

Countdown to 2030
LAC Regional Network

Haiti Country-Case Study
on Maternal and Child Health 1990-2018:
progress and challenges towards the SDGs

Final Technical Report
2019



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Haiti Country-Case Study

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Executive summary

Background

In Haiti, despite frequent political turmoil, natural disasters and economic stagnation, considerable efforts have been directed towards the improvement of maternal and child health in the last three decades. We aimed to comprehensively assess the progress made in both coverage of and equity in key reproductive, maternal, neonatal, and child health (RMNCH) interventions and health-related outcomes from 1990 to 2018, and to explore their main drivers.

Methods

We applied a mixed methods approach. The qualitative approach was based on collecting information about policies and programs directly or indirectly related to RMNCH, carried out in Haiti since 1990, through iterative discussions with key informants and through a comprehensive desk review of relevant governmental and non-governmental documentation, complemented by a literature review based on bibliographic databases. The quantitative approach included time trend analyses of coverage and inequality of RMNCH interventions at national and departmental level, as well as trend analyses of the study outcomes. Association with drivers of coverage at departmental level was also explored. We relied primarily on data from nationally representative surveys carried out in the country since 1994, as well as on secondary data on contextual factors that might have influenced RMNCH coverage and outcome indicators. We developed a conceptual framework to guide our analysis and to explain how different factors may influence the study outcomes. A financial flows analysis was carried out at the national level to assess trends in health financing.

We also performed policy and health system analyses, informed by interviews with individuals from governmental, non-

governmental and multilateral agencies actively working in the country, to explore main policies and programs that might have influenced RMNCH overtime. Two local workshops were organized to present study findings to the local authorities and to validate information on key policies and programs collected through literature review and interviews with key informants. The composite coverage index (CCI) was calculated to assess the coverage gap in RMNCH along the continuum of care. We performed inequality analyses to assess trends in inequality for coverage and outcome indicators. We carried out multilevel mixed-effects linear regression analyses to explore predictors that might have influenced under-five stunting prevalence at departmental level from 1994 to 2016.

Results

The prevalence of stunting in children under five years of age decreased by 40%, from 36.8% in 1994 to 21.9% in 2016. Neonatal mortality rate decreased by 37%, from 38.9 to 24.6 deaths per 1,000 live births; infant mortality rate by 49%, from 100.4 to 50.9 deaths per 1,000 live births; and under-five mortality rate by 54%, from 144.9 in 1994 to 67.0 deaths per 1,000 live births in 2016. Substantial improvements were also observed during the same period in coverage indicators such as the use of modern contraceptive methods, family planning needs satisfied, antenatal care visits, institutional deliveries and skilled attendant at delivery (SBA). A moderate reduction of poverty rate was observed, despite the indicators showing a stagnant GDP and slight increase in income inequality. Regarding policies and programs implemented in the country since 1990 with a potential impact in RMNCH, we can highlight strategies to improve women's education, which have surely played a role in improving health care for both women and children; programs

aimed at expanding human resources for health; the implementation of a compulsory social service program for recently graduated doctors to specifically cover rural and remote areas of the country; the “*Cooperación Haitiano-Cubana*” aimed at providing free health care service to the population and training health professionals; the reproductive health and family planning strategies as well as vaccination programs leading to increased contact of women with maternal and child health services; training and deployment of increased numbers of community health workers for the provision of preventative and curative health services at community level; the increase in quality and quantity of care provided by nutrition programs for undernourished children both at facility and community levels; the implementation of basic emergency obstetric care in the country; the contribution of NGOs like GHESKIO and Zanmi Lasante through deployment of health care facilities that provide high quality health care to the most deprived segments of the population, among others.

In terms of financing, change was observed in total health expenditure from 2010 to 2013; while household health expenditure as percentage of total health expenditure increased by 7.5 times from 2010 to 2011 and then stabilized. Likewise, the total disbursement for maternal and neonatal health increased by 11.3 times from 2003 to 2011 and particularly from 2009 to 2011 and decreased from 2012 onwards. Total disbursements to reproductive and child health also increased, but at a much lower rate.

Disaggregation of the indicators by wealth quintiles and by urban or rural place of residence showed that for about half of the indicators analyzed, the gap between poor and rich remained the same or increased over time. The interventions for which wealth inequalities increased were mostly related to delivery care, vaccination and water and sanitation. Modern

contraceptive use, family planning needs satisfied, antenatal care and use of oral rehydration salts for children with diarrhea, were indicators that showed a decrease in inequalities. A slight reduction in the gap between the poorest and the richest was also observed for under-five stunting prevalence and under-five mortality rate. At departmental level, moderate progress was observed for all the indicators during the same period. We were unable to identify a consistent pattern of well-performing departments in terms of the rate of progress for the indicators studied. The multilevel mixed-effect linear regression analyses at departmental level showed that, after accounting for confounding factors, only women’s schooling (coefficient: -1.67; $p=0.047$), access to improved drinking water source (coefficient: -0.16; $p=0.001$) and antenatal care with at least four or more visits (coefficient: -0.31; $p<0.001$) were statistically associated with a reduction in under-five stunting prevalence.

Conclusion

Haiti has made some progress in RMNCH from 1990 to 2018, despite the scenario of political instability, natural disasters and lack of economic growth. But there is much to be done if the SDGs are to be achieved. Some interventions presented with more progress, such as family planning and antenatal care. Overall, however, there is still a long way until universal coverage is achieved. Inequalities are also sizeable, and despite reduction for some interventions, large gap between rich and poor remain or are increasing. This is the case of improved sanitation and facility-based health care. Many health policies have been identified in our study, as well as a large number of NGOs working in the country. More coordination between government policies and NGO actions is needed, as well as monitoring policies for their results in both coverage and reduction of inequalities.

LIST OF ABBREVIATIONS

AIDS: Acquired immunodeficiency syndrome	IMR: Infant mortality rate
ANC: Antenatal care	IRB: Institutional Review Board
BCG: Bacille Calmette Guerin	IUD: Intra-uterine-device
BEmOC: Basic Emergency Obstetric Care	KMC: Kangaroo Mother Care
CCI: Composite Coverage Index	LAC: Latin America and the Caribbean
CEmOC: Comprehensive Emergency Obstetric Care	MATS: Maternal and Child in Health
ECLAC: Economic Commission for Latin America and the Caribbean	MDG: Millennium Development Goal
CI: Confidence interval	MINUJUSTH: United Nations Mission for Justice Support in Haiti
CIX: Concentration index	MINUSTAH: United Nations Stabilization Mission in Haiti
CME: Child Mortality Estimate	MMR: Maternal mortality ratio
CPNM: Care seeking for suspected pneumonia	MOH: Ministry of Health
CRED: Centre for Research on the Epidemiology of Disasters	MPCE: Ministry of Planning and External Cooperation
DHS: Demographic Health Surveys	MSL: Measles
DPT: Diphtheria, Tetanus and Pertussis	NGO: Non-Governmental Organization
EM-DAT: Emergency Events Database	NHA: National Health Accounts
EmOC: Emergency Obstetric Care	NMR: Neonatal mortality rate
EPI: Expanded Program on Immunization	ODA: Official Development Assistance
FPS: Family planning satisfied	ORS: Oral rehydration salt
GDP: Gross Domestic Product	ORT: Oral rehydration therapy
HDI: Human Development Index	PAHO: Pan American Health Organization
HIV: Human Immunodeficiency Virus	PASSMISSI: Maternal and Infant Health Improvement Project through Integrated Social Services.
IGME: Inter-agency Group for Child Mortality Estimation	PCMA: Acute Malnutrition Management Program
IHSI: Haitian Institute of Statistics and Informatics	PMTCT: Prevention of mother to child HIV
IHE: Haitian Institute of Childhood	PPAc-PEV: Full Annual Plan of the Expanded Program of Immunization
ILO: International Labor Organization	PPP: Purchasing Power Parity
IMCI: Integrated management of childhood illness	

RMNCH: Reproductive, maternal, neonatal and child health

SBA: Skilled attendant at birth

SD: Standard deviation

SDG: Sustainable Development Goal

SIG: Free Infant Care

SII: Slope index of inequality

SOG: Free Obstetric Care

TFR: Total fertility rate

UNDP: United Nations Development Programmes

UNFPA: United Nations Population Fund

UNICEF: United Nation Children's Fund

USAID: United States Agency for International Development

US\$: United State dollars

U5MR: Under-five mortality rate

WB-WGI: World Bank - Worldwide Governance Indicators

WHO: World Health Organization

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1 BACKGROUND AND JUSTIFICATION

Countries all over the world embraced the Millennium Development Goals (MDGs) as part of their efforts to improve their citizens' quality of life.¹ Specific health goals included the reduction of under-five mortality by two thirds (MDG 4) and maternal mortality by three quarters (MDG 5) from 1990 to 2015. This commitment inspired the launch of the Countdown to 2015 for Women's, Children's and Adolescents' Health, a global initiative of academics from institutions around the world and representatives from UN agencies and civil society created with the aim of monitoring progress towards reproductive, maternal, neonatal and child health (RMNCH) targets in the countries with the highest burden of maternal, neonatal, and child mortality.²

To better understand the drivers for progress in RMNCH, Countdown to 2015 commissioned several country case studies in diverse regions of the world. Building on the lessons provided by these country case studies, Countdown to 2030, a follow-up of Countdown to 2015 into the Sustainable Development Goals (SDG) era, is conducting further case studies such as the Haiti country case study, the results of which are reported here. This is seen as a unique opportunity for the country to redouble its effort to accelerate progress, based on the commitment of leaving no one behind. We hope that the study will help policymakers in Haiti by identifying the success factors and the bottlenecks in the implementation of interventions within the last three decades, as well as documenting how inequalities in health evolved over time.

Haiti is the poorest country in the Latin America and the Caribbean (LAC) region and has faced, for a long time, many challenges that hamper the efforts to meet development goals, including sustained progress in RMCNH. Such factors comprise political and social unrest, recurrent economic crises and natural disasters, and a state struggling to meet its citizens' aspirations³⁻⁹ Despite these challenges and although it could not reach the MDGs on RMNCH, Haiti was able to make some progress. The maternal mortality ratio (MMR) decreased 43%, from 625 in 1990 to 359 per 100,000 live births in 2015,¹⁰ and the under-five mortality rate (U5MR) declined by 53%, from 146 in 1990 to 69 per 1,000 live births in 2015.¹¹

Several surveys were conducted in Haiti since the 1990s that can be used to support a country case study. Since 1994, Haiti has conducted five Demographic Health Surveys (DHS) that are representative at national and departmental levels. These surveys were conducted in 1994, 2000, 2005, 2012 and 2016. They collected information on several social determinants of health, on coverage of various health interventions, and on some health impact indicators such as nutritional status and mortality in children less than five years old.

We put together an experienced team to design and conduct a Haiti case study, with the collaboration of key local and regional stakeholders able to provide relevant information and help focus the study on the most important issues seen as essential for the revision of policies already in place and the design of new policies and programs. These partners included government officials from the Haitian Ministry of Health (MOH), Haitian Institute of Statistics and Informatics (IHSI), the Pan American Health Organization, World Health Organization (PAHO/WHO), and the International Center for Equity in Health of the Federal University of Pelotas (ICEH, Pelotas), a premier WHO/PAHO Collaborating Center in Health Equity.

In this country case study, we aimed to assess the progress made in coverage of key RMNCH interventions and in inequalities in RMNCH coverage. We also explored progress towards outcomes, such as early childhood mortality and child malnutrition. Furthermore, we sought to identify the drivers of progress

and the bottlenecks hampering progress. This involved the analysis of the role of natural disasters, social determinants, antipoverty strategies, political and governance levels, health system reforms, health sector financing, health policy and program implementation, specific RMNCH implementation coverage, as well as the role of international assistance and of non-governmental organizations (NGOs) operating in Haiti.

The report includes the descriptive time trends at national level, equity trends analyses, departmental level equity analyses, bivariate correlations between the determinants and outcomes at both national and departmental level, multilevel health system and policy analysis, and financial flow analysis. The report concludes with the main messages emerging from the analyses, and the challenges faced. Hopefully, the findings of this study will be useful to policymakers to help them designing and implementing further effective actions to continue improving RMNCH in Haiti.

2 METHODS

We used a mixed-method approach (quantitative and qualitative). The quantitative approach was based primarily on analyses of data from all nationally representative surveys (DHS) carried out in the country since 1994. We reviewed secondary data sources on contextual factors that might have influenced RMNCH coverage and outcomes indicators, from 1990 to date. The quantitative data sources are described in more detail in section 2.2 below. The qualitative approach was based on collecting information about policies and programs, directly or indirectly related to RMNCH, carried out in Haiti since 1990, in addition to conducting interviews with key informants from different local and international organizations that are actively working in the country. Lastly, we performed a financial analysis based on national health accounts information and on Official Development Assistance (ODA) data for Haiti.

2.1 CONCEPTUAL FRAMEWORK

We developed a conceptual framework to guide our analyses and to explain the different factors that can influence the main outcomes of the study – childhood mortality and nutrition (Fig. 1). It is made up of six levels of determinants, ranging from distal (political and socioeconomic factors) to proximal (health interventions). Our assumption is that, in general, distal determinants will influence the factors at the lower proximal levels, but not necessarily the opposite. A description of the determinants within each level and the reasons for inclusion are described in this section and illustrated in Table 1.

At the most distal level, we entered a variable that measures the occurrence of natural disasters. We chose this variable because Haiti is located in a geographic region where at least three natural disasters are expected every year.¹² It was placed at the most distal level since it is a factor beyond human control. Moreover, the occurrence of natural disasters —and, more precisely, their consequences, particularly in settings such as Haiti’s, with low preparedness and low resilience— may have a direct effect on the outcomes or act indirectly by influencing the intermediate determinants.

Figure 1: The conceptual framework illustrating a number of selected distal, intermediate and proximal determinants that may impact RMNCH outcomes in Haiti.

