonstrated high cost-effectiveness of antenatal care, first level skilled attendance at birth, and emergency obstetric and neonatal care around and after birth.

[10] Assessment by the United Nations agencies (UNFPA, PAHO / WHO, UNICEF and UNAIDS) – unpublished.

Adam et al (2005) also showed that while community-based strategies can be highly cost-effective, they have limited overall impact on mortality and it is only with accessible and good quality clinical services that most maternal and neonatal deaths will be averted, along with appropriate, timely referral to hospitals for more complex care. The Disease Control Priorities Project 3 (Horton S, Levin C, 2017) reaffirmed the cost effectivenesss of maternal health interventions in their summary chapter on Cost-Effectiveness of Interventions for Reproductive, Maternal, Neonatal, and Child Health. They summarise existing studies and report that safe motherhood initiatives with a package combining antenatal and postpartum care with trained birth attendants in various countries fall in the range of US$150 to US$1,000 per DALY averted. The chapter by Stenberg, Axelsson, et al (2017) in the same volume reports benefit-cost ratios for a broad package of child and maternal health including family planning, and estimate these to be around 7 for low-income countries at 3 percent discount rate, with broad variation between country contexts.

Resource needs have been estimated for expanding coverage to these packages in low and middle income countries, and estimates have been further refined over time. In 2005, WHO estimated an incremental cost of $39 bilion was required above current expenditure to strengthen maternal and newborn care, or an additional $1.18 per capita (WHO, 2005b). In 2014, the Global Investment Framework for Women's and Children's Health estimated that an additional US$5 per person per year up to 2035 in 74 high-burden countries could yield up to nine times that value in economic and social benefits, and that this would require an additional investment of US$30 billion per year (Stenberg K et al., 2014).

2. Theory

2.1 Objective

The objective of the analysis presented here is to estimate the cost, benefits, and the relative return on investment from providing skilled care before, during and immediately after birth in Haiti.[11] The theory underpinning this analysis is that the rate of return to investments differs

[11] The analysis presented here shares a common methodology with two other analyses conducted for the Haiti Priorise project: prevention and management of childhood illness, and interventions to reduce the transmission and disease burden of HIV / AIDS.

across different health sector interventions. However, evidence on the value for money of making one investment versus another may not be readily available and thus current investment plans may not follow the most optimal pattern. By making information on the benefit-cost ratio available, decisions around priority setting can be better informed, and decision makers can be informed about the trade-offs of making one investment choice versus another.

2.2 Overall approach and scope of analysis

The overall approach taken is to project health impact and costs associated with scaling up maternal health interventions, specifically those provided through antenatal care and through skilled assistance at delivery, provided by trained professionals. The projected health outcomes are translated into economic benefits and compared against the projected costs, in order to derive cost benefit ratios.

2.2.1 Interventions included

The selection of interventions was determined based on past work which has looked at identifying high-impact evidence-based maternal and child health services (PMNCH, 2011). We limited the interventions to those included in the joint United Nations supported OneHealth Tool – which includes interventions for which there is evidence on effectiveness. Intervention definitions follow WHO guidelines. The intervention list was also discussed in view of the current health situation in Haiti and agreed upon with Ministry of Health.

We model an expansion of interventions provided by midwifes (inclused nurse-midwifes; hereafter we use the denomination “midwifes” to include both), and other health personnel providing skilled maternal health care. We consider several packages of interventions covering antenatal care and skilled care at birth including the newborn.

Antenatal care (ANC) entails a set of visits through which the health worker undertakes a standard set of examinations with the aim to promote preventive care as well as to identifiy risks and manage obstetric complications. Under package **P1 Antenatal care** we include the following interventions with demonstrated effectiveness:

1. Tetanus toxoid immunization
2. Syphilis detection and treatment

3. Ectopic pregnancy case management
4. Hypertensive disorder case management
5. Management of pre-eclampsia (with magnesium sulphate)

Following WHO guidelines, we project antenatal care to be provided during 8 outpatient visits (WHO, 2016).

We consider two packages for skilled care at birth, where the first (P2) entails routine care provided during normal delivery, and the second (P3) also considers management of complications.

Under package **P2 Skilled assistance for normal delivery,** we include the following:

- Labor and delivery management (skilled care at birth/normal delivery)
- Active management of the third stage of labour
- Neonatal resuscitation
- Clean postnatal practices
- Clean cord care (umbilical cord cleansing, with chlorhexidine or other disinfectant)

Package **P3. Skilled delivery including referral and management of complications** includes the same interventions as in P2, and in addition the following interventions which are assumed to be delivered primarily at hospital level:

Maternal complications

- Pre-referral management of labor complications
- Management of eclampsia (with magnesium sulphate)
- Maternal sepsis case management
- Induction of labor (beyond 41 weeks pregnancy)
- Antibiotics for premature rupture of membranes (pPROM)

Newborn care

- Immediate essential newborn care
- Management of newborn sepsis through full supportive care
- Kangaroo mother care

Finally, we consider a combination package: **P4 Combination maternal and newborn health** which includes both comprehensive antenatal care and skilled care at birth (P1, P3); as well as an **Extended combination package (P5**) which considers the full package in P4 with the addition of safe abortion and management of post-abortion care.[12]

2.2.2 Analytical framework and Perspective

Table 2 illustrates the cost and benefit accounting framework used for this analysis. Additional detail on each component covered is provided in the sections below.

[12] This analysis does not consider family planning since such interventions were covered under another analysis carried out for Haiti Priorise.

Table 2. Cost and benefit accounting framework used in analysis

Costs		**Estimation of costs in the analysis**
Non-market valued	• Patient health care seeking cost (transport, time lost in productive activity due to care-seeking) • Volunteer labour	Not included
Market-valued health sector costs	Direct costs related to intervention delivery: • Commodities: e.g., the drugs, vaccines, supplies and lab tests needed for each service. • Service delivery costs (inpatient bed days, outpatient visits) – which include operational costs and health worker time. • Additional health worker cost (includes the value of the extended duration of care and support provided during birth by midwifes for all births, and by obstretric/gynecological specialists in the case of complications • Programme costs (administrative costs for running the programme and ensuring quality of care). • Supply chain costs and commodity waste	Costs are estimated using an inputs based approach (Quantities and Prices)
Market-valued costs in other sectors	• Pre-service education for midwifes	
Benefits		Estimation of benefits in the analysis
Non-market valued benefits	Intrinsic health benefits: • Increased longevity • Increased wellbeing and quality of life • Increased social participation	Instrumental and intrinsic benefits are captured in a combined measure for the value of statistical life, estimated at 3x GDP per capita per DALY
Market-valued benefits	Instrumental health benefits: • Increased employment (reduced absence due to illness and death) • Increased productivity (increased quality of human capital due to greater wellbeing) • Fewer days of work lost by family members caring for those who are ill	
	Savings: • Reduced expenditure on medical care (effect of preventive interventions)	Savings are estimated using an inputs based approach (Quantities and Prices)

The perspective taken for estimation of costs is to only include the direct costs incurred by the health system. We therefore do not include any indirect cost incurred by the households or individuals seeking care, e.g., for transport, lost income, etc. [13]

2.2.3 Time horizon

The analysis is conducted for a time horizon of 20 years, from 2017 to 2036. Costs and benefits are effectively captured for 19 years i.e., from year 2018 onwards, with year 2017 as the comparator (baseline).

2.2.4 Scenarios

Incremental scale-up scenarios

The analysis considers an increase in coverage, and estimates costs and benefits associated with the additional number of services provided. The counterfactual for the incremental analysis is the current level of coverage and the current epidemiology of the country. The costs and health benefits are compared to the current status quo.

Coverage levels

We analyse costs and benefits resulting from providing all interventions and packages at two target coverage levels: 80% and 95%. The reason for this is to assess how benefit-cost ratios may vary across different target levels.[14] In situations where the current coverage of an intervention is already above one of the target coverage levels, the outputs for that coverage level are zero.

2.2.5 Tools

The analysis was carried out using a recently developed tool: *Spectrum – General Cost Effectiveness Analysis (GCEA).* This tool is developed by the World Health Organization in order to support the incorporation of cost-effectiveness analysis into the widely used Spectrum platform of tools for priority setting and decision making.[15] Spectrum consists of several software models that are widely used for health projection modelling, including the Lives Saved Tool (LiST) for child and maternal health. LiST is a model developed by the Institute for International Programs at Johns Hopkins Bloomberg School of Public Health, to support projections of health impact from scaling up health and nutrition interventions on maternal, newborn, and child health. The model been used for over 10 years and is regularly updated to

[13] An analysis of previous research undertaken for the Copenhagen Consensus processes in Bangladesh and Haiti demonstrated a wide variation in the extent to which household costs were incorporated.
[14] Our presentation of results focuses on the 95% coverage scenario scine this approximates universal coverage.
[15] http://www.avenirhealth.org/software-spectrum.php

incorporate the latest evidence from the scientific literature and household survey data (see Walker N et al (2013a), and Walker N et al (2013b)).

2.3 Calculation of costs and benefits

2.3.1 Projecting increases in people reached

Costs and benefits are driven by how many people will receive an intervention. We project changes in coverage levels, which are then converted into numbers of people reached with the different health interventions. Each intervention is associated with specific assumptions around maternal mortality.

Most recent data available on current coverage is used to determine the number of people reached in the current year (2017). In the scale-up scenario, the target coverage is immediately reached in year 2 (2018), and then kept constant throughout the analytical time period. The example below in Table 3 illustrates (years beyond 2023 not shown since coverage remains constant).

Table 3: Scaling up antenatal care to 80% target coverage*

Intervention	2017	2018	2019	2020	2021	2022	2023
Ectopic case management	30	80	80	80	80	80	80
Tetanus toxoid immunization	81	81	81	81	81	81	81
Syphilis detection and treatment in pregnant women	67	80	80	80	80	80	80
Hypertensive disorder case management	3.3	80	80	80	80	80	80
Management of pre-eclampsia (with magnesium sulphate)	3.3	80	80	80	80	80	80

*projections beyond 2023 not shown since coverage remains at constant level

We estimate costs as the difference between the costs incurred in the scale-up scenario, and the cost incurred in the counterfactual scenario. Similarly, health outcomes in the scale-up scenario are compared with those in the counterfactual scenario.

2.3.2 Determining the population in need and baseline coverage

The Spectrum DemProj module includes demographic projections from the UN population medium variant. [16] We used these standardised projections as they are deemed more reliable than the Population projections from the Haitian Institute of Statistics (Institut haïtien de statistique et d'informatique (IHSI)) given that the most recent census in Haiti was carried out in 2003, and the overall weakness of the IHSI projections are widely acknowledged.

[16] UN population projections. *https://esa.un.org/unpd/wpp/Download/Standard/Population/*

Table 4 shows the assumptions used for the target population, population in need, and current (baseline) coverage of each intervention. The population in need reflects current risks and incidence of complications, and therefore determines the share of the target population that requires the intervention. The analysis of packages takes the average current coverage of the interventions included within the package, to derive an estimated starting coverage for the package.

Example of coverage estimation:

In 2018 the estimated number of pregnant women is estimated to be 391,852. Syphilis detection and treatment is part of antenatal care and the screening component is needed for all women. Coverage is currently estimated to be 67%. This would mean reaching 262,541 women. However if the intervention was scaled to 80% or 95% coverage, 313,171 vs 372,260 pregnant women would be reached.

Table 4. Target population, Population in need, and Current coverage

	Target population	Population in need (disease incidence) (%)	Current coverage (%)	Source for current coverage
Safe abortion	Abortions *	100	53.7	Sedgh G, Singh S, Shah IH, et al. (2012) Country-specific estimates are not available. Regional data are being used
Post-abortion case management	Abortions *	0.47	53.7	Assume same coverage as safe abortion
Ectopic case management	Pregnant women	1	30	Assume same value as Management of eclampsia (Magnesium sulphate)
Tetanus toxoid immunization	Pregnant women	100	81	WHO/UNICEF. Immunization surveillance, assessment, and monitoring. "Protected at birth" indicator (http://apps.who.int/immunization_monitoring/globalsummary/timeseries/tswucoveragepab.html). The most recent available data are through 2013.
Syphilis detection and treatment	Pregnant women	100	67	Estimated based on coverage data from mesi.ht/index.aspx.
Hypertensive disorder case management	Pregnant women	0.72	3.3	Coverage data for this indicator are not typically available. As a proxy, it is assumed that 5% of women who attend 4 or more ANC visits (ANC4+) will be appropriately screened and managed.
Management of pre-eclampsia (Magnesium sulphate)	Pregnant women	2.8	3.3	Coverage data for this indicator are not typically available. As a proxy, it is assumed that 5% of women who attend 4 or more ANC visits (ANC4+)

				will be appropriately screened and managed.
Labor and delivery management (skilled care at birth)	Pregnant women	100	37.3	MSPP
Active management of the 3rd stage of labour	Pregnant women	100	30	Assume same value as Management of eclampsia (Magnesium sulphate)
Management of eclampsia (Magnesium sulphate)	Pregnant women	1	30	Estimated as a share of current SBA coverage following Souza et al estimates for low income countries (80.4%, high MMR),
Neonatal resuscitation (institutional)	Births	1	30	Assume same value as Management of eclampsia (Magnesium sulphate)
Kangaroo mother care	Births	14.1	5	Assumption based on expert opinion
Clean practices and immediate essential newborn care (home)	Births	100	37.3	Assumption: same as skilled care at birth (labor and delivery management)
Referral	Births	15**	30	Assume same value as Management of eclampsia (Magnesium sulphate)
Antenatal corticosteroids for preterm labor	Pregnant women	7	30	Assume same value as Management of eclampsia (Magnesium sulphate)
Antibiotics for pPRoM	Pregnant women	8.3	30	Assumption: assume same value as Management of eclampsia (Magnesium sulphate)
Induction of labor (beyond 41 weeks)	Pregnant women	5	30	Assumption: assume same value as Management of eclampsia (Magnesium sulphate)
Maternal sepsis case management	Pregnant women	5.2	23	Estimated as a share (62.6%) of current SBA coverage following Souza et al, Table 6
Newborn sepsis - Full supportive care	Births	1	0	No data
Clean postnatal practices	Births	100	21.85	MSPP [17]
Clean cord care e.g., chlorhexidine	Births	100	37.3	Assumption: same as skilled care at birth (labor and delivery management)

* Abortions are estimated within the FamPlan module of Spectrum.
** 15% of births are assumed to have complications.

2.3.3 Determining at what level of the health system interventions are delivered

The World Health Report 2005 proposed a "close to client" approach for maternal health care with back up services at referral level (WHO, 2005a). While antenatal care can be delivered at lower level facilities, skilled care at birth is assumed to be provided at facilities that are capable of providing Emergency Obstetric Care, should complications arise. This includes Basic Emergency Obstetric Care (BEmOC), as well

[17] Ministere de la sante publique et de la population (MSPP) unite d'etudes et de programmation (UEP) rapport statistique 2015**:** pourcentage % des accouchements ayant bénéficié de consultation postnatale (0-6 jours).

as access to comprehensive Emergency Obstetric Care (CEmOC) referral services, in case the need arises.[18]

Table 5 outlines assumptions for delivery levels. Such assumptions are important because they drive both costs and outcomes within our model. Service delivery costs will differ depending on where services are delivered (see section 3.3.5). Moreover, effectiveness of interventions delivered around birth is expected to differ depending on where the care is provided.

Table 5. Assumptions on delivery level for maternal health interventions

	Outreach	Clinic	Hospital
Antenatal care			
Ectopic case management			100%
Tetanus toxoid immunization	30%	70%	
Syphilis detection and treatment		85%	15%
Hypertensive disorder case management		85%	15%
Management of pre-eclampsia (Magnesium sulphate)		85%	15%
Care at birth and postnatal care			
Labor and delivery management (skilled care at birth)		85%	15%
Active management of the third stage of labour		85%	15%
Management of eclampsia (Magnesium sulphate)			100%
Neonatal resuscitation (institutional)			100%
Kangaroo mother care		20%	80%
Antibiotics for pPRoM			100%
Induction of labor (beyond 41 weeks pregnancy)			100%
Maternal sepsis case management			100%
Newborn sepsis - Full supportive care			100%
Clean postnatal practices		85%	15%
Chlorhexidine		50%	50%

With respect to skilled delivery, the LiST model uses assumptions of coverage changes at five distinct levels, as seen in Table 6. The impact of most childbirth care is linked to the birth delivery level. For example, interventions available at Facility deliveries 3/ CEmOC level are more effective than those available only via Facility deliveries 1/ Essential care (see section 3.3.4). The target set for the scale-up projections is for all births to occur in settings where emergency obstetric care is available as needed, and where 15% of births would access comprehensive emergency obstetric care due to complications.