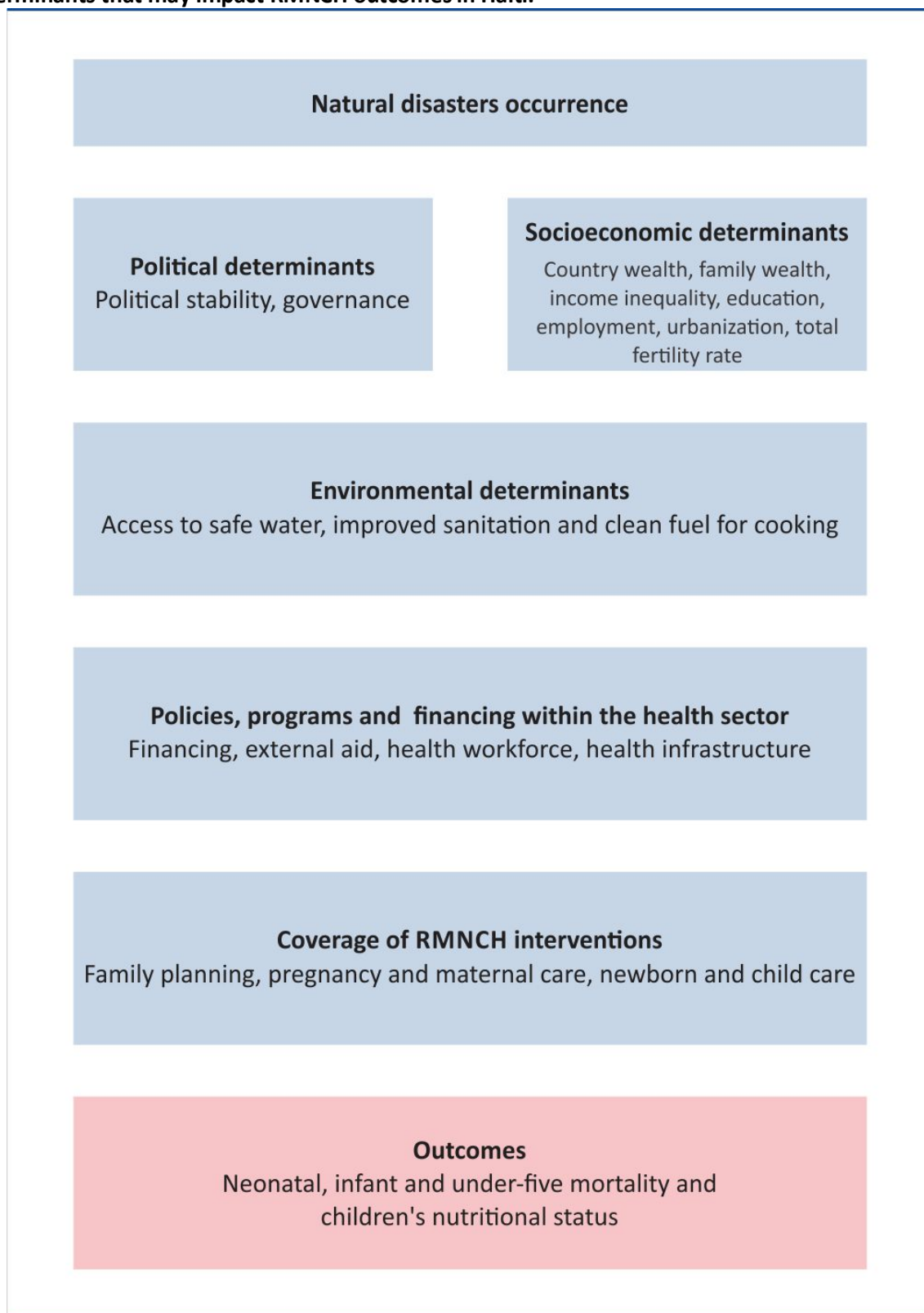


Table 1: Description of the determinants and outcomes included in the conceptual framework.

Hierarchical level of the determinants	Indicators selected	Availability National/ regional level	Reason for being selected	Source
Natural disasters occurrence	Occurrence of natural disasters (yes/no)	Both	Frequent occurrence in the country	CRED: EM-DAT
Political determinants	Index of political stability	National	Frequent political turmoil in the country/evidence from the literature	WB - WGI
	Index of control of corruption	National	Frequent political turmoil in the country/evidence from the literature	WB - WGI
Socioeconomic determinants	GDP per capita	National	Evidence from the literature	ECLAC
	Gini coefficient	National	Evidence from the literature	IHSI
	Poverty line	Both	Evidence from the literature	IHSI
	Absolute income	Both	Evidence from the literature	Fink et al. ¹³
	Women's education	Both	Evidence from the literature	DHS
	Women's employment	National	Evidence from the literature	ILO
	Life expectancy at birth	National	Evidence from the literature	ECLAC
	Human development index	Both	Evidence from the literature	UNDP
	Urbanization	Both	Evidence from the literature	IHSI
Environmental determinants	Fertility rate	Both	Evidence from the literature	DHS
	Access to improved drinking water source	Both	Evidence from the literature	DHS
	Improved sanitation	Both	Evidence from the literature	DHS
Policies, programs and financing within the health sector	Clean cooking fuels	Both	Evidence from the literature	DHS
	ODA per capita	National	Evidence from the literature	Grollman ¹⁴
	Health expenditure	National	Evidence from the literature	National health account
Coverage of RMNCH interventions	Health workforce	Both	Evidence from the literature	MOH
	Health infrastructure	Both	Evidence from the literature	MOH
	Modern contraceptive methods used	Both	Evidence from the literature	DHS
	Family planning needs satisfied	Both	Evidence from the literature	DHS
	Antenatal care (4 or more visits)	Both	Evidence from the literature	DHS
	Neonatal tetanus protection	Both	Evidence from the literature	DHS
	Institutional delivery	Both	Evidence from the literature	DHS
	Skilled birth attendance	Both	Evidence from the literature	DHS
	Early initiation of breastfeeding	Both	Evidence from the literature	DHS
	Exclusive breastfeeding	Both	Evidence from the literature	DHS
	Immunization coverage	Both	Evidence from the literature	DHS
Care-seeking for symptoms of pneumonia	Both	Evidence from the literature	DHS	
Diarrhea treatment: Oral rehydration salts	Both	Evidence from the literature	DHS	
RMNCH outcomes	<i>Under-five stunting prevalence, neonatal mortality rate, infant mortality rate, under-five mortality rate</i>	<i>Both</i>	<i>Moderate progress observed</i>	<i>DHS/CMEInfo</i>

Notes: CRED: EM-DAT: Centre for Research on the Epidemiology of Disasters: Emergency Events Database | ECLAC: United Nations Economic Commission for Latin America and the Caribbean | IHSI: Haitian Institute of Statistics and Informatics | DHS: Demographic Health Surveys | UNDP: United Nations Development Program | WB - WGI: The World Bank - Worldwide Governance Indicators | MOH: Ministry of Health | ILO: International Labor Organization | CMEInfo: Child Mortality Estimate

At the second level of the framework we included socioeconomic and political determinants. We chose the socioeconomic determinants based on their relationship with our study outcomes, as published in the literature.¹⁵⁻¹⁷ Our choice to include the political determinants was due to the fact that the country has witnessed frequent political turmoil during the last four decades. Furthermore, there is evidence from the literature showing that good governance is linked to better child nutrition¹⁸ and lower under-five mortality rate.^{19, 20} We hypothesized that a low index of political stability and control of corruption would have a negative effect on our study outcomes. The socioeconomic and political determinants may interact between each other, and they may have a direct effect on the outcomes or an indirect effect through the intermediate determinants.

The third level is made up of indicators of environmental determinants such as access to safe drinking water, improved sanitation, clean fuel for cooking and technology. Such indicators were selected based on previous results from the literature.^{16, 17, 21-23} Increased access to safe drinking water and improved sanitation tend to reduce under-five stunting as well as child mortality.^{16, 21} Likewise, household air pollution resulted from traditional ways of using solid fuels is associated with increasing risk in deaths among under-five children.^{22, 24, 25} The literature also shows that women that are economically independent or autonomous tend to have higher improvement in their children's health.^{16, 17, 21-23} We expected that an increase in coverage of access to safe drinking water, improved sanitation, clean fuel for cooking and in women's employment would reduce under-five stunting prevalence, as well as infant and under-five mortality rate.

At a more intermediate level, we included determinants of policies, programs and financing within the health sector. We aimed to assess whether changes in policies and programs are accompanied with changes in the outcomes over time. Thus, we hypothesized that with more policies and programs being adopted over the years, the population would have better health coverage, hence, a reduction in under-five stunting and mortality among children and newborns, similar to what is shown in the literature.¹⁵ In parallel, we expected that an increase in financing within the health sector, as well as in availability of health workforce and infrastructure would improve the study outcomes. Furthermore, well-structured policies and programs should contribute to increase the density of qualified health personnel and the quality of health infrastructure; and vice versa, the improvement in health personnel and infrastructure could, in turn, improve policies and programs in the country. In other words, these three determinants may act horizontally and affect each other, or they may exert their effect directly on the outcomes or indirectly through the proximate determinants.

At the fifth level of the conceptual framework, we included the proximal determinants, that is the coverage of RMNCH interventions. They have been selected based on what is already known from the literature.^{26,27} All these indicators may influence the study outcomes directly or indirectly through diverse pathways. For example, family planning may reduce under-five stunting and child mortality by allowing women to time their pregnancies to occur during a healthy phase in their life and to possibly avoid high-risk pregnancies. It may also help women space their births, recuperate and replenish essential nutrients which can lead to better nutritional outcomes during pregnancy, such as a healthy birth weight for their newborns. Thus, when pregnancies are spaced, mothers may have more time, energy, and resources to adequately breastfeed and feed their young infants and children, and have more time to seek adequate health care services and improve the health status of their children.²⁶

The final level of our framework refers to the outcomes of our study. We chose neonatal, infant and under-five mortality and children's nutritional status, based on the moderate progress observed in these

indicators between 1994 and 2016. We aimed to assess the impact of the selected distal, intermediate and proximal determinants on the improvement of these outcomes, as well as the bottlenecks faced over time.

2.2 DATA SOURCES

Primarily, we used data from the five nationally representative DHS surveys conducted in Haiti from 1994 to 2016. These surveys were conducted by the Haitian Institute of Childhood (IHE) and were sponsored by the Haitian MOH. They were technically assessed by the DHS program from Macro International, and by the IHSI. Funding for the DHS surveys comes from the United States Agency for International Development (USAID) and logistical support was obtained from the United Nations Population Fund (UNFPA), the Pan American Health Organization (PAHO/WHO) and UNICEF. These surveys collect information on a wide range of socio-economic, demographic and health indicators for the general population as well as for subgroups such as women aged 15-49 and children under-five. Three types of questionnaires are frequently used to collect data: the household questionnaire, the individual woman's questionnaire, and the individual man's questionnaire.²⁸ The household questionnaire collects information on the whole household and household members' characteristics such as age, level of education, household assets, among other data. The women's questionnaire collects information on reproductive health (contraception, family planning), pregnancy, delivery, postnatal care for both women and newborn, immunizations, nutritional status and other health aspects in children under-five.²⁸

Each survey's sample was designed to be representative at the national level and at departmental level. The samples were based on a stratified two-stage cluster design where the first stage involved selecting clusters consisting of enumeration areas that are drawn from the national census. In the second stage, for each selected cluster, a sample of households is drawn from an updated list of households through an equal probability systematic selection process. Every survey was approved by the Ministry of Health National Ethics Committee and by the Institutional Review Board (IRB) of the DHS program. Further details about DHS methodology can be found on their website (<https://dhsprogram.com>).

We also used data from other sources, such as GDP per capita from the United Nations Economic Commission for Latin America and the Caribbean (ECLAC); the Gini coefficient, poverty line and urbanization from IHSI; the proportion of women's employment from the International Labor Organization (ILO); density of health workforce and health infrastructure from the Haitian Ministry of Health (MOH); human development index from the United Nations Development Program (UNDP); the index of political stability and index of control of corruption from the World Bank; information on maternal, newborn, child and adolescent health policy indicators from the World Health Organization (WHO); the occurrence of natural disasters from Centre for Research on the Epidemiology of Disasters - Emergency Events Database (CREED EM-DAT); child mortality estimate at national level from Child Mortality Estimate (CME Info); among others (Table 1). All the mentioned data sources are publicly available and can be used for scientific purpose.

2.3 HEALTH OUTCOMES

- **Prevalence of stunting in under-five children:** It is calculated as the proportion of all children measured whose height or length-for-age is more than 2 standard deviations (SD) below the median age- and sex-specific value of the WHO Child Growth Standards (<https://www.who.int/childgrowth/en/>). The numerator includes the number of children aged five years or younger that meet the criteria for stunting, and the denominator is the total number of children aged less than five years in the survey.

- **Under-five mortality rate (U5MR):** Probability of dying before the fifth birthday per 1,000 livebirths. For the calculation of this probability in surveys, the births reported by the mothers in the 10 years before the survey and the deaths at selected age groups are used. The age specific probabilities of surviving each age are then multiplied to obtain the probability of surviving the whole period. The probability of dying before the age of 5 is then calculated as one minus the probability of surviving until age 5.
- **Infant mortality rate (IMR):** Probability of dying before the first birthday per 1,000 livebirths. The calculation follows the same logic described for U5MR.
- **Neonatal mortality rate (NMR):** Probability of dying within the first 30 days of life per 1,000 livebirths. The calculation follows the same logic described for U5MR. In surveys, given the mothers often report deaths happening just before 30 days as exactly 30, NMR is not defined as deaths in the first 28 days of life.

Child mortality indicators disaggregated by wealth quintiles and at departmental level were obtained from the DHS surveys. The national child mortality indicators were obtained from the UN Inter-agency Group for Child Mortality Estimation (UN IGME).²⁹

From the DHS surveys, mortality indicators were calculated using the data collected in the birth histories, which consisted of women's reports on all the births they have had in the five years preceding the survey. Each birth has data on the date of birth, the state at current age (if the child is alive) or age at death (if the child was dead). Using this data, we calculated neonatal, infant and under-five mortality rates by department.

The child mortality indicators obtained from CME Info, which are based on the UN Inter-agency Group for Child Mortality Estimation (UN IGME), were calculated using data collected annually from various sources (vital registration systems, surveys, censuses). These sources record recent births and deaths on an ongoing basis, or they collect retrospective data on child mortality in the form of complete or partial birth histories provided by women. More details about the calculation of child mortality indicators can be found at the UN IGME website.²⁹

2.4 CONTEXTUAL DETERMINANTS

2.4.1 Natural disasters occurrence

Natural disasters considered in this variable are geophysical, meteorological, hydrological, and climatological disasters such as earthquakes, droughts, epidemics, floods and storms. They were assessed as a dummy variable (yes/no), according to the occurrence of natural disasters in a given year, for each department.³⁰

2.4.2 Socioeconomic determinants

- **Gross domestic product (GDP) per capita:** It is the measure of a country's economic output by the number of people in the country. It is calculated as the value of all final goods and services produced in a country in one year, divided by its population. It was estimated adjusting for exchange rate fluctuations and presented as 2010 constant US dollars.³¹
- **Absolute income in Purchasing Power Parity (PPP)-adjusted 2011 US\$:** It is calculated based on national income levels and national income inequality data and expressed as a mean personal annual income in PPP adjusted US\$.¹³

- **Life expectancy at birth:** The average number of years a newborn is expected to live if mortality patterns at the time of birth remain constant in the future. It is calculated based on age-specific mortality rates for a particular calendar period using life tables.³¹
- **Gini coefficient for income:** It is the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution. It measures the area between the Lorenz curve and the hypothetical line of absolute equality, expressed as a proportion of the maximum area under the line. The Gini coefficient is calculated as the area between the diagonal at 45-degree of the graph and the income distribution curve, divided by the total area below the 45-degree diagonal.³²
- **Urbanization:** Percentage of the population living in urban areas. It is calculated using data from national censuses carried out in Haiti and presented in five-year groups with projections until 2050. Linear interpolation is used to derive percentages related to time points of the outcomes.³¹
- **Families living under the poverty line:** Percentage of families living with less than 2 US\$/day. It is calculated based on surveys of living conditions in 2001 and 2012. IHSI adopts the same method recommended by Deaton and Zaidi in 2002³³ using total annual household consumption.³²
- **Families living under extreme poverty line:** Percentage of families living with less than 1.23 US\$/day. It is calculated based on surveys of living conditions in 2001 and 2012. IHSI adopts the same method recommended by Deaton and Zaidi in 2002³³ using total annual household consumption.³²
- **Human development index (HDI):** It is a composite index that is calculated using life expectancy at birth, education, and per capita income indicators, and ranks countries into four tiers of human development.³⁴
- **Women's schooling:** Median years of schooling among women ages 15 years and older. It is calculated using the population of women aged 15 years and older and the highest level of education attained.²⁸
- **Women's employment (%):** Percentage of women who have a paid employment and hold a written or oral employment contract, which stipulates a fixed remuneration, that is not directly dependent upon the revenue of the unit for which they work. It is calculated from econometrics models based on data from national labor force surveys. The denominator includes all women aged 15 years and older according to the minimum age convention (C-183) for admission to employment that was ratified in Haiti in 2009.³⁵
- **Total fertility rate (TFR):** Total number of children born or likely to be born to a woman in her lifetime if she were subject to the prevailing rate of age-specific fertility in the population. The fertility rate is calculated for the three-year period preceding the survey using detailed birth histories provided by women aged 15 to 49 years old. TFR is the sum of the age-specific fertility rates for all women multiplied by five. The age-specific fertility rates are those for the seven 5-year age groups from 15 to 19 and from 45 to 49.²⁸

2.4.3 Political determinants

- **Index of political stability/no violence:** Political stability and absence of violence/terrorism reflects perceptions of the possibility that the government will be disrupted or overthrown by illegal or violent actions, including politically motivated violence and terrorism. The index values

range from -2.5 (weak governance estimate) to 2.5 (strong governance estimate). Details of the index calculation can be found elsewhere.³⁶

- **Control of corruption index:** Reflects opinions of the extent to which private advancement, including both petty and grand forms of corruption, is gained among those with public power, as well as the level of influence exerted by the elites and private interests in the state. The index values range from -2.5 (weak governance estimate) to 2.5 (strong governance estimate). Details for calculation of the index of control of corruption could be found elsewhere.³⁶

2.4.4 Policies, programs and financing within the health sector

- **Total ODA for RMNCH:** Total disbursement allocated to reproductive, maternal, neonatal and child health activities including safe motherhood, care during childbirth and newborn care. It is calculated using the total disbursement in international dollars received by the country each year for RMNCH.¹⁴
- **Total health expenditure in million US\$.** It is the sum of general government health expenditure, private health expenditure and expenditure from external cooperation in a given year, calculated in national currency units in current prices. It is calculated using two main sources of data. Primary data refers to data collected from donors, NGOs, health care providers, insurance companies, among others. Secondary data is based on reports from institutions involved in the management or coordination of technical and financial partners and NGOs, as well as, surveys on living conditions in the country. Such data were processed by the National Health Accounts (HAPT) production tool in accordance with the principles of the Health Accounts System methodology.³⁷
- **Per capita total expenditure for health:** It is the total expenditure for health divided by the population size for a given year. The sources of data used to calculate this indicator are the same as 'Total health expenditure'.³⁷
- **Total health expenditure as percentage of GDP per capita:** It is the total health expenditure expressed as a percentage of GDP per capita. The sources of data used to calculate this indicator are the same as 'Total health expenditure'.³⁷
- **Public health expenditure as percentage of total health expenditure:** It represents the contribution of the government as a percentage of total health expenditure. The sources of data used to calculate this indicator are the same used for the total health expenditure.³⁷
- **Household health expenditure as percentage of total health expenditure:** It represents the total contribution of the household, expressed as the percentage of total health expenditure. The sources of data used to calculate this indicator are the same used for the total health expenditure.³⁷
- **Density of health workforce:** Number of health workers (doctors, nurses and midwives) per 10,000 population.³⁸⁻⁴⁰
- **Density of health infrastructure:** Number of health infrastructure (public, private, mixed) per 10,000 population.^{38, 40, 41}

2.5 ENVIRONMENTAL DETERMINANTS

- **Improved household drinking water:** Proportion of households that use water sources that, by nature of its construction or through active intervention, are protected from outside

contamination, in particular from contamination with fecal matter. It is calculated using information on what the country considers as improved drinking water sources (tap water, public taps/fountains, pump wells, boreholes, dug wells, protected springs, rainwater, bottled water). The numerator includes the number of household members using improved sources of drinking water and the denominator is the total number of household members.²⁸

- **Improved household sanitation:** Proportion of households that use sanitation techniques that hygienically separate human excreta from human contact. The calculation of improved household sanitation implies flush or pour-flush to piped sewer system, septic tank or pit latrine, ventilated improved pit latrine, pit latrine with slab. The numerator includes the number of household members using improved sanitation facilities and the denominator is the total number of household members.²⁸
- **Clean fuels for cooking:** Proportion of households that use clean fuels for cooking (electricity, liquefied propane gas, natural gas/biogas). The numerator includes the number of household members using clean fuels for cooking and the denominator is the total number of household members.²⁸

2.6 COVERAGE OF RMNCH INTERVENTIONS

All the indicators in this section are obtained from the DHS surveys that are conducted through face-to-face questionnaires.

- **Current use of modern contraceptives:** Percentage of women aged 15-49 years currently married or in a union who are using (or whose partner is using) any modern contraceptive method. It is calculated based on the questions “Are you or your partner currently doing anything or are you currently using a method to delay or avoid pregnancy?” If yes, “which method do you use?” Modern methods comprise oral hormonal pills, the intra-uterine device (IUD), the male condom, injectables, the implant (including Norplant), vaginal barriers method, the female condom, emergency contraception and male and female sterilization. The denominator includes all women aged 15-49 years currently married or in a union, and the numerator those women who (or whose partner) are using any modern method.
- **Demand for family planning satisfied with modern methods:** Percentage of women aged 15-49, married or in a union, who are fecund and do not plan to get pregnant in the next two years who are using any modern contraceptive method. The denominator includes women aged 15–49 that are married or in a union, fecund and do not want to get pregnant in the next two years. The numerator comprises women from the denominator who (or their partner) are using any modern contraceptive method.
- **Antenatal care (four or more visits):** Percentage of women who attended antenatal care (ANC) at least four time during pregnancy with any provider (skilled or unskilled) for reasons related to pregnancy. It is assessed through the question “During this pregnancy, how many times did you receive prenatal care?” Response options included the number of times they received ANC. The numerator includes number of women aged 15–49 with a live birth in the last five years preceding the surveys, attended at least four times during pregnancy by any provider (skilled or unskilled) for reasons related to the pregnancy – only the last live-born child is considered. The denominator includes total number of women aged 15–49 who had a live birth occurring in the same period.

- **Tetanus toxoid in pregnancy:** Percentage of women who received two or more shots of tetanus during pregnancy, with at least one during the ANC visit. This indicator is calculated using two main questions “During this pregnancy, were you injected into the arm to prevent baby to have tetanus, that is, convulsions after birth?” and, “During this pregnancy, how many times have you been injected against the tetanus?” Response options included yes and number of times, respectively. The numerator includes women who received two or more shots of tetanus during pregnancy with at least one during an ANC visit, and the denominator includes women aged from 15 to 49 years with a live birth in the last five years preceding the surveys.
- **Skilled attendant at delivery (SBA):** Percentage of live births attended by skilled health personnel as defined by the country in each survey. Skilled health personnel include doctors, nurses, midwives and auxiliary midwives. This information was obtained through the question “Who assisted with the delivery of (Name of the child)” The options included are as followed: Health personnel (doctors, nurses and midwives, auxiliary midwives), other personnel (community health worker, traditional birth attendant, healers, priest vodou, among others). It is calculated for the last live birth in the five years preceding the surveys. The numerator includes pregnant women that were delivered by a health professional in the last five years preceding the survey, and the denominator is made up of all live births during the same period among women aged 15 to 49 years old.
- **Institutional delivery:** Percentage of births delivered in health facilities in the last five years. The question for this indicator was “Where did you give birth to (NAME)?” The discrete nominal response variable was as followed: home (respondent’s home or another non-institutional setting); Public sector (public hospital, health center, dispensary, maternity); private medical sector (private hospital or clinic, health center, dispensary, maternity), or mixed sector (hospital/clinic, health center, dispensary, maternity). Public, private and mixed sector deliveries were considered as “institutional”. The numerator includes pregnant women who delivered at a health facility, and the denominator, all live births in the last 5 years preceding the surveys among women aged 15 to 49 years old.
- **Early initiation of breastfeeding:** Percentage of newborns who had early initiation of breastfeeding (within the first hour of birth). It refers to the last live birth in the two years preceding the surveys. It was obtained through the question “How long after birth did you put (NAME) on the breast for the first time?” Response options included minutes, hours and days. The numerator includes the number of women with a live birth in the two years prior to the survey who put the newborn infant to the breast within one hour of birth, and the denominator includes the total number of women with a live birth in the period prior to the survey.
- **Exclusive breastfeeding 0-5 months:** Percentage of children exclusively breastfed from birth to five complete months of age. It is calculated as the number of children whose mothers reported that the child received only breastmilk (except for medicines or vitamins) on the day before the survey, among last-born children 0-5 months living with the mother.
- **BCG vaccine:** Percentage of children aged 12-23 months immunized with BCG vaccine.
- **DPT3 vaccine:** Percentage of children ages 12-23 months who received three doses of diphtheria, tetanus and pertussis vaccine.
- **Measles vaccine:** Percentage of children ages 12-23 months who received a measles vaccine.

- **Polio vaccine:** Percentage of children ages 12-23 months who received at least three doses of polio vaccine.
- **Fully vaccinated:** Percentage of children ages 12-23 months who received all doses of BCG, DPT, measles and polio vaccines.

The numerator for immunization coverage included all children who received the specific vaccination and, in the denominator, all living children aged 12 to 23 months. These indicators are calculated using information for children who received specific vaccines at any time before the survey according to the vaccination card or the mother's report.

- **Care-seeking for pneumonia:** Percentage of children aged 0-59 months with suspected pneumonia taken to an appropriate health provider. The numerator includes the number of children aged 0–59 months with pneumonia symptoms (cough accompanied by short, rapid breathing that is chest-related and/or difficult breathing that is chest-related) in the two weeks prior to the survey and who were taken to an appropriate health provider. The denominator includes total number of children aged 0–59 months with pneumonia symptoms in the two weeks prior to the survey.
- **Oral rehydration salt (ORS):** Percentage of children aged 0-59 months with diarrhea receiving oral rehydration therapy. The numerator includes number of children aged 0–59 months with diarrhea in the two weeks prior to the survey and receiving oral rehydration salts. The denominator is made up of the total number of children aged 0–59 months with diarrhea in the two weeks prior to the survey.
- **Composite coverage index (CCI):** It is a weighted average of the coverage of eight preventative and curative interventions selected from family planning, maternity care, child immunization, and case management. It is calculated using the formula:

$$CCI = 1/4 \left(FPS + \frac{SBA + ANCS}{2} + \frac{2DPT3 + MSL + BCG}{4} + \frac{ORT + CPNM}{2} \right).$$

Where FPS = demand for family planning need satisfied; SBA = skilled birth attendant; ANCS = 1+ antenatal care visits with a skilled provider; DPT3 = three doses of diphtheria– pertussis–tetanus vaccine; MSL = measles vaccination; BCG = BCG (tuberculosis) vaccination; ORT = oral rehydration therapy for children with diarrhea; CPNM = care-seeking for suspected pneumonia in children.