[18] BEmOC care is defined as access to seven life-saving interventions or 'signal functions' (antibiotics for sepsis, oxytocics, and anticonvulsants; assisted vaginal delivery; manual removal of placenta; neonatal resuscitation and removal of retained products). Facilities that provide two additional signal functions – caesarean delivery and blood transfusion - essential for pregnancies with complications, are categorized CEmOC facilities (WHO, UNFPA, UNICEF and Mailman School of Public Health (2009)).

Table 6. Assumptions within model on distribution of births at different levels of emergency obstretric care

Level of delivery	Assumption on quality of care	Current distribution (%)	Target distribution for scale-up (%)	Comment
Home deliveries	Unassisted delivery	62.7	0	
Home deliveries 2	Assisted delivery at home	0	0	
Facility deliveries 1	Essential care	3	0	
Facility deliveries 2	Basic Emergency Obstetric Care (BEmOC)*	11.9	85	Centre avec lit (30%) OR hospital (55%)
Facility deliveries 3	Comprehensive Emergency Obstetric Care (CEmOC)**	22.4	15	Hospital (15%)

* Equivalent to birth in a facility with beds, or a Hôpital communautaire de référence - with a midwife or specialist nurse; ** Hôpital communautaire de référence with midwife and with Gynéco-Obstetrician if needed.

3.3.4 Estimating health impact

Health impact projections are derived from the Lives Saved Tool, or "LiST" (Winfrey W et al, 2011). The effectiveness data used in LiST have been documented in detail elsewhere (Walker N et al, 2013a). Effectiveness data are organized into impact matrices for each cause of death, and reflect the anticipated effect of an intervention's coverage increase on a given cause of death. Reductions in cause-specific mortality are estimated by applying intervention effectivenesses and affected fractions to intervention coverage changes. Impacts of interventions are calculated separately for nine causes of maternal death. Some of these data are summarized below in Table 7 for the labor and delivery management intervention. The example serves to show that impact of providing an intervention at BEmOC and CEmOC level is estimated to be higher than at other levels (for more details on projected effectiveness see Walker N et al, 2013a).

The reductions in maternal mortality are translated into total maternal deaths and then to maternal deaths averted compared to a constant coverage scenario, whilst linking to total population and total number of live births calculated in the Demographic projection module of Spectrum (DemProj).

Table 7. Impact matrix showing effectiveness of Labor and delivery management intervention on five causes of maternal mortality (source: LiST)

Cause of death	Unassisted delivery	Assisted delivery at home	Essential care	BEmOC	CEmOC	All deliveries
	Effectiveness					Affected fraction
Antepartum hemorrhage	0	0	0	0.2	0.8	1
Intrapartum hemorrhage	0	0	0	0.2	0.8	1
Postpartum hemorrhage	0	0	0	0.35	0.65	1
Hypertensive disorders	0	0	0	0	0.68	1
Other direct causes	0	0	0	0.38	0.93	0.41

Note: Labor and delivery management intervention does not have a direct modelled impact on 4 causes of death: sepsis, abortion, embolism, and indirect causes. Other interventions within our analysis impact on those causes.

Spectrum-GCEA converts health outcomes - such as maternal deaths, newborn deaths and stillbirths averted - into healthy life years (HLYs). Deaths averted are calculated as the difference between the projected number of deaths occurring in the current coverage scenario and in the scaleup scenarios. Deaths averted are then converted to healthy life years gained based on the estimated age at time of death, average life expectancy for that age bracket, and the health state valuation, or disability weight for that age group.[19] In this current analysis we only consider impact on life expectancy; and estimates exclude morbidity because of lack of data on disability. Each death averted is added to the demographic (population) projection which has a "background disability weight" as individuals are exposed to future health risks.

[19] Spectrum-GCEA includes a formula that calculates HLYs as a function of the Difference in deaths * average life expectancy * (1-health state valuation). This is repeated for each age bracket – e.g., 0-4 years, maternal deaths, and stillbirths. For the analysis presented here however, we applied the standard assumptions of the Copenhagen Consensus methodological approach in terms of valuing years of years of life lost (YLL).

3.3.5 Estimating costs

We estimate six types of costs associated with each package:

- Commodities: e.g., the drugs, vaccines, supplies and lab tests needed for each service.
- Supply chain costs and commodity waste: these costs are included as a percentage (%) mark-up on the commodity cost.
- Service delivery costs (inpatient bed days, outpatient visits) – which include operational costs and health worker time.
- Additional health workforce cost (includes the value of the extended duration of care and support provided during birth by midwifes for all births, and by obstretric/gynecological specialists in the case of complications
- Pre-service education for midwifes
- Programme costs: these include administrative costs for running the programme, as well as training and supervision.

Commodities

Assumptions for the number of drugs and supplies required per service are provided through the OneHealth Tool cost assumptions, which are fully integrated into the Spectrum-GCEA. These contain default regimens that are based on standard WHO protocols and expert opinion. The intervention regimens include: 1) required drugs and supplies, and 2) number/length of outpatient and inpatient visits. While default regimens are embedded in the Tool, each input can be modified to represent a given country's context. Table 8 indicates the average commodity cost per intervention. More details can be found in Annex 1 or through consulting the OneHealth Tool cost assumptions document. [20]

[20] OneHealth Tool Intervention Assumptions Document
http://avenirhealth.org/Download/Spectrum/Manuals/Treatment%20Assumptions%202016%201%2010.pdf

Table 8. Average commodity cost and average number of outpatient visits and inpatient days per intervention as used in the analysis

Intervention	Commodity cost (US$)	Number of outpatient visits	Number of inpatient days
Safe abortion	1.3	1.5	
Post-abortion case management	15.6		2.0
Ectopic case management	26.0		3.0
Tetanus toxoid (pregnant women)	0.2	2	
Syphilis detection and treatment (pregnant women)	0.6	0 (part of ANC)	
Basic ANC (2 extra visits)	0.0	2	
Hypertensive disorder case management	0.2	5	
Management of pre-eclampsia (Magnesium sulphate)	8.5		7
Labor and delivery management	2.3	1	
Active management of the 3rd stage of labour	0.2		
Pre-referal management of labor complications	30.0		
Management of eclampsia (Magnesium sulphate)	8.5		7
Neonatal resuscitation (institutional)	0.4		1
Kangaroo mother care	0.0		
Antenatal corticosteroids for preterm labor	3.4		2
Antibiotics for pPRoM	0.9		2
Induction of labor (beyond 41 weeks)	0.0		
Maternal sepsis case management	41.2		5
Newborn sepsis - Full supportive care	2.0		10
Clean postnatal practices	0.2	4	
Chlorhexidine	0.4		

Markup rates for supply chain costs and commodity waste

An increase in the number of people reached with the interventions will also incur a cost in terms of transporting greater amounts of commodities through the health system. We apply a mark-up rate to the value of commodity costs in order to approximate resource requirements for expanding the supply chain. A recent review by Sarley et al. (2010) reports estimates undertaken by various USAID | DELIVER PROJECT studies in different countries. Estimates range from 1 to 44% for different commodities and country settings. Sarley et al. classify 49 countries into groups, with Haiti belonging to a group for which the generic model indicates that the mark-up rate is 30%.[21] We therefore apply a 30% rate.

Moreover, with respect to medicines that are stored but not used before their expiry date, data is lacking but we applied an overall assumption of 5% waste to supplies and commodities.

[21] Sarley D, Allain L, Akkihal A. Estimating the global in-country supply chain costs of meeting the MDGs by 2015. Arlington, Va, USAID/DELIVER Project, 2009. Available at: http://pdf.usaid.gov/pdf_docs/PNADP080.pdf. See Table 5.