2.7 INEQUALITY MEASURES

Four measures of inequality are used to describe inequality for coverage indicators and outcomes. These measures are the difference and ratio (simple measures of inequality), and the slope index of inequality and the concentration index (complex measures).^{42, 43}

Simple measures of inequality establish pairwise comparison of health between two subgroups such as households from rural and urban areas. Such measures can be calculated for all health indicators and dimensions of inequalities, and the results are simple and easy to understand. When we need to compare only two subgroups and want to assess absolute and relative inequality, simple measures of inequality are the best option. However, when using simple measures of inequality for more than two subgroups, all but the extreme subgroups are ignored, and the size of the subgroups in the population are not taken into account.^{42, 43} In contrast, complex measures of inequality use data from all the subgroups, ordered or

not, as well as the size of the subgroups in the population to assess inequality, and can be calculated for all health indicators with more than two subgroups. Complex measures of inequality produce a single number representing the amount of inequality across all subgroups of a population.^{42, 43}

Difference: It is a measure of absolute inequality and is calculated using the mean value of a health indicator in one subgroup, subtracted from the mean value of the health indicator in the other subgroup.

Ratio: It is a measure of relative inequality calculated using the mean value of a health indicator in one subgroup, divided by the mean value of the health indicator in the other subgroup.

Slope index of inequality (SII): It is a complex measure of absolute inequality used to show the absolute difference, in the same units of the health indicator, between the two extremes of the wealth distribution. To calculate SII, the sample is ranked from the lowest to the highest socioeconomic status. Then, coverage for the top and the bottom of the wealth scale are estimated through a logistic regression model where the endpoint is the coverage and the independent variable is the wealth rank.⁴⁴ An SII of zero indicates absence of inequality. Positive values indicate that the outcome is more prevalent in the rich, while negative values mean that the indicator is more prevalent in the poor.^{44, 45} Typically, the SII for health interventions such as vaccination is positive, while for negative health outcomes such as stunting, it takes negative values.

Concentration index of inequality (CIX): It is a complex measure of relative inequality that shows the health gradient across multiple subgroups with natural ordering. The CIX is similar to the Gini index that is commonly used to describe income concentration. It also takes values from -100 to 100, where zero means there is no inequality between subgroups. Negative values indicate concentration of the health indicator towards the poorer, and positive values concentration towards the richer.^{38, 41, 43, 46}

2.8 TREND ANALYSES

For the trend analyses, we estimated the average absolute annual change that give an idea of how much the indicator being examined changed in coverage or prevalence per year. For example, an average absolute annual change of 2 percentage points for contraceptive prevalence, means that, on average, every year the coverage was 2 percentage points higher than the previous year. The changes were estimated through variance weighted least square regression using the estimates available for each survey.

2.9 FINANCIAL FLOW ANALYSIS

We carried out national level descriptive time trend analyses of health financing from 2003 to 2013. This includes the total health expenditure as a percentage of GDP per capita, the household health expenditure as a percentage of total health expenditure, the public health expenditure as a percentage of total health expenditure, and the ODA for RMNCH. Information on health expenditure from 2010 to 2013 was obtained, as mentioned earlier, from the National Health Accounts.³⁷

Information on ODA was retrieved from Grollman C et al.,¹⁴ from 2003 to 2013. ODA refers to the international aid provided to developing countries for the purpose of improving the economic development and welfare in areas such as RMNCH. Disbursements are analyzed in million of US\$ and provide information for a series of interventions related to the RMNCH, such as family planning, prevention of mother to child HIV transmission (PMTCT), sexual health, immunization, integrated management of childhood illness (IMCI), amongst others. In our analysis, instead of using information on ODA disaggregated by each intervention separately, we used three categories of disbursements, namely

total disbursement for reproductive health (RH), total disbursement for maternal and neonatal health (MNH), and total disbursement for child health (CH).

2.10 HEALTH SYSTEM AND POLICY ANALYSIS

For policy and health system analysis, we used the same standardized tools developed by the Countdown Drivers Technical Working Group: the Policy and Program Timeline Tool, the Policy Tracer indicators and the System Tracer indicators.⁴⁷ We reviewed information on policies and programs carried out in Haiti since 1990 till 2017, from different published and unpublished sources involving different sectors such as the Haitian MOH, the Ministry of Social Affairs, WHO, other UN agencies, and NGOs active in the country. Part of this information was obtained from key informants and part through a desk review performed by our team.

Moreover, we conducted two mini-workshops and interviews with key informants from different national and international organizations, to discuss main policies and programs related to RMNCH, in addition to validating the information collected through the literature review.

2.11 DETERMINANTS OF MORTALITY AND MALNUTRITION

2.11.1 Bivariate correlations

To explore the magnitude of the associations and their directions and to validate the outcome variables of mortality and height for age, we ran national and departmental bivariate correlations between them and well-established determinants for the whole study period (1990 to 2018).

2.11.2 Departmental ecological multilevel analyses

A multilevel mixed-effects linear regression analysis was performed to assess the effect of the determinants of our conceptual framework on the study outcomes, over time and across departments. However, most of the contextual factors proposed previously were not available for the country at the departmental level. Even when available, they did not coincide with the same DHS time points. Therefore, GDP per capita, Gini coefficient, poverty line, life expectancy at birth, index of political stability, index of control of corruption, ODA per capita, health expenditure, density of health workforce, density of health infrastructure and women's employment were not included in the modeling exercise. For such determinants, we described the trends over time at national and departmental level, as well as their correlation with the outcomes, when applicable.

Other determinants such as the HDI, use of modern contraceptive methods, SBA and early initiation of breastfeeding were excluded to avoid multicollinearity in the analysis. For example, instead of using both SBA and institutional delivery, we opted for using institutional delivery, due to the high correlation that exists between them.⁴⁶

Thus, the multilevel analysis consisted of indicators included in the conceptual framework for natural disasters occurrence, the socioeconomic determinants (urbanization, women's schooling, absolute income and TFR), the indicators of environmental determinants (access to improved drinking water, improved sanitation, clean fuel for cooking), as well as the pre-selected indicators for coverage of RMNCH interventions due to its relationship with the outcome, as explained earlier (family planning needs satisfied with modern methods, 4 or more visits of antenatal care, institutional delivery, exclusive breastfeeding, care-seeking for symptoms of pneumonia, ORS, CCI) (Table 1). The conceptual framework was used to guide the multilevel analysis.

The unit of the analysis was each time point available per department. Given that the original classification and grouping of departments changed over time, we had to harmonize it so that we had the same subnational areas in each time point. In 1994 and 2000, the departments were grouped into nine departments. In later surveys we had 10 or 11 departments. In the analysis we grouped the households consistently into nine departments: Ouest (including Port-au-Prince metropolitan area), Artibonite, Centre, Grande-Anse/Nippes, Nord, Nord-Est, Nord-Ouest, Sud, and Sud-Est. We, therefore, ended up with 45 (9 departments x 5 surveys) time points as our units of analysis. These level one units of analysis were grouped into the level two units (departments) in the multilevel model, so that any correlation within department is taken into account by the model.

The model included the fixed effects of the determinants at each level of the conceptual model, as well as the fixed effect of time. We performed the modelling at the departmental level due to the theoretical advantages of the individual modeling and that it is tightly driven by individual characteristics, such as education.¹⁵ We aimed to use a parsimonious model with great explanatory predictive power, capable of explaining the results using the right number of predictors. Variables from each level were selected according to their influence on stunting.

For each level of the conceptual framework, starting with level 1, we first ran a crude mixed-effects linear regression between the outcomes and one predictor at a time. Variables with a p-value ≤ 0.20 were selected for inclusion in the adjusted multilevel mixed-effects linear regression. We then used a backward stepwise selection procedure to exclude variables with $p > 0.20$, by starting with the variables with highest p-value. This strategy allowed us to obtain a final model for each level with variables to be incorporated in the next level. In all cases, the model included the variable year that took into account the effect of time.

We repeated the same procedure for level 2, level 4 and level 5. The final model obtained from level 2 was then added to the final model from level 1 and a new backward stepwise selection for level 1 plus level 2 was applied. Variables that remained from this final model ($p < 0.20$) were kept for incorporation in the final model from level 4. In the level 4, we applied again a backward stepwise selection using $p \leq 0.20$ and beginning with the variables with highest p-value. Variables that were already included in the previous level were kept in the model irrespective of change in their p-values or coefficients. Variables selected from level 1 plus level 2 plus level 4 were then added to the final model of level 5, following the same steps. In the final model, variables with $p < 0.05$ were considered statistically significant. Our analysis focused on under-five stunting prevalence because we had no information available for registered child mortality and the data captured by DHS referred to child mortality that occurred within 10 years prior to the surveys.

All the analyses were carried out using STATA (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP).

3 RESULTS

This section summarizes the main results derived from the analysis. First, we describe the trends of the factors under study, as presented in the conceptual framework, from distal to proximal, including the impact indicators. Next, we describe the time trends in inequalities of the different factors and outcomes, stratified by place of residence and by wealth quintiles. We also present national and departmental bivariate correlations between the determinants and the outcomes. Finally, we present the results of the analysis carried out at departmental level, including the multilevel linear regression analyses.

3.1 NATIONAL TIME TRENDS

3.1.1 Natural disasters and political situation

Haiti often faces natural disasters such as hurricanes and earthquakes, which facilitate, in turn, the occurrence of epidemics. On the other hand, the study period has been characterized by political instability. Fig. 2 summarizes the main natural disasters including droughts, floods, epidemics, earthquakes and storms that occurred in the country from 1990 to 2017. Information on disasters was not available for 1991, 1995 and 1997. About 90 natural disasters were registered during this period (5 droughts, 1 earthquake, 7 epidemics, 43 floods and 34 storms), with nearly half occurring between 2010 and 2017. Only in 2005, the country faced three floods and five storms affecting particularly the south regions and the Artibonite department, which resulted in losses of about US\$ 50 million and deaths of about 90 people. In 2010, in addition to two storms, three floods and an epidemic of cholera, part of the Ouest (including the metropolitan area), Sud-Est and Nippes were severely affected by a powerful earthquake, which led to approximately 200,000 deaths and an economic loss estimated in US\$ 8 billion.³⁰

Since 1990, several political incidents occurred in the country, including the military coup against President Jean-Bertrand Aristide in 1991; the embargo imposed by the Organization of American States and the freezing of Haiti's assets abroad from 1991 to 1994; the return of President Aristide and the United Nations military intervention in 1994; the fall and exile of President Jean-Bertrand Aristide and another United Nations military intervention in 2004, the United Nations Stabilization Mission in Haiti (MINUSTAH); and the hunger riots in 2008. The United Nations intervention, whose mission was to establish peace, ended 13 years later in October 2017, once an apparent calm was observed. It was replaced by a follow-up mission, the United Nations Mission for Justice Support in Haiti (MINUJUSTH), which is still operating in the country.⁴⁸

From 1990 to 2017, 15 presidents led the country, out of which only three were able to conclude their five-year mandates. One president (Hérard Abraham) was in power for only 3 days in April 1991. The political situation improved slightly since 2006, with different presidents being elected democratically, although in 2016 a second round of presidential election was postponed due to opposition challenges, resulting in a provisional government. Since February 2017, the country is being headed by a president elected by universal suffrage for a presidential mandate of 5 years.

Fig. 3 shows changes in socioeconomic and political determinants over time. In terms of political stability and control of corruption (Fig. 3A), little progress was observed from 1996 to 2017, and the index of political stability moved only from -0.89 to -0.73, which corresponds to an average absolute annual change of 0.04 (Table 2). The index of control of corruption changed slightly for worse, from -1.11 to -1.28, corresponding to an average absolute annual change of minus 0.02.

As for the trend of economic growth, no relevant progress was observed between 1990 and 2016 (Fig. 3B & 3C). From 1991 to 1994, the GDP per capita in constant 2010 US dollars declined by about 42%, which occurred in parallel with the period of trade embargo imposed on the country.⁴⁹ Since then, the GDP per capita could not recover to the level of 1990.

Likewise, mean annual personal absolute income decreased from US\$ 1,665 in 1994 to US\$ 1,523 in 2005, and began to increase from US\$ 1,545 in 2012 to US\$ 1,607 in 2016 (Fig. 3C).

Income inequality, measured by the Gini coefficient increased from 0.66 in 2001 to 0.76 in 2012,^{50, 51} and the HDI increased only slightly from 0.408 in 1990 to 0.498 in 2017 (Fig. 3D). Despite the increase in income inequality, it seems that some progress was observed in the reduction of extreme poverty. The proportion of families living with less than US\$ 2/day decreased from 76.0% in 2001 to 58.7% in 2012, while the percentage of families living with less than US\$ 1.23/day decreased from 31.4% to 23.8% during the same period.¹² In brief, very little improvement in the Haitian economic situation was observed as of 2012, that is two years after the massive earthquake that hit the country.

Life expectancy at birth increased from 54.6 years in 1990 to 63.0 years in 2015 (Fig. 3E). Median schooling years for women increased sharply, from 2 years in 1994 to 6 years in 2016 (Fig. 3F). The proportion of people living in urban areas increased by 63% from 1994 (32.4%) to 2016 (52.9%) (Fig. 3G), with an average absolute annual change of 0.93 percentage points (Table 2). The total fertility rate (TFR) also had an important reduction, from 5.0 in 1994 to 3.1 in 2016 (Fig. 3H), meeting the target determined by the Haitian Ministry of Health (MOH) for 2016.⁵²

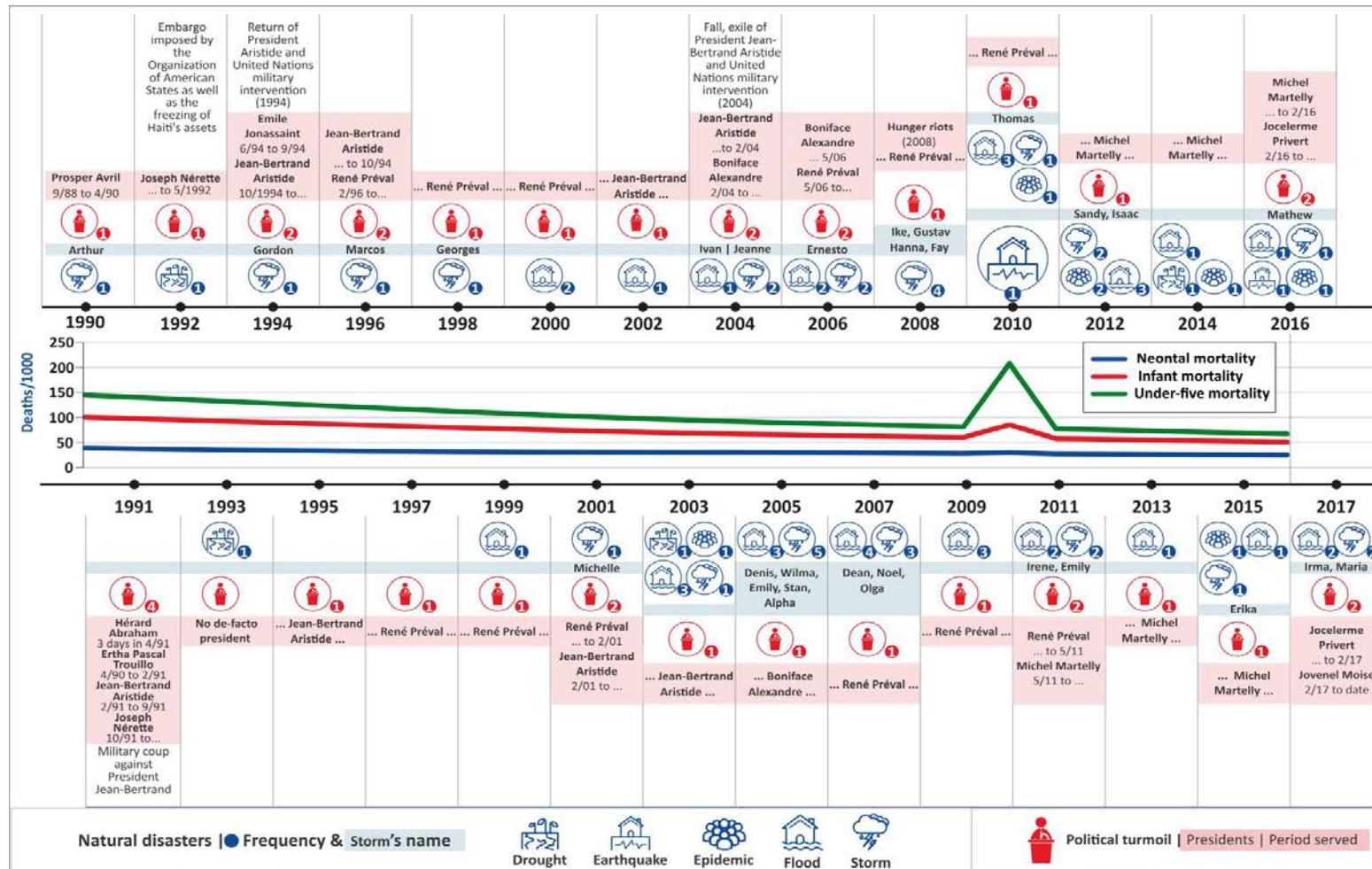
Fig. 4 displays the proportion of women with paid employment, which decreased slightly from 10.6% in 2000 to 9.1% in 2017.

Table 2: Average absolute annual change in determinants and outcomes for Haiti between 1990 and 2017.

Determinants and outcomes	Average absolute annual change (AAAC)	
	Coverage and outcomes (SE)	SII (SE)
Political stability	0.04 (0.01)	-
Control of corruption	0.02 (0.01)	-
GDP per capita in constant 2010 US\$	-5.34 (1.2)	-
Human development index	0.00 (0.00)	-
Women's schooling	0.20 (0.03)	-
Absolute income	-3.67 (3.18)	-
Urbanization	0.93 (0.08)	-
Life expectancy at birth	0.34 (0.02)	-
Total fertility rate	-0.08 (0.01)	-
Improved drinking water source	0.94 (0.13)	0.19 (0.21)
Improved sanitation	0.89 (0.10)	1.39 (0.25)
Clean cooking fuels	0.12 (0.03)	0.05 (0.37)
Current use of any contraceptive (modern method)	0.82 (0.05)	-1.02 (0.16)
Family planning satisfied (modern methods)	0.98 (0.06)	-0.94 (0.20)
Antenatal care (4 or more visits)	1.44 (0.08)	-0.90 (0.20)
Neonatal tetanus protection	0.79 (0.07)	-0.84 (0.23)
Institutional delivery	0.93 (0.07)	0.26 (0.14)
Skilled attendant at delivery	0.97 (0.08)	0.28 (0.13)
Early initiation of breastfeeding	0.37 (0.11)	-0.77 (0.32)
Exclusive breastfeeding (0-5 months)	1.98 (0.09)	0.12 (0.34)
BCG immunization	0.55 (0.12)	-0.59 (0.35)
DPT3 immunization	0.84 (0.13)	0.05 (0.39)
Polio immunization	0.78 (0.13)	-0.34 (0.39)
Measles immunization	0.69 (0.13)	-0.12 (0.40)
Full immunization coverage	0.65 (0.12)	-0.14 (0.39)
Care-seeking for symptoms of pneumonia	0.52 (0.37)	0.88 (1.17)
Diarrhea treatment: Oral rehydration salts	0.86 (0.11)	-0.93 (0.33)
Composite coverage index	1.07 (0.08)	0.48 (0.05)
Under-five stunting prevalence	-0.65 (0.06)	-0.03 (0.16)
Neonatal mortality rate	-0.29 (0.16)	0.00 (0.00)
Infant mortality rate	-1.50 (0.21)	0.06 (0.04)
Under-five mortality rate	-2.86 (0.28)	0.16 (0.07)

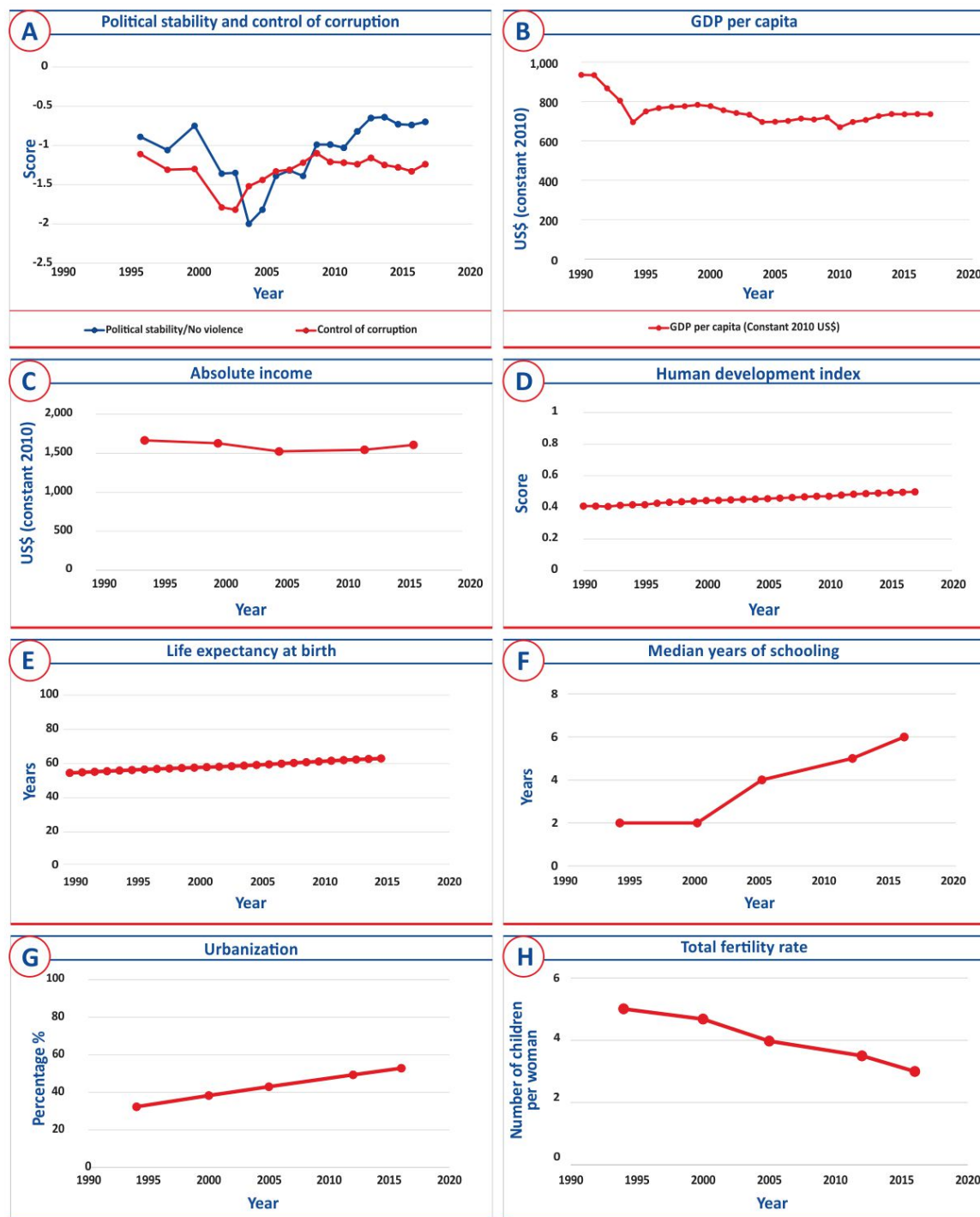
SII: slope index of inequality.

Figure 2: Main natural disasters, political incidents, number of presidents, and mortality rate among children in Haiti, from 1990 to 2017.



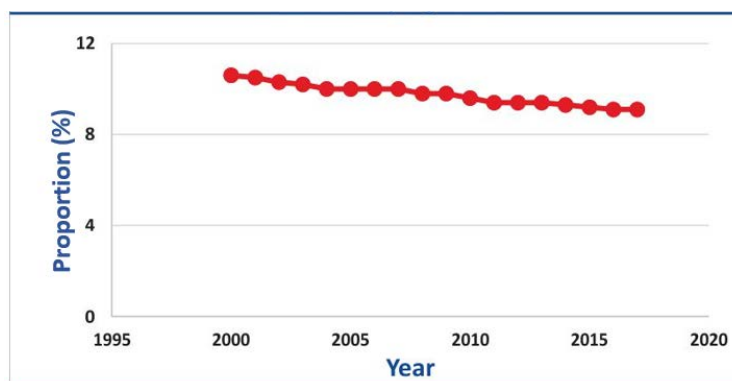
Sources: Natural disasters: CRED-EMDAT³⁰, political incidents and number of presidents: World Bank.¹²

Figure 3: National time trends in socioeconomic and political determinants, Haiti.



Various sources: Political stability/control of corruption: WGI. GDP per capita: ECLAC.³¹ Absolute income: Fink et al.,¹³ Human development index: UNDP.³⁴ Life expectancy at birth: ECLAC. Women’s schooling: DHS. Urbanization: IHSI. Total fertility rate: DHS.

Figure 4: National time trends in proportion of women in paid employment in Haiti, from 2000 to 2017.



Source: ILO (www.ilo.org).

3.1.2 Health policies, programs and financing

Despite the political instability, natural disasters and economic stagnation, a number of health policies and programs were implemented by the government in the country since the 1990's. Fig. 5 summarizes key policies and programs that are likely to have influenced the observed increase in life expectancy and reduction in the total fertility rate described above.

The role of NGOs in the implementation of different strategies directly or indirectly related to RMNCH is prominent in Haiti. Both the frequency of natural disasters and political turmoil favored, at least in part, a rapid increase in the number of NGOs active in the country, particularly after the 2010 earthquake. According to key informants, this factor has contributed to weaken even more the capacity of the government to plan for the health sector and to satisfy the basic needs of the population, particularly after emergency situations, as most of the external aid along with the capacity building efforts, go to the NGOs and not to the national government.^{53, 54}

In 2013, the number of NGOs registered at the Ministry of Planning and External Cooperation (MPCE) was estimated at about 500 NGOs⁵⁵. Of these 500, over 235 NGOs were working in the health sector.⁵⁶

Among several RMNCH-related strategies adopted by the government between 1990 and 2000, we can highlight the National Health Policies introduced in 1991 and in 1996,⁵⁷⁻⁵⁹ the Sante Fanm program in Centre by Zanmi Lasante implemented since 1994, the Integrated Management of Childhood Illness (IMCI) introduced in 1995 and then expanded at national level, the National Campaign to Promote Exclusive Breastfeeding for six months in 1995, the National Strategic Plan in Reproductive Health launched in 1996, the Program of Management and Integration of Reproductive, Maternal, Neonatal and Child Health Services introduced by GHESKIO Centers (1996), the National Plan for Maternal Mortality Reduction (1997), the adoption of the Ottawa Chart for Health Promotion as well as the Integrated Health Program Cuba-Haiti in 1998, also known as "Cooperación Haitiano-Cubana".⁶⁰

The National Strategic Plan in Reproductive Health was introduced in 1996 and one of its objectives was to reduce maternal mortality rate from 457 to 300 per 100,000 live births and the TFR from 4.8 to 3.6 children per woman by 2000.⁴⁰ However, the literature showed that these goals were far from being achieved in 2000.^{7, 10} Likewise, the National Plan for Maternal Mortality Reduction, launched in 1997, aimed to guarantee access to high quality maternal care to all women during pregnancy, childbirth and postpartum, to ensure that 80% of home deliveries are performed by trained traditional birth attendants (also known as matrones). It also aimed to promote the use of family planning across the country to

reduce the number of unwanted pregnancies, especially among teenagers, and to educate 80% of the population about the problem of maternal mortality.⁴⁰ However, the impact of this policy in the country remains unknown.