Health Service Delivery costs

Health Service Delivery costs refer to shared costs such as health worker salaries, the running cost of the facility and equipment, and utilities such as water and electricity. As mentioned above, assumptions for the average number of outpatient visits and inpatient days required per service are based on standard WHO protocols and expert opinion. Our analysis of maternal health interventions considers both outpatient and inpatient care models, which differ by the level of care. We used the WHO-CHOICE modelled estimates for Haiti as the starting point (Table 9). In order to validate the WHO-CHOICE estimates we examined existing studies carried out in Haiti on service delivery costs. For more details see Annex 2. A comparison of WHO-CHOICE estimates with the locally derived estimates suggests that they fall within the same ball park.

We used an assumption that 50% of services will be delivered through public sector facilities and 50% through privately managed facilities, and used the average of the WHO-CHOICE cost estimates.[22]

Table 9. Estimated cost per outpatient visit used in the study (US$ 2014)

Generic name of delivery level	Community	Outreach	First level clinic/ Health Centre	Hospital
Cost per outpatient visit (US$)/ public sector assumption	1.39	1.39	1.72	1.95
Cost per outpatient visit (US$$)/ private sector assumption	1.96	1.96	2.43	2.75
Cost per outpatient visit (US$): average public/private	1.67	1.67	2.07	2.35
Cost per inpatient day (US$$)/ public sector assumption			5.20	5.90
Cost per inpatient day (US$$)/ private sector assumption			6.70	7.60
Cost per inpatient day (US$)/ average public/private			5.95	6.75

Notes to Table 9. Costs for outreach are derived from the category "health centre without beds". Costs for first level clinic/health centre are derived from the category ""health centre with beds". Costs for Hospital based care are derived from the category of primary level hospital.

Additional health workforce costs

According to assumptions used by WHO in other studies, a midwife would on average deliver 175 births per year (WHO 2005). If 95% coverage was attained, this would require an average 131,563 births to be

[22] Current health system data indicates that 47% of health facilities are private, 37% are public, and 16% ae mixed [Source : MSPP (2015). Liste des institutions sanitaires du pays. Port-au-Prince, Haïti. p.105].

attended per year, the equivalent of 752 additional midwifes (see Results section below). Given that the WHO-CHOICE estimates represent average inpatient days and do not account for the duration/intensity of care provided during birth, we added the cost of midwife salaries for skilled attendance at birth (estimated as current salary for nurse/midwife $4,600 divided by 175). This cost was added to packages P2, P3, P4 and P5. Moreover, since around 15% of births are estimated to have complications and require specialized care, we added the equivalent salary component for an obstretrician/gynecologist direct inputs for 2 hours per complicated birth (salary estimated at $6,200; direct cost per birth for ob/gyn time is estimated at $36 per birth).[23] This cost was added to packages P3, P4 and P5.

Pre-service education for midwifes

Given the health worker shortage in Haiti, implementation of the packages requires investments in training midwifes with the necessary skills to provide the interventions. We used a simplified approach whereby we multiplied the gap in terms of number of midwifes required by year (as described in the section above) by an estimated cost of graduation.[24] This cost was added to all packages.

Programme costs

Programme costs refer to costs that are incurred at an administrative level that is outside the point of delivery, and reflect a set of activities that are aimed at improving the quality of delivery or encouraging the uptake of services. These include activities such as training, supervision, and general programme management. The WHO-CHOICE project provides a set of default assumptions around the resources needed for an efficiently run programme implementing 10 interventions at full coverage. Using the WHO-CHOICE assumptions and price estimates for Haiti results in an average annual programme cost of USD (2014) 5.37 million (Table 10).

[23] Source for salary estimates: MSPP. Ob/Gyn specialists are assumed to work 220 days per year and spend 20% in direct contact with patients providing care.
[24] The cost to the system to train and graduate one midwife is estimated at USD 6,109, based on a WHO projection model for health workforce production costs.

Table 10. Annual estimated programme cost to run an efficient programme implementing 10 interventions at full coverage (USD 2014)

Category	Estimated annual cost, thousands (USD 2014)	Scaled to number of interventions (scope)	Scaled to coverage target	Rationale for scale
Human Resources for planning and administration	1,455	Yes	No	This category refers to overall management of the programme; production of norms and standards etc thus is not linked to coverage
In-service training	489	No	Yes	Training costs increase with coverage
Supervision	2,035	No	Yes	Supervision costs increase with coverage
Monitoring and Evaluation	877	No	No	Monitoring and evaluation is assumed to be carried out under the overall health system thus no additional specific effort by maternity care programme
Transport	346	Yes	Yes	Transport costs increase with coverage and with scope of programme
Communication, Media & Outreach	25	No	Yes	Communication costs increase with coverage
General Programme Management	140	No	No	This category refers to overall management of the programme; production of norms and standards etc thus is not linked to coverage nor to the scope
SUM	**5,367**			

Source: WHO-CHOICE 2017 (www.who.int/choice)

To validate these estimates, we examined existing documents that project programme costs. For example the Immunization strategy costing for 2016-2020 includes a category of “Gestion du programme” which amounts to USD 5.64 million, which is close to the WHO-CHOICE default estimates. For comparisons with other available reports see Table 11. The comparisons indicate that estimates of programme costs range widely. The reason for this may include the scope of work, the anticipated coverage levels to be attained in the years to come, the assumptions on effectiveness and quality of the programme, and sometimes budget projections being carried out to match the likely available resources (as opposed to aspirational estimates).

Table 11. Comparing WHO-CHOICE estimates with available estimates for programme costs (USD million)

WHO-CHOICE Defaults	Immunization costing[25] category of "Gestion du programme" (year 2020)	HIV/AIDS REDES (average of 2014-2015)	HIV/AIDS CCM under category of "Module 12. Gestion du programme"	SRH costing[26]
USD 2014	USD 2015	USD 2014/2015	Average years 2 and 3[27]	Average 2014-2016
5.37	5.65	24.97	2.13	0.91

In view of the above comparison, and the challenges entailed with comparing the different estimates for programme costs and what they refer to, we apply the standard WHO-CHOICE programme costs for this analysis, with one adjustment made: the price of motorcycles (within transport costs) was adjusted from $1,827 to $5,000 (based on prices used for the cost projections of the 2016-2020 Immunization strategy).

The programme costs are incorporated into our analysis as follows:

- For each single intervention or package, a corresponding programme cost is estimated. This estimate takes into account adjustments based on the number of interventions in the package, and the target coverage level, as shown in table 10. For example:
  - The assumption is that a programme running at full capacity can support the implementation of 10 interventions at a 100% coverage rate. If running with fewer than 10 interventions, certain costs such as those related to human resources and vehicles are reduced.
  - The assumption is that many costs remain constant regardless of the coverage level of interventions delivered by the programme and are only influenced by the number of interventions delivered. They are treated as a fixed cost. However other components of programme costs are scaled to coverage, such as in-service training and supervision visits (i.e. achieving lower coverage targets require fewer health workers to be trained, and less supervision efforts).
- For an incremental scenario analysis, the programme cost is relative to current coverage. Therefore, only those components that are scaled with coverage are included in the programme costs. Annex 3 provides an example.

[25] MSPP/OPS-OMS (2016). Calcul des coûts du plan pluriannuel complet en faveur de la vaccination 2016-2020. Port-au-Prince, Haïti. Fichiel Excel

[26] Costing du Plan Stratégique Santé de la Reproduction Et Planification Familiale 2013-2016. Costs extracted for IEC, Training, Supervision and M&E

[27] Estimates include HR, but does not include costs for Training, which are included under other modules.

3.3.6 Converting health impact into economic benefits and deriving Benefit-Cost Ratios

Valuing health impact

Health impact is estimated in terms of healthy life years gained. This is effectively the same as a DALY, but where DALYs as measured by Global Burden of Disease studies are properly speaking a loss measure and Healthy Life Years measured in cost-effectiveness analysis are a gain measure. To value benefits in monetary terms, the Healthy Life Years gained by year are multiplied by the year-specific estimated GDP per capita. There are numerous reviews available that discuss the valuation of health gains using so-called values of statistical life (VSL). Jamison et al (2012) noted that existing estimates for counties generate a range of VSL valuations that range between 2 to 4 times GDP per capita. The VSL estimations include both the intrinsic valuation of a healthy life (health and life having a value in its own right) as well as the economic contribution to society, including higher labor productivity. The methodology used here is the standard approach adopted by the Copenhagen Consensus analyses which present HLYs valued at 3 times GDP per capita (we also present results using 1 and 8 times GDP per capita in Annex 4).

In addition to attributing a dollar ($) value to the intrinsic value of health, healthier populations also bring additional benefits, including higher labor productivity and reduced spending on treatment. For the purpose of this analysis we assume that labor productivity gains are captured within the 3 times GDP per capita estimate.

Calculating Benefit-cost ratios

Costs are summed for the entire period of analysis and converted from US$ 2014 to HTG 2016 using price deflator data from IMF World Economic outlook April 2016, in order to be consistent with the valuation of health benefits in HTG 2016.

Estimates of costs and benefits were discounted at 3, 5 and 12% discount rate. Benefit-cost ratios (BCRs) were calculated by dividing the total benefits with the total intervention costs. This ratio estimates the return on investment, i.e., the economic benefits that would be realized for each dollar invested.

3. Results and Discussion

3.1 Direct benefits

Table 12 indicates the current number of people reached with a selected set of tracer interventions for the different packages, as well as the additional number of services that would be provided if expanding towards 95% coverage. The greatest increase in service reach would be for skilled attendance at birth, where on average an additional 131,000 women would give birth in facilities with skilled assistance, every year. Expanding access to care will lead to a reduction in maternal and newborn deaths (table 13). A comprehensive antenatal care package (P1) is estimated to avert over 3,000 maternal deaths if scaled to 95% coverage, on average 163 deaths per year. Skilled assistance for normal deliveries (P2) would avert almost 1,000 maternal deaths, or 52 deaths per year on average. The largest impact however would be achieved by making emergency obstretric care widely available to manage complications: this would avert close to 10,000 maternal deaths or 505 deaths per year (P3). A comprehensive package when expanded to include safe abortion and post abortion care (P5) would avert over 12,000 maternal deaths if made universally available (95%), and bring the maternal mortality ratio down from current 359 to reach 125 per 100,000 (a reduction by 65%). With respect to newborn care, again, providing skilled delivery through BEmOC/CEmOC including referral and management of complications is the key to mortality reduction, with packages 3, 4 and 5 estimated to avert around 60,000 newborn deaths and successfully reduce the newborn mortality rate to 12 per 1,000, if scaled to 95% coverage. All packages would also result in significant reduction in stillbirths: up to 25,000 stillbirths would be averted with packages P4 and P5 – equivalent to 1300 stillbirths averted per year.

Table 12. Number of additional services and projected health outcomes with an increase in coverage to 95% target coverage, compared with a constant coverage scenario, 2018-2036

Package	Tracer intervention	Number of people reached in baseline year 2017 (*)	Average additional number of people reached by year, 2018-2036 (**)	Projected need in 2030
P1 Antenatal care	Tetanus toxoid immunization	312,887	92,186	415,775
P2 Skilled assistance for normal delivery	Labor and delivery management	98,236	174,403	278,997
P3 Skilled delivery including referral and management of complications	Management of eclampsia (Magnesium sulphate)	790	1,936	2,790
P4 Combination maternal and newborn health	(as above)			
P5 Extended combination package	Safe abortion	42,477	5,655	49,902

(*) Modelled estimates based on parameters as outlined in section 2.3.2; (**) modelled estimates for a 95% coverage scenario

Table 13. Deaths averted through the provision of different maternal health packages, total 2018-2036 (modelled estimates)

Package	Target coverage level (%)	Maternal deaths averted (2018-2036)	Maternal deaths averted (annual average)	MMR achieved	Newborn deaths averted (2018-2036)	Newborn deaths averted (annual average)	NMR achieved	Stillbirths averted (2018-2036)
P1 Antenatal care	80	2,694	142	310	802	42	25	7,763
	95	3,095	163	302	1,726	91	25	9,360
P2 Skilled assistance for normal delivery	80	704	37	347	22,248	1171	21	2,898
	95	979	52	342	28,239	1486	20	3,917
P3 Skilled delivery including referral and management of complications	80	7,821	412	214	60,728	3196	14	12,493
	95	9,612	506	180	73,277	3857	12	16,321
P4 Combination maternal and newborn health	80	8,934	470	193	60,897	3205	14	19,585
	95	10,522	554	163	73,751	3882	12	24,631
P5 Extended combination package	80	10,413	548	165	60,897	3205	14	19,585
	95	12,493	658	125	73,751	3882	12	24,631

3.2 Cost projections

As shown in Table 14A and 14B, total additional resource need per year varies between 11 and 24 million depending on the scope of the package. A significant share of the estimated costs would be incurred by the education sector for midwifery training (USD 4.6 million per year if attaining 80% coverage, and USD 6.1 million per year if aiming for 95% coverage). Remaining costs would be covered by the health sector, with service delivery and health worker time constituting the largest drivers of additional cost.

Table 14A. Breakdown of costs by type of input, by package (incremental scale-up, million USD 2014)

		Average annual cost 2018-2036							
Intervention	Target level	Commodities	Service Delivery	Midwifery training	Additional health worker cost for skilled attendance	Supply chain	Programme costs	Average annual cost (additional)	Total additonal cost 2018-2036
P1 Antenatal care	80%	0.3	5.1	4.6	0.0	0.1	0.8	10.9	206
	95%	0.4	6.3	6.1	0.0	0.1	1.1	14.0	265
P2 Skilled assistance for normal delivery	80%	0.5	2.5	4.6	3.5	0.2	0.9	12.2	232
	95%	0.7	3.3	6.1	4.6	0.2	1.2	16.1	305
P3 Skilled delivery including referral and management of complications	80%	1.5	5.1	4.6	4.2	0.5	1.1	17.0	324
	95%	2.0	6.4	6.1	5.5	0.7	1.4	22.1	419
P4 Combination maternal and newborn health (P1+P3)	80%	1.8	5.7	4.6	4.2	0.6	1.1	17.9	340
	95%	2.3	7.3	6.1	5.5	0.8	1.4	23.5	446
P5 Extended combination package including safe abortion and post abortion care	80%	1.8	5.7	4.6	4.2	0.6	1.0	18.0	342
	95%	2.4	7.5	6.1	5.5	0.8	1.4	23.6	449

Estimates in this table are not discounted.

14B. Breakdown of costs by type of input, by intervention (incremental scale-up), Percentage shares of estimated incremental cost 2018-2036 (total for 19 years)

Package	Target coverage level	Commodities	Service Delivery	Midwifery training	Additional health worker cost for skilled attendance	Supply chain	Programme costs
P1 Antenatal care	80%	3%	47%	42%	0%	1%	7%
	95%	3%	45%	44%	0%	1%	8%
P2 Skilled assistance for normal delivery	80%	4%	21%	38%	28%	2%	8%
	95%	4%	20%	38%	29%	2%	7%
P3 Skilled delivery including referral and management of complications	80%	9%	30%	27%	24%	3%	6%
	95%	9%	29%	28%	25%	3%	6%
P4 Combination maternal and newborn health (P1+P3)	80%	10%	32%	26%	23%	4%	6%
	95%	10%	31%	26%	23%	3%	6%
P5 Extended combination package including safe abortion and post abortion care	80%	10%	32%	26%	23%	4%	6%
	95%	10%	32%	26%	23%	4%	6%

The estimated additional cost per capita is around $1.95 per capita per year for the comprehensive package P5 (Table 15). This would be the equivalent of USD 135 per birth if scaled to 95% coverage. Out of the per capita costs for package P5 – 95%, US$1.45 (73%) are estimated to be carried by the health sector, and 27% by the education sector.

Table 15. Estimated additional cost per capita (US$ 2014) for expanding coverage of maternal health interventions to 80% and 95% coverage, average annual amount during time period 2018-2036

Package	Target coverage level	Per capita (total projected additional cost divided by total projected population – average per year 2018-2036)	Per birth (total projected additional cost divided by total projected additional births provided with skilled care – average per year 2018-2036)
P1 Antenatal care	80%	0.90	83
	95%	1.15	80
P2 Skilled assistance for normal delivery	80%	1.01	93
	95%	1.33	92
P3 Skilled delivery including referral and management of complications	80%	1.40	129
	95%	1.82	127
P4 Combination maternal and newborn health (P1+P3)	80%	1.48	136
	95%	1.94	135
P5 Extended combination package including safe abortion and post abortion care	80%	1.48	137
	95%	1.95	135

Estimates in this table are not discounted.