The National Expanded Program on Immunization (EPI) was launched well before the 1990's to reduce infant and child mortality. However, the EPI faced several difficulties in achieving its goals, such as few institutions participating in the EPI service delivery network, daily long waiting times at health institutions for child vaccinations, lack of epidemiological surveillance, and lack of government involvement in funding program activities, among other difficulties.⁵⁷ To improve the performance of the program, the Full Multi-Year Plan of the Expanded Program on Immunization-PPAc-PEV-2011-2015 was launched in 2011, with the aim to achieve a 90% immunization coverage for all EPI vaccines among children under 1 year of age, and to increase DT2 immunization coverage of pregnant women to at least 80% by 2015. One year later, in 2012, the pentavalent vaccine was introduced to the national vaccination calendar.^{57, 61} Some coverage improvement could be noticed, and the percentage of fully vaccinated children aged 12-23 months increased from 30% in 1994 to 42% in 2016.³⁸

The IMCI implementation, which aimed to reduce under-five mortality, was hampered by low budgetary allocation, unequal distribution of resources between the different IMCI components, fragmentation of the activities, lack of collaboration between the involved actors, lack of monitoring and evaluation data, lack of leadership and coordination by the MOH, and heavy dependence on international aid.⁵⁶

The GHESKIO centers and Zanmi Lasante are two NGOs that have been working in the country to fight the HIV/AIDS epidemic, among other problems. GHESKIO Centers operate in 7 out of the 10 country departments, while Zanmi Lasante covers the other 3 departments. Key informants from GHESKIO reported that the management and integration of reproductive, maternal, neonatal and child health services, implemented at national level since 1996, was associated with a reduction of mother to child HIV transmission rate from 30% (1996) to 3% (2018). Furthermore, over 15,000 medical personnel (doctors, nurses, laboratory technicians and social workers) from the public & private sector and over 400,000 faith-based and community leaders have been trained to date at GHESKIO centers.⁶²

The Sante Fanm program, run by Zanmi Lasante, aimed to provide quality health services to women of reproductive age and to pregnant women, and to reduce the maternal mortality rate. By 2000, it had provided free obstetric care to over 30,000 women in the Centre department. Additionally, this program is responsible for providing about 25% of long-term family planning across the country (www.pih.org). Key informants reported that the departments covered by Zanmi Lasante, particularly the Centre department, are listed among the best performers in terms of progress in RMNCH indicators.³⁸

The adoption of the Ottawa Chart for Health Promotion stimulated the adoption of policies for health promotion by the MOH. For instance, we can highlight the creation of a Directorate for Health Promotion and Environmental Protection and the adoption of the National Health Promotion Policy in 2009.⁶³

The "Cooperación Haitiano-Cubana" that was launched in 1998 to support the MOH to strengthen the Haitian health system, has two main components. First, the deployment of Cuban health professionals (doctors, nurses, and other health cadres) to provide medical assistance to the Haitian rural population. The second is to train Haitian medical students in Cuba, whom upon graduation must return to their communities of origin, to provide medical assistance to the population. Key informants from the Cuban medical brigade in Haiti reported several key bottlenecks for an improved access to health services, including the socioeconomic situation of the country, distance and transportation problems, a high

prevalence of home births in the country, and the absence of policies for the retention of health professionals.

Haiti was one of the 189 countries that signed the United Nations Millennium Development Goals (MDGs). One of the first actions taken by the government after this commitment was the re-opening of the midwifery school in 2000. Since then, 349 nurse-midwives have been trained and 74 midwives graduated. However, this school, the only one in the country, was destroyed by the 2010 earthquake, which also caused the death of several students and teachers. Besides, key informants from this school reported the difficulties these professionals faced finding a job after midwifery training, which led to the emigration of some of them to other countries.

Other important strategies launched by the government include the prevention of mother to child transmission (PMTCT) of human immunodeficiency virus (HIV) program in 2000 that was reviewed and implemented as of 2006, the First National Nutrition Policy in 2001 that was also implemented as of 2006, and the Strategic Plan of the Health Sector for Reform introduced in 2005 and expanded the same year to the national level.

Regarding the HIV PMTCT program, the number of health institutions offering PMTCT services increased from 113 in 2008 to 139 in 2017. To date, about 40% of health institutions with antenatal care services also offer HIV PMTCT services. In 2016, over 80% of all pregnant women were tested for HIV and of those identified as HIV-infected, 90% received antiretroviral treatment. Likewise, the percentage of HIV-exposed infants who started antiretroviral prophylaxis at birth increased from 47% in 2010 to over 90% in 2016.^{38, 64, 65}

By 2008, the government along with some NGOs launched a series of strategies including the Free Obstetric Care Project (SOG-2008), which provided qualified care to more than 70,000 women and newborns during pregnancy, childbirth and the postnatal period; the Free Infant Care project introduced right after the earthquake in 2010 (SIG-2010) that provided free care to more than 50,000 children under-five;⁶⁶ the Maternal and Child in Health (MATS) introduced in 2011 as a continuation of the SOG and SIG projects;⁶⁷ the national EmOC strategy in 2009 that rehabilitated more than 52 Comprehensive Emergency Obstetric Care (CEmOC) facilities and 39 Basic Emergency Obstetric Care (BEEmOC) facilities, allowing the provision of high quality obstetric and neonatal care to women and newborns across the country (www.mspp.gouv.ht); and the Acute Malnutrition Management Program (PCMA) in 2009, which according to interviewees has positively impacted the nutritional status of the children and facilitated the reduction of national under-five stunting prevalence from 30% in 2006 to 22% in 2017.⁶⁸

In 2007, the government published the National Growth and Poverty Reduction Strategy aimed at taking Haiti out of the category of least developed countries, as well as to improve the living conditions of the population and reduce poverty.^{69, 70} This was considered the first global reference framework for public policies and development programs of the Haitian government, according to key informants.

In 2010, Haiti was affected by a massive earthquake, a turning point in the history of the country. The number of related casualties was estimated at over 200,000 people, and the economic loss reached about US\$ 8 billion. In response, the government launched in that same year the Action Plan for Recovery and Development of Haiti, to improve the country's socioeconomic situation and reduce poverty, while taking into account the National Growth and Poverty Reduction Strategy.⁷¹ This was followed by two other plans, the Haiti's Strategic Development Plan that aimed to make Haiti an emerging country by 2030,⁷² and the Plan for Accelerated Development to Reduce and end Poverty that was launched in 2014, which is still in progress.⁷³ The latter includes the Ede Pèp program, which aims to protect the vulnerable population

living in extreme poverty to ensure, in the long term, the investment in their human capital and in offering them opportunities to get out of the extreme poverty situation. Ede Pèp program consists of different components such as the “Bon Solidarité”, an emergency response program in the form of cash transfer to accompany the victims after a natural disaster occurrence; the “Kantin mobil” and “restoran kominotè” which are responsible for the distribution of food to the most deprived populations in the urban and metropolitan areas of Port-au-Prince, as well as the “Panye solidarite”, which does the same task but for rural deprived populations.⁷⁴ A study carried out in Haiti in 2014 by the World Bank Group revealed that only 11% of the extremely poor population received such assistance from the government, including cash transfer and food aid. According to this study, these strategies are frequently criticized due to lack of sustainable financing and tax prioritization and targeting problems, to implementation difficulties of weak monitoring and evaluation mechanisms, as well as to the funding fragmentation that allocates the budget to multiple small-scale interventions.^{74, 75} It should be highlighted that in 2017, the Ede Pèp program was reviewed and is currently operating as “Kore pep”, which included most components of the Ede Pèp such as “Panye Solidarité”, “restoran kominotè”, “Kantin mobil”, among others.⁷⁶

In terms of RMNCH, a new National Health Policy and the Second Nutrition Health Policy were adopted in 2012.^{59, 77} The Health Master Plan published the same year stipulated specific targets that should be reached to improve RMNCH by 2022.⁵² The MOH aims to reduce maternal mortality ratio by 50% (from 650 to 250/100,000 live births), to increase prevalence of HIV-infected pregnant women on ARV treatment from 86.3% to 100%, to increase prevalence of modern contraceptive use from 31% to 50%, and to increase skilled birth attendance from 37% to 70%. Regarding child health specifically, the targets until 2022 include the reduction of infant mortality rate from 59 to 20/1000 live births, the increase in the percentage of children supported by the IMCI program from 30% to 90%, the increase of DTP3 coverage from 80.4% to 98% and the reduction of under-five stunting from 23.4% to 15%.

The National Strategic Plan for Reproductive Health and Family Planning was launched in 2013, and the National Strategic Plan for Sexual and Reproductive Health was introduced in 2018. Under these policies, the government aims, from 2018 to 2022, to reduce the neonatal mortality rate from 32 to 28 per 1000 livebirths, to reduce the unmet family planning needs among 15-49 year old women in union from 38% to 10%, to increase the coverage of midwifery needs from 10% to 25%, to increase the proportion of institutions offering EmOC services with all essential functions and with qualified health personal from 35% to 50%, and to increase the percentage of BEmOC services with the presence of a midwife from 37% to 60%.⁷⁶

The Kangaroo Mother Care (KMC) initiative, which started in 2011⁷⁸ in the West department, is currently being implemented at national level, but no data is available about the number of health institutions implementing this method or about its impact. According to informants, it has helped to shorten hospital stay after childbirth and to reduce the risk of mothers abandoning their newborns. They also reported that the initiative is well accepted by the population and by health professionals, has a well-trained health staff available, and has the UNICEF's support, even as the sole financial partner.

Of note, apart from the “Kore Lavi project” funded by the USAID in 2013 to provide food vouchers to pregnant and lactating women and to under-five malnourished children in five departments of Haiti, no voucher program or cash transfer from the MOH is currently under-way to encourage pregnant women to seek formal health care services. Only in 2013, the “Kore-Lavi project” provided social assistance to about 109,790 people. Over 18,000 households gained access to locally produced and nutritious foods

through monthly electronic and paper food vouchers, and 7,800 households received monthly voucher-based transfers to buy locally produced food.⁷⁹

Currently, a cash transfer initiative by the project “Ti Mama” is being implemented at a pilot scale in two communities of the south department (Cavaillon since November-2017 and Saint Louis du Sud since April-2018), to encourage pregnant women to seek antenatal and delivery care.

Recently, in 2014, the MOH launched the first phase of Maternal and Infant Health Improvement Project through Integrated Social Services (PASSMISSI), a performance-based financing pilot program in seven health facilities in Nord-Est department, which aimed to increase the quality and equity of maternal and child health services for over 100,000 people, while improving the overall management of health services. An evaluation study of this program conducted in 2017 showed significant improvements in terms of utilization of priority services, of improvement in technical quality of care, and of community satisfaction. Based on these results, the MOH implemented this program in eight out of the 10 departments, through funding from the World Bank, USAID, and the Global Fund.⁸⁰

The literature review and the information provided by key informants highlighted a series of bottlenecks faced by most of the above indicated strategies, which hampered the achievement of their goals. They include but are not limited to political turmoil, lack of political leadership, dependence on international financing, religious beliefs, frequent natural disasters, and precarious socioeconomic conditions.

Another key bottleneck is the lack of a functional information system in the country. To date, the vital registration system is not able to provide complete and updated information for monitoring maternal, neonatal, infant and under-five mortality. This does not allow an appropriate measurement of the impact of RMNCH interventions. Key informants reported that since 2015, some NGOs have tried to monitor maternal mortality in some sentinel sites, but no results have been published to date.

Finally, we observed a mixed picture in the progress of Countdown RMNCH 11 policy tracer indicators dashboard and the health system dashboard. Except for female condom that is not commonly used in the country, all the other medicines related to life saving commodities were included in the essential service package manual published by the MOH in 2015.⁸¹ Since 2010, Haiti had only adopted seven of the eleven policies and had met 94.1% (95/101) of the minimum recommended BEmOC and CEmOC facilities (Fig. 6).⁸²⁻⁸⁴ However, out of the 91 facilities that are currently providing EmOC in Haiti, only 39 (42.9%) are functioning as BEmOC.

Figure 5: Main policies and programs related to reproductive, maternal, neonatal and child health in Haiti, 1990-2018.

A: policies. B: programs. SDGs: Sustainable development goals, EmOC: Emergency Obstetric Care, EPI: Expanded Program on Immunization, HIV: Human Immunodeficiency Virus, PMTCT: Prevention of mother-to-child transmission. PASSMISSI: Maternal and Infant Health Improvement Project through Integrated Social Services.

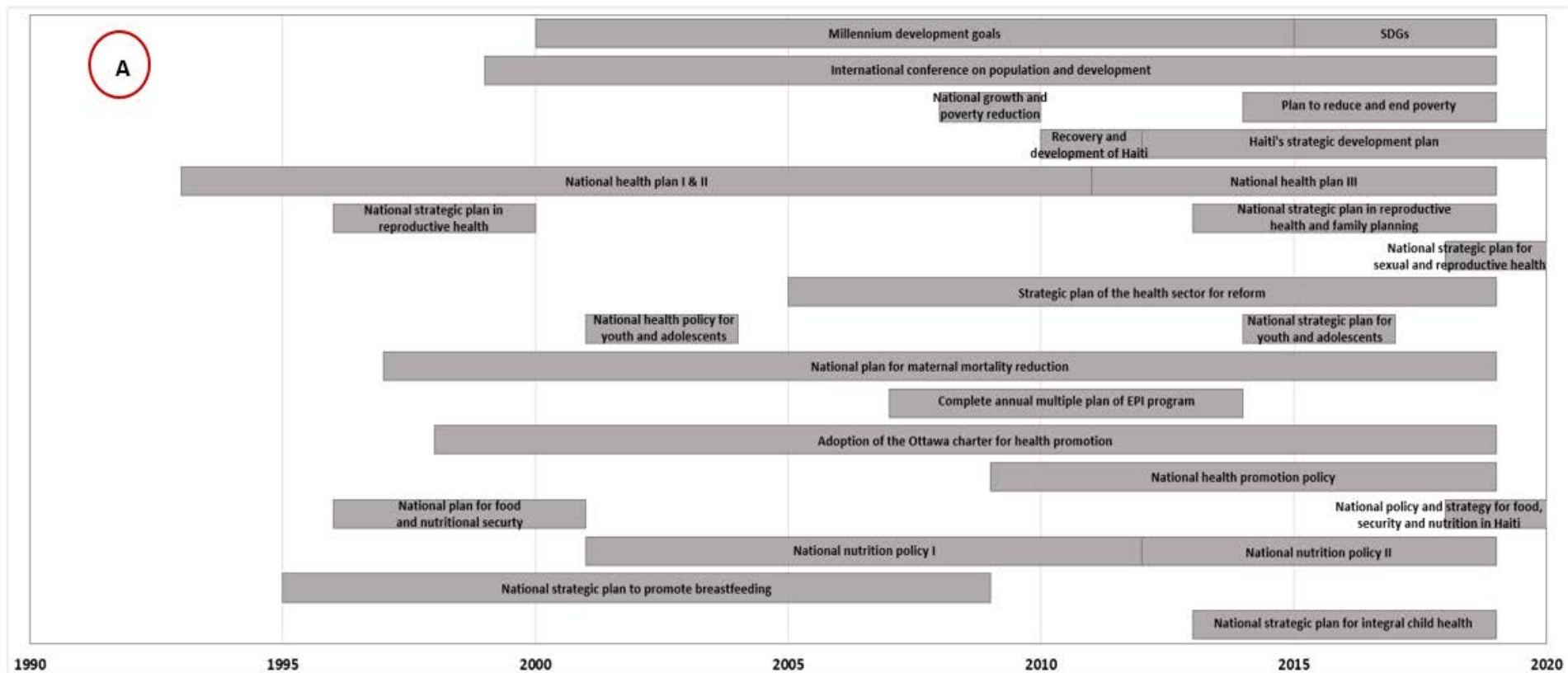


Figure 5 (cont'd): Main policies and programs related to reproductive, maternal, neonatal and child health in Haiti, 1990-2018.