3.3 Benefit-cost ratios

Table 16 presents the estimated benefit-cost ratios of packages implemented at 80% and 95% coverage. When benefits and costs are discounted at 5%, benefit-cost ratios range from 2.6-2.7 for antenatal care (P1) to 6.5-6.7 for skilled assistance at normal delivery (P2), and reach 15-16 when comprehensive emergency obstretric care is included (P3). Combining antenatal care and skilled care at birth including emergency obstretric care (P4) increases the BCR somewhat further, and when incorporating safe abortion and post abortion care into an extended combination package, BCRs reach a maximum of 17.2 for package P5 implemented at 80% coverage.

Table 16. Benefits, Costs, and Benefit-Cost Ratios relative to expanding coverage beyond current coverage (incremental scenario), at a 5% discount rate

Package	Target coverage	Benefits NPV	Costs NPV	BCR

P1 Antenatal care	80%	19,967,222,619	5,382,189,582	3.7
	95%	25,175,075,349	6,930,109,589	3.6
P2 Skilled assistance for normal delivery	80%	46,391,876,207	6,045,305,946	7.7
	95%	59,454,478,956	7,967,738,024	7.5
P3 Skilled delivery including referral and management of complications	80%	144,833,590,238	8,438,325,692	16.2
	95%	177,297,676,119	10,949,315,886	16.2
P4 Combination maternal and newborn health (P1+P3)	80%	159,767,226,203	8,876,045,033	17.0
	95%	194,621,045,556	11,642,588,094	16.7
P5 Extended combination package including safe abortion and post abortion care	80%	162,265,261,777	8,916,756,238	17.2
	95%	197,949,681,155	11,720,105,003	16.9

Benefits are valued at 3x GDP. Costs and benefits are presented in Net Present Value terms for 2018-2036; discounted at 5%.

Table 17 provides summary BCRs for all packages at three discount rates: 3%, 5% and 12%. BCRs are lower when a higher discount rate is used, but still remain at 1.6 or higher for a 12% discount rate, thus implying good value for money. When applying a 3% disount rate, the BCR is very high for packages including emergency obstretric care at birth (P3-P5), valued at between 24 and 27.

Table 17. Summary Table for Benefit-Cost Ratios, based on projected health impact relative to projected cost, at selected discount rates (incremental scenario)

Package	Target coverage	3% BCR	5% BCR	12% BCR
P1 Antenatal care	80%	5.4	3.7	1.6
	95%	5.3	3.6	1.6
P2 Skilled assistance for normal delivery	80%	11.4	7.7	3.3
	95%	11.1	7.5	3.2
P3 Skilled delivery including referral and management of complications	80%	25.4	17.2	7.4
	95%	23.9	16.2	7.0
P4 Combination maternal and newborn health (P1+P3)	80%	26.6	18.0	7.7
	95%	24.7	16.7	7.2
P5 Extended combination package including safe abortion and post abortion care	80%	26.9	18.2	7.8
	95%	25.0	16.9	7.3

Note: Benefits are valued at 3x GDP.

Benefit cost ratios are slightly higher for 80% compared to 95%, most likely reflecting somewhat diminishing returns when increasing coverage above 80%; although the difference is small. The quality of evidence is discussed in section 3.5 below.

3.4 Discussion

The existing literature indicates that investments in maternal health contribute to more productive and better-educated societies (Onarheim et al, 2016). Our analysis indicates benefit-cost ratios of between 1.6 and 27, depending on the discount rates used. For a 5% discount rate, they vary between 4 and 18. Our results are in the same range as findings from other studies (Stenberg et al 2014 estimated a BCR of 8.7 for maternal and child health interventions when provided for 23 years, and discounted at 3 percent; whereas Foster and Bryant 2013 found benefit-cost ratios to vary between 14 to 24 in low income countries).

In order to generate real impact and bring maternal and newborn mortality rates down, and to avert the greatest numbers of deaths, access to emergency obstretric care is essential and such packages also show the highest rates of return (P3, P4, P5).

In addition to high returns to investment, an additional argument for investing in maternal health is that it can catalyze a cycle of positive social development. Our analysis values health gains in terms of a summary per capita GDP measure, which intends to capture a variety of benefits that individuals value as important. Therefore we do not separately project and quantify the different range of socioeconomic impacts of investing in specific interventions such as increased survival, increased economic productivity, increased school enrolment, etc. However, several studies have concluded that interventions that allow women and families to plan pregnancies and births– not just family planning (not covered in our analysis) but also greater access to safe abortion- result in significant societal gains (Pop-Eleches C, 2006).

Secondly, allowing planned pregnancy and birth to continue safely has substantial benefits beyond the individual mother (and baby). Maternal survival has particularly significant effects on child health outcomes, and studies in low- and middle income countries have shown an increased mortality risk for children following a mother's death (Miller and Belizan 2015). Additional intergenerational effects – not quantified in our analysis - include orphans' lower school enrolment and increased prevalence of high risk factors for health (see Onarheim et al 2016 for an overview). Long-term consequences also include loss of financial stability for the household, and increased risk of early marriage for orphan daughters (Miller and Belizan 2015). Better population health can encourage greater domestic savings and foreign investment and can improve social stability. Benefits from investing in maternal and reproductive health therefore go beyond short-term gains; they include longer term sustainable development.

Whilst arguments for investment in skilled care are strong, current availability of EmOC and skilled midwifes, remains limited. A study indicates that only 28 out of 88 BEmOC facilities in Haiti are operating at an acceptable level. We have not included costs for equipment to make BEmOC facilities operational, due to lack of data. We also haven't considered costs for building new health facilities, since costs of facility construction would benefit more than just maternal health services, and therefore including the full cost of facility construction under maternal health would be inappropriate. Similarly, EmOC monitoring, in place since 2015 only, has inventoried 46 BEmOC and 41 CEmOC but considers that only 13 CEmOC are functional [MSPP-DSF / UNFPA (2016)]. In other words, virtually all hospitals in the country do not even provide BEmOC services, and the majority of women with direct obstetric complications do not access health facilities with the required capacity. Thus in 2015, 89% of assisted deliveries in EmOC take place in CEmOC and only 11% in BEmOC [MSPP-DSF / UNFPA (2016)]. The lack of an estimated cost for facility upgrades is a limitation of our study. Howevers, such costs are context-specific and would need to be developed locally.

On the other hand we have included costs for expanding the required health workforce. Using the assumption that a midwife would on average deliver 175 births per year, this would require an average 174,403 births to be attended per year if 95% coverage was to be attained, the equivalent of 997 additional midwifes. Current midwifery schools allow for about 80 graduates per year, which is less than 10% of the additional need, not accounting for attrition of midwifes in the current system. Other reports have pointed to similar challenges in closing the gap: an analysis done for the State of the World's Midwifery report indicated that if health workforce outputs remain at current capacity, only 9% of the need will be met by 2030, and that even in a scenario where numbers of midwife graduates doubled by 2020, efficiency was irmpoved and attrition was halved, only 37% of the need would be met (UNFPA, ICM, WHO (2014). Attaining these targets thus poses considerable workforce-related implementation challenges.

The health system implications include how best to organize service delivery with an equitably deployed workforce to cover close to 300,000 births by 2030 – three times current coverage. Given that a large share of services is currently provided through NGOs, efforts require a more coordinated implementation. A national EmOC strategy exists, but implementation to date has been fragmented.

Finally, financing these investments poses an additional challenge. Our estimates for the annual additional costs to reach 95% coverage range from USD 11 million for antenatal care to 24 million for a comprehensive package. Current (2014) health spending is estimated at USD 650 million – with

government health expenditure accounting for about one-fifth at 134 billion (http://www.who.int/health-accounts/ghed/en/) . As discussed above, a significant increase in the budget going towards reproductive health functions would be required (30-40% increase above current spending on reproductive health - from all sources).

Even if funds were made available and these investments were made, actual practice at facility level would need to change. Direct payment at the point of care currently is the norm despite the free maternal and neonatal care and family planning services advocated in the National Strategic Plan for Reproductive Health and Family Planning 2013-2016 [MSPP of the Republic of Haiti (2013) and constitute an insurmountable obstacle for a large part of the population [EMMUS V]. Overall financing structures need to be reviewed to ensure that services intended to be free, actually do not incur patient-level costs.

Our analysis entails running a country-contextualized model to project the healthy life years gained, and then translate these into economic benefits. The GCEA-Spectrum approach can be completely customized to the local context, and thereby adds significant added value compared to alternative approaches that use pre-published unit costs derived from other settings for the resource needs. Moreover, the model offers transparency regarding the assumptions used and the cost components of each intervention, as opposed to using prior publications of cost estimates, where assumptions around cost and impact estimates may not always be clear to the reader.

Next steps at the country level entail more careful planning around strategic scenarios and operational planning on what should be the short- and medium term priorities to strengthen quality maternal care for improved maternal and newborn health in Haiti.

3.5 Quality of evidence

Overall limitations

Our model assumes an instantaneous jump to 80% or 95% coverage in year 2, which is obviously not meant to be realistic. The approach nevertheless provides an indicative estimate on the benefits and costs of implementing maternal health interventions, which can be compared against those of other investment options, which was the purpose of the study. More detailed planning should be done to carefully evaluate the financial and system implications of progressive implementation strategies.

Quality of benefit measure

The estimate of health benefits uses the LiST model which incorporates effectiveness estimates that have been reviewed by the Child Health Epidemiology Reference Group (CHERG), established in 2001 by the World Health Organization. We therefore have high confidence in the projection of health outcomes.

At the same time we acknowledge considerable uncertainties regarding the effectiveness estimates in particular related to the quality of care provided. Our estimates are not intended to be precise, but to provide an indicative benefit-cost ratio for expanding maternal care interventions.

Our inclusion of maternal and newborn deaths as well as stillbirths allows us to measure a range of mortality outcomes. We don't include morbidity, nor broader intergenerational effects, and estimates are therefore conservative. The valuation of averted mortality into HLYs follows a standard transparent approach based on disability weights. The subsequent valuation of HLYs in economic terms follows the standard recommendation of the Copenhagen Consensus to value each HLY (or DALY) gained as 3 times GDP per capita. As shown in section 2.2.2, this is assumed to capture both intrinsic and instrumental values of health. In Annex 4 we present ranges for the estimates when valuing each HLY as 1 or 8 times GDP per capita.

Quality of cost measure

Our model uses standardized WHO-CHOICE costs, because of the transparency of these in terms of separating out quantities from price assumptions. We examined available studies carried out in Haiti to contextualize assumptions. However, most standard assumptions were retained. Assumptions behind quantities of resource use are reported transparently, and quantities are reported separately from costs (e.g., number of outpatient visits per intervention; number of people reached per intervention). Such reporting aligns with principles of high quality economic evaluation.

Our focus on recurrent provider costs limits the scope of costs included – i.e, we do not include any indirect cost incurred by the households or individuals seeking care, such as for transport, and lost income - but this approach is consistent with many analyses in the field. Moreover, we haven't included capital costs on the provider side for upgrading existing EmOC facilities and/or constructing new facilities to expand access to care. When women are asked about reasons for not accessing care, 43% report distance as a problem (EMMUS-V). Including capital costs, and transportation costs incurred by households, would therefore have provided a more complete picture of resource needs. The incorporation of such addiotional costs would have increased cost estimates thus lowering the BCR. At

the same time, if broader social and intergenerational benefits had been modelled, those would increase the estimation of benefits and result in a higher BCR.

Given the above, we have still rated the quality of the estimates as high, since we have used pre-existing projection models vetted by expert groups, and because we report transparently on assumptions used.

4. Conclusion

The objective of this study is to estimate the cost, benefits, and the relative return on investment from providing skilled care before, during and immediately after birth in Haiti.

SDG3 includes a number of specific targets for maternal and reproductive health, where target 3.1 is to by 2030, reduce the global maternal mortality ratio to less than 70 per 100 000 live births, and by 2030, to end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1000 live births. Reaching these targets will require moving towards universal coverage of antenatal care, skilled care at birth including management of complications, and ensuring that – in the case of unplanned pregnancy - women have access to safe abortion should they choose to terminate the pregnancy. Our analysis indicates that providing these services can result in benefits around 17 times higher than the costs incurred.

While skilled care at birth increased from 24.2% in 2000 to 37% in 2015, access remains limited and there is scarcity of trained personnel. Midwifes can play a key role for maternal and newborn health outcomes (Renfrew et al, 2014). However current outputs from midwifery training schools would need to increase by a factor of ten to fulfil the estimated need. The current national strategy aims to integrate traditional birth attendants into the institutional system of maternal care, such that their role changes to accompany mothers to the health centres (MSPP of the Republic of Haiti (2013). When women are asked about reasons for not accessing care, 43% report distance as a problem, and 76% report health care costs as a bottleneck (EMMUS-V). Health policy will therefore need to address not only health workforce production and retention, but also geographic accessibility of services, and sustainable financing aimed to reduce out of pocket payments. Around 7.7% of current health expenditure – or an equivalent of USD 4.7 per capita - is estimated to be devoted to reproductive health (MSPP of the Republic of Haiti (2015b)). Adding USD 1.45 per capita (the estimated need for the health sector; since health workforce production costs are carried by the education sector) would be the equivalent of increasing the budget for reproductive health by 30%. Advancing towards the SDG targets for maternal and newborn health thus

poses real implementation challenges in a country that is struck by environmental and political crises, poverty, and volatile external funding.

Benefits from investing in maternal and reproductive health have high rates of return which go beyond short-term gains; they include longer term sustainable development. Implementation will need to advance progressively, and attempts made to secure sustainable funding for strengthening the health system to expand access to quality maternal health interventions.

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Annex 1. Example of commodity assumptions

This annex provides additional examples of detailed cost assumptions for commodities. The approach taken is illustrated using the example of management of eclampsia, which ie estimated to occur in around 1% of births. Specific commodity inputs are listed in table A1, including information on the number of units required per day and case; the cost per input; and the total average cost per case.

Table A1. Commodity assumptions for management of eclampsia

Drug/Supply	Percent receiving this aspect of the treatment	Note	Number of units	Times per day	Days per case	Units per case	Unit cost (USD)	Cost per average case (USD)
Severe pre-eclampsia								
Bag, urine, collecting, 2000 ml	100	Urine collection	1	1	1	1	0.36	0.36
Foley catheter	100	Control of urine output	1	1	1	1	0.58	0.58
Test strips, urine analysis	100	Urine test	8	1	1	8	0.03	0.24
High blood pressure (if diastolic BP > 0mmHg)								
Hydralazine, powder for injection, 20 mg ampoule	100	5mg IV or IM, repeat every 30 minutes as needed (max. 20mg)	0.25	4	1	1	4.67	4.67
IV giving/infusion set, with needle	100	For drip	1	1	1	1	0.28	0.28
Sodium lactate injection (Ringer's), 500 ml, with giving set	100	IV drip	1	1	1	1	0.77	0.77
If pregnancy > 7 months and sign of fetal compromise, expedite delivery								
Misoprostol, tablet, 200 mcg	40	To ripen the cervix	1	2	1	2	0.35	0.28
Oxytocin, injection, 10 IU in 1 ml ampoule	40	To induce labor	1	2	1	2	0.18	0.144
Sodium chloride, injectable solution, 0,9 %, 500 ml	40	For oxytocin infusion	1	1	1	1	0.5	0.2
Convulsions								
Magnesium sulfate, injection, 500 mg/ml in 10-ml ampoule	10	4g (20ml of 20% solution) IV over 20 minutes	1	1	1	1	0.4	0.04
Sodium lactate injection (Ringer's), 500 ml, with giving set	10	1 liter in 6-8 hours	4	1	1	4	0.77	0.308
Syringe, needle + swab	10	For magnesium sulfate IM injections	1	1	1	1	0.05	0.005
Water for injection, 10 ml ampoule	10	To create 20% magnesium sulphate solution	2	1	1	2	0.05	0.01
If pregnancy < 7 months monitor blood pressure and urine)								
Test strips, urine	50	Monitor for proteinuria (pre-eclampsia)	1	1	5	5	0.03	0.075

analysis		2x weekly						
Continued convulsions								
Lidocaine HCl (in dextrose 7.5%), ampoule 2 ml	10	For IM injection, 1ml, in same syringe as magnesium sulfate	1	1	1	1	0.33	0.033
Magnesium sulfate, injection, 500 mg/ml in 10-ml ampoule	10	In addition, 10g (10ml of 50% solution) as deep IM injection, 5g into each buttocks	1	1	1	1	0.4	0.04
Delayed labor or late referral								
Lidocaine HCl (in dextrose 7.5%), ampoule 2 ml	5	For IM injection, 1ml, in same syringe as magnesium sulfate, also repeat every 4 hours	1	12	1	12	0.33	0.198
Magnesium sulfate, injection, 500 mg/ml in 10-ml ampoule	5	Continue if woman is in late labour or referral delayed for long - 5g in altenate buttocks every 4 hours until 24 hours after birth	1	12	1	12	0.4	0.24
Recurring conversions								
Magnesium sulfate, injection, 500 mg/ml in 10-ml ampoule	10	If convulsions recur, after 15 minutes give 2g IV over 20 minutes	1	1	1	1	0.4	0.04
Total cost								8.513