A: policies. B: programs. SDGs: Sustainable development goals, EmOC: Emergency Obstetric Care, EPI: Expanded Program on Immunization, HIV: Human Immunodeficiency Virus, PMTCT: Prevention of mother-to-child transmission. PASSMISSI: Maternal and Infant Health Improvement Project through Integrated Social Services.

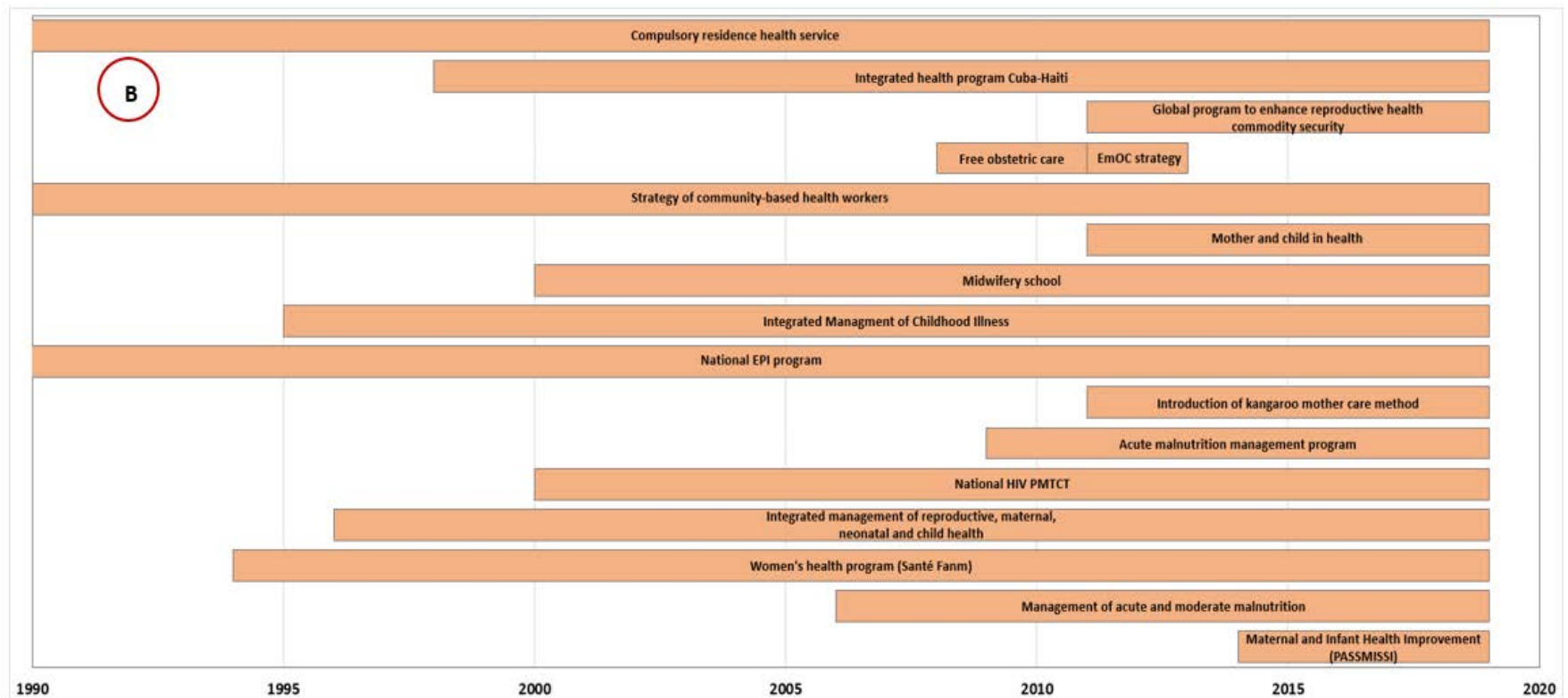


Figure 6: Policy tracer indicators for reproductive (R), maternal (M), newborn (N), and child (C) health policies in Haiti.

Policy tracer indicators		pre-2000	2000-2010	post-2010
R	Family planning for adolescents without spousal or parental consent			
	Legal status of abortion (X 7 circumstances)			
M	Midwives authorized for specific tasks (X 7 tasks)	4*	7	7
	Maternity protection (Convention 183)			
	A national policy to notify all maternal deaths within 24h to a central authority			
M/N	Postnatal home visits in the first week after birth by a trained provider for mother and newborn			
N	Kangaroo mother care for low birthweight or preterm newborns			
	Antenatal corticosteroids for management of preterm labor			
	International Code of Marketing of Breastmilk Substitutes			
C	Low osmolarity oral rehydration solution and zinc for management of diarrhea			
	Community treatment of pneumonia with antibiotics			
	Strategy does not exist			
	Strategy exists			
	Only ORS, not zinc			

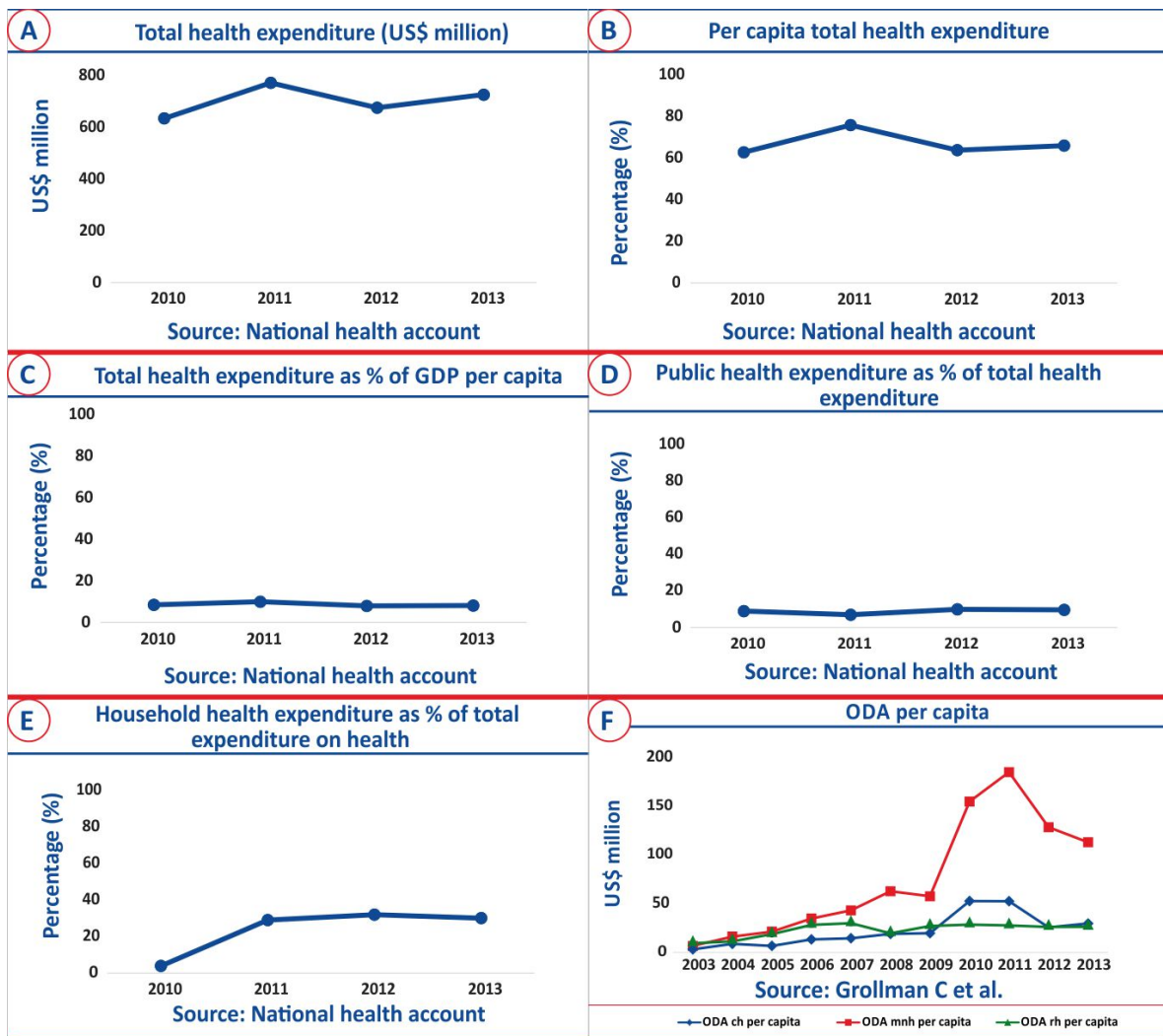
*Administer parental antibiotics, parental oxytocin, assisted vaginal delivery, perform newborn resuscitation

Fig. 7 shows trends in domestic financing and ODA within the health sector. Little change was observed in total health expenditure from 2010 to 2013 (Fig. 7A-7C). There was an increase of US\$ 100 million in total health expenditure, as a consequence of the 2010 earthquake (Fig. 7A). This increase is reflected in per capita total health expenditure and expenditure as a percentage of GDP per capita (Fig. 7B-7C). This also impacts the share of public health expenditure, given that most of the observed increase was due to investments from overseas donors.

Household health expenditure as a percentage of total health expenditure increased by 7.5 times from 2010 to 2011 and then stabilized (Fig. 7E). Such differences between 2010 and 2013 could be explained by the following reasons. First, early after the earthquake in 2010, most services at health facilities were free of charge due to the number of NGOs deployed and acting in the country's health sector, as well as the international aid received by the government. Thus, it was easier for the population to access health care services. Second, this low percentage observed in 2010 could be due to the quality of the data as it was the first report on national health account elaborated in the country. In Fig. 7F, we see that the total disbursement for maternal and neonatal health (red trend line) increased by 11.3 times from 2003 to 2011 and particularly from 2009 to 2011 and decreased from 2012 onwards. Total disbursements to child health (blue line) and reproductive health (green line) also increased, but in a much more modest magnitude.

During the study period there was improvement in the availability of health professionals and facilities. The density of doctors, nurses and midwives per 10,000 population increased from 3.2 in 1998 to 7.7 in 2018.^{38, 40, 85} The density of health infrastructure (public, private, mixed) per 10,000 population increased to a lesser degree, from 0.8 to 1 during the same period.^{39, 41, 85}

Figure 7: National time trends in domestic financing and ODA within the health sector: Haiti, 2010-2013.



Health expenditure source: National Health Accounts (www.mspp.gouv.ht). ODA source: Grollman C et al.¹⁴

NOTE: Fig. 7F presents ODA for child health (blue line), maternal and neonatal health (red line) and reproductive health (green line).

3.1.3 National time trends in health sector indicators

Fig. 8 shows the coverage of reproductive and maternal health interventions from 1994 to 2016. Progress was observed in all five indicators. The percentage of women currently using a modern contraceptive method increased from 13.2% in 1994 to 31.2% in 2016, an estimated average absolute annual change of 0.85 percentage points (p.p.) (Table 2). The percentage of women with family planning needs satisfied increased from 21.2% in 1994 to 44% in 2012, an average absolute annual change of 0.98 p.p. In 1994, 37.4% of pregnant women had at least four antenatal care visits, which rose to 66.6% in 2016, an average absolute annual change of 1.44 p.p. (Table 2). Coverage of pregnant women vaccinated with tetanus toxoid increased slightly from 48.2% to 64.9% during the same period. Regarding births in a health facility, the coverage increased from 19.5% in 1994 to 39.4% in 2016. Likewise, coverage with SBA increased from 20.6% in 1994 to 41.7% in 2016, with an average absolute annual change of 0.97 p.p. (Table 2).