Source: OneHealth Tool Intervention Assumptions Document

http://avenirhealth.org/Download/Spectrum/Manuals/Treatment%20Assumptions%202016%201%2010.pdf

Annex 2. Health service delivery costs

In order to validate the WHO-CHOICE estimates we examined existing studies carried out in Haiti on service delivery costs. These included:

- Analyse de Coûts du Paquet Minimum des Services de santé (PMS) d'Haïti 2011 (USAID) Santé pour le Développement et la Stabilité d'Haïti / Pwojè Djanm: Analyse de Coûts du Paquet Minimum (PMS) à Haïti, 2011 Cambridge MA: Santé pour le Développement et la Stabilité d'Haïti—Pwojè Djanm; Management Sciences for Health, 2012.
- Koné Georges (2011). Analyse des coûts et financement des soins de santé primaire dans la zone goavienne en Haïti. Médecins du Monde (MDM), Port-au-Prince.
- Unité de santé internationale / Université de Montréal (2011). Coûts de la prise en charge de la santé maternelle, périnatale et reproductive en Haïti. USI/CRCHUM Université de Montréal, Port-au-Prince/Montréal.
- MSPP/PNLS (2016). Rapport REDES 2014/2015 – Estimation du flux des ressources et dépenses liées au VIH/SIDA. MSPP/PNLS, Port-au-Prince.

As an illustrative example, the table below shows data extracted from the USAID (2011) study for selected interventions.

Table A2. USAID (2011) study, average standard cost, 100% coverage scenario *(Haitian Gourde (HTG) and USD)

	Consultation Prénatale, HTG	USD 2011	Vaccination < 5 years BCG, HTG	USD 2011	Match to delivery level in GCEA	Default 2010 cost in Spectrum GCEA (public sector)
Dispensaries ONG	77	1.90	13	0.32	Community	1.26
Zones Ciblées	102	2.52	14	0.35	Outreach	1.26
CSL ONG (Facility without beds)	79	1.95	9	0.22	Clinic	1.56
CSL ZC	120	2.96	11	0.27	Clinic	1.56
CAL ONG(Facility with beds)	90	2.22	10	0.25	Clinic	1.56
CAL Zones Ciblées	77	1.90	11	0.27	Clinic	1.56
Average (community and outreach level)	89.5	2.21	13.5	0.33		
Average (clinic level)	91.5	2.26	10.25	0.25		
Average (interventions combined) - community and outreach	51.5	1.3				
Average (interventions combined) - clinic	50.9	1.3				

**Taking only the cost of "Personnel technique" and "Coûts fixes par Service"*

The comparison illustrates a number of points:

- Facility based studies show a large variation in costs for different types of services
- Facility based studies show a large variation in costs between different delivery levels
- Based on a quick comparison, the WHO-CHOICE estimates fall within the same ball park as the locally derived estimates.

The above also illustrated how sensitive the cost assumptions are to which services are included in an average weighted package. To do such weighting is beyond the scope of this project. The comparison suggests that WHO-CHOICE estimates for service delivery costs can be used to inform the analysis.

Annex 3. Estimates of programme costs use in analysis

This annex provides an example to illustrate how programme acosts are scaled for the incremental scenario analysis, using package 1. Antenatal care scaled to 95% as the example.

The package includes the following 5 interventions:

1. Tetanus toxoid immunization
2. Syphilis detection and treatment
3. Ectopic pregnancy case management
4. Hypertensive disorder case management
5. Management of pre-eclampsia (with magnesium sulphate)

The average coverage across the 5 interventions is 36.9%. Scaling coverage to 95% would require an additional USD 1.1 million dollars for overall programme activities in relation to training, supervision, transport and communication activities, according to the model used. This approach assumes an effective management of resources, and may underestimate actual needs. However we were not able to validate the estimates for this particular exercise.

Table A3. Programme costs assumptions for management of eclampsia

Category	Estimated annual cost, for a fully functioning programme with 10 interventions thousands (USD 2014)	Rule applied	Resulting value for incremental cost to increase coverage from 36.9% to 95%, (thousands USD 2014)
Human Resources for planning and administration	1,455	• Cost depends on the scope of the package • Same cost at all coverage levels	0
In-service training	489	• Same cost regardless of scope of package • Cost differs according to coverage level	282
Supervision	2,035	• Same cost regardless of scope of package • Cost differs according to coverage level	772
Monitoring and Evaluation	877	• Same cost regardless of scope of package, and for all coverage levels	0
Transport	357*	• Cost depends on the scope of the package • Cost differs according to coverage level	127
Communication, Media & Outreach	25	• Same cost regardless of scope of package • Cost differs according to coverage level	15
General Programme Management	140	• Same cost regardless of scope of package, and coverage level	0
SUM	**5,378**		**1,096**

*Costs for transport updated to incorporate Haiti-specific prices for motorcycles.

Annex 4. Estimates of BCRs with differential valuation of health benefits

Benefit-cost ratios with health benefits valued at 1, 3 and 8 times GDP per capita.

Intervention	Discount rate	BCR (benefits valued at 1 x GDP per capita)	BCR (benefits valued at 3 x GDP per capita)	BCR (benefits valued at 8 x GDP per capita)
P1 Antenatal care	3%	5.3	1.8	14.2
	5%	3.6	1.2	9.7
	12%	1.6	0.5	4.2
P2 Skilled assistance for normal delivery	3%	11.1	3.7	29.5
	5%	7.5	2.5	19.9
	12%	3.2	1.1	8.5
P3. Skilled delivery including referral and management of complications	3%	23.9	8.0	63.8
	5%	16.2	5.4	43.2
	12%	7.0	2.3	18.5
P4 Combination Maternal and newborn health (P1 + P3)	3%	24.7	8.2	65.9
	5%	16.7	5.6	44.6
	12%	7.2	2.4	19.1
P5 Expanded Combination including safe abortion and Post abortion care	3%	25.0	8.3	66.5
	5%	16.9	5.6	45.0
	12%	7.3	2.4	19.4

Haiti faces some of the most acute social and economic development challenges in the world. Despite an influx of aid in the aftermath of the 2010 earthquake, growth and progress continue to be minimal, at best. With so many actors and the wide breadth of challenges from food security and clean water access to health, education, environmental degradation, and infrastructure, what should the top priorities be for policy makers, international donors, NGOs and businesses? With limited resources and time, it is crucial that focus is informed by what will do the most good for each gourde spent. The Haïti Priorise project will work with stakeholders across the country to find, analyze, rank and disseminate the best solutions for the country. We engage Haitans from all parts of society, through readers of newspapers, along with NGOs, decision makers, sector experts and businesses to propose the best solutions. We have commissioned some of the best economists from Haiti and the world to calculate the social, environmental and economic costs and benefits of these proposals. This research will help set priorities for the country through a nationwide conversation about what the smart - and not-so-smart - solutions are for Haiti's future.

For more information visit www.HaitiPriorise.com

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Copenhagen Consensus Center is a think tank that investigates and publishes the best policies and investment opportunities based on social good (measured in dollars, but also incorporating e.g. welfare, health and environmental protection) for every dollar spent. The Copenhagen Consensus was conceived to address a fundamental, but overlooked topic in international development: In a world with limited budgets and attention spans, we need to find effective ways to do the most good for the most people. The Copenhagen Consensus works with 300+ of the world's top economists including 7 Nobel Laureates to prioritize solutions to the world's biggest problems, on the basis of data and cost-benefit analysis.