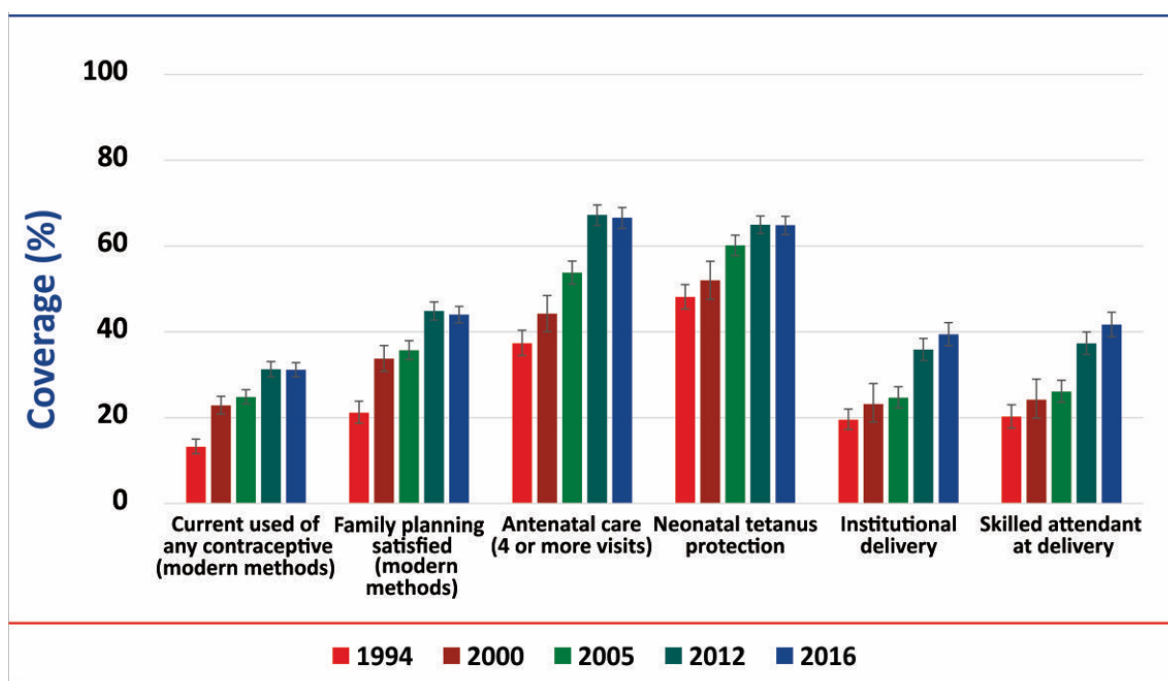
Regarding neonatal and child health interventions, we also observed progress in all indicators (Fig. 9). In terms of breastfeeding, early initiation (within one hour of birth) increased only slightly, but we observed an impressive improvement in exclusive breastfeeding among children less than 6 months of age. The

proportion of children under-6 months exclusively breastfed increased from 2.5% in 1994 to 40.0% in 2016.

The CCI is a weighted average of selected RMNCH interventions and gives a summary of the intervention coverage scenario. Fig. 9 shows its trend over time, with an increase of 60.0%, from 34.6% in 1994 to 55.4% in 2016. We estimated an absolute average annual change of 1.1 p.p. (Table 2).

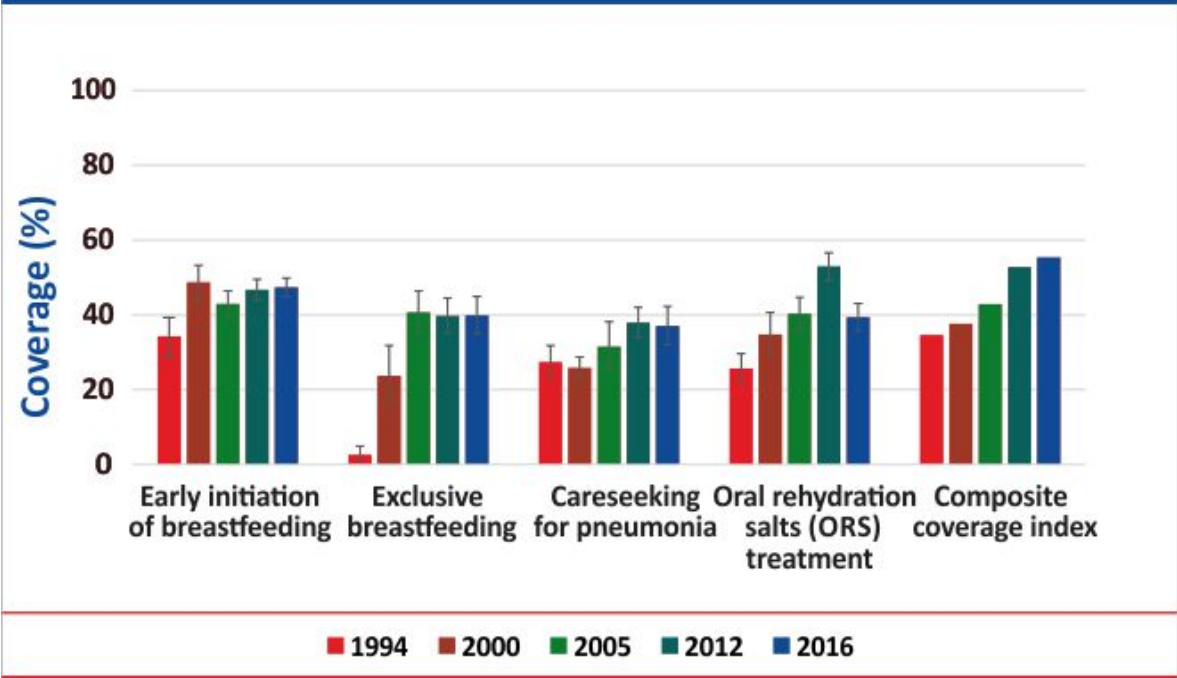
Immunization coverage increased for all vaccines studied from 1994 to 2012. In 2016 a decline in coverage was observed for DPT3, polio and measles. The confidence intervals for 2012 and 2016 overlap, so it is not possible to be sure if this is only due to random variation. The exception was BCG, that is usually given at the health facilities soon after birth. The proportion of children aged 12 to 23 months with full immunization rose from 30.2% in 1994 to 41.8% in 2016, which corresponded to an average absolute annual change of 0.65 p.p. (Fig. 10).

Figure 8: National time trends in coverage of reproductive and maternal health interventions: Haiti, 1994-2016.



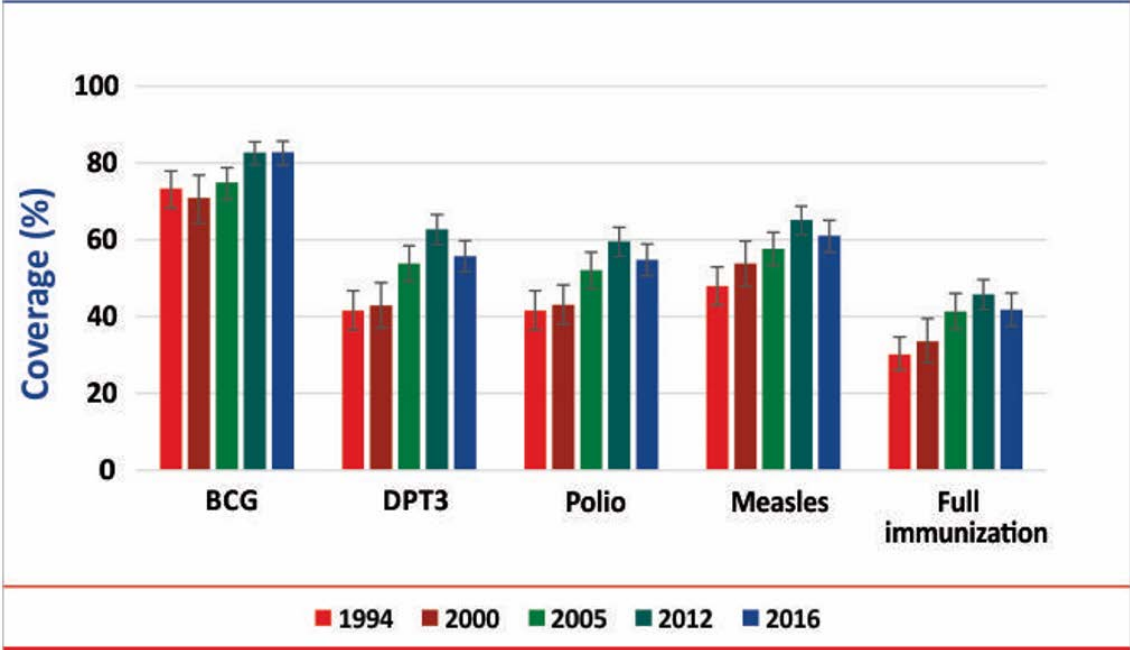
Source: DHS.

Figure 9: National time trends in coverage of neonatal and child health interventions: Haiti, 1994-2016



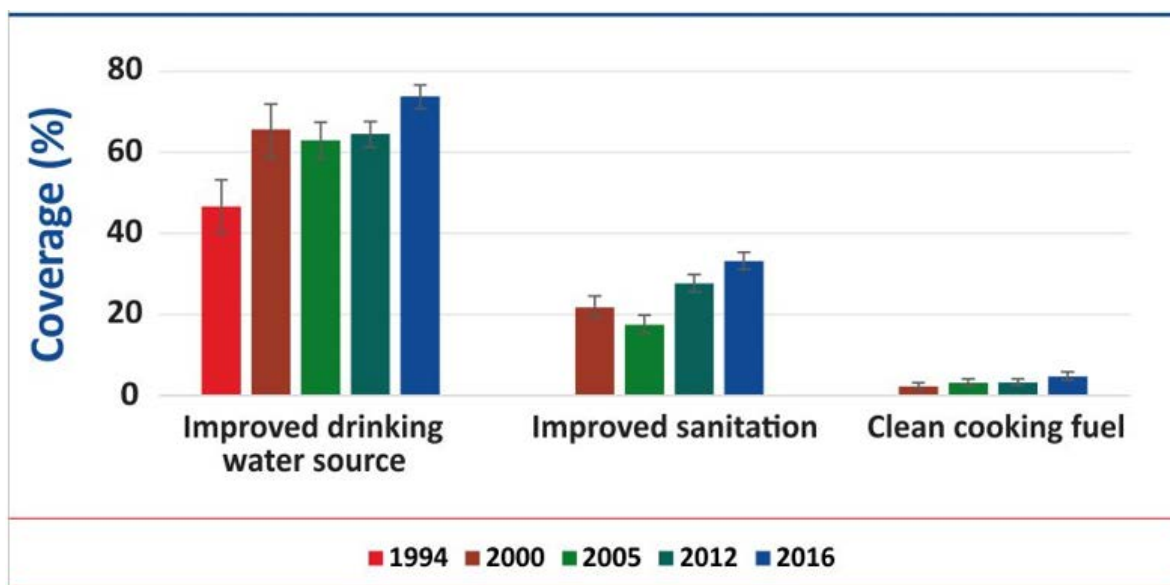
Source: DHS.

Figure 10: National time trends in child health immunization coverage: Haiti, 1994-2016



Source: DHS.

Figure 11: National time trends in household access to improved water and sanitation, and clean cooking fuel: Haiti, 1994-2016



Source: DHS.

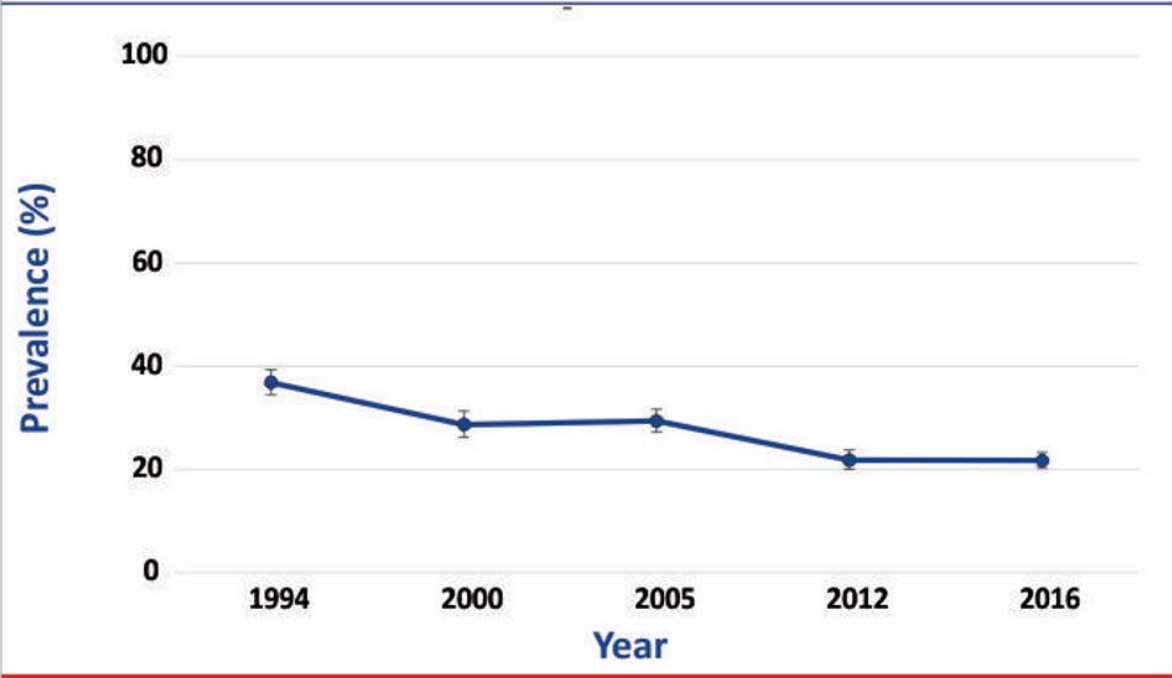
The proportions of families with access to improved water, sanitation and clear fuel are presented in Fig. 11. Coverage with improved drinking water source increased by 57.0%, from 47.0% in 1994 to 74.0% in 2016. The proportion of families with access to improved sanitation increased by 50%, from 22.0% in 2000 to 33.0% in 2016 (no data for 1994). Utilization of clean fuel for cooking, such as gas or electricity, is not common in Haiti. The proportion of households using clean fuel for cooking was 2.3% in 1994 and went up slightly to 5.0% in 2016. The average absolute annual change was 0.94 p.p. for improved drinking water and 0.89 p.p. for improved sanitation (Table 2).

3.1.4 Time trends for the outcomes

The prevalence of stunting in children under-five years of age decreased from 36.8% in 1994 to 21.9% in 2016, with an average absolute annual change of -1.36 p.p. from 1994 to 2000, and -0.66 p.p. from 2005 to 2016. As observed in Fig. 12, the pace of reduction was not constant, and we can observe periods of stagnation from 2000 to 2005 and from 2012 to 2016.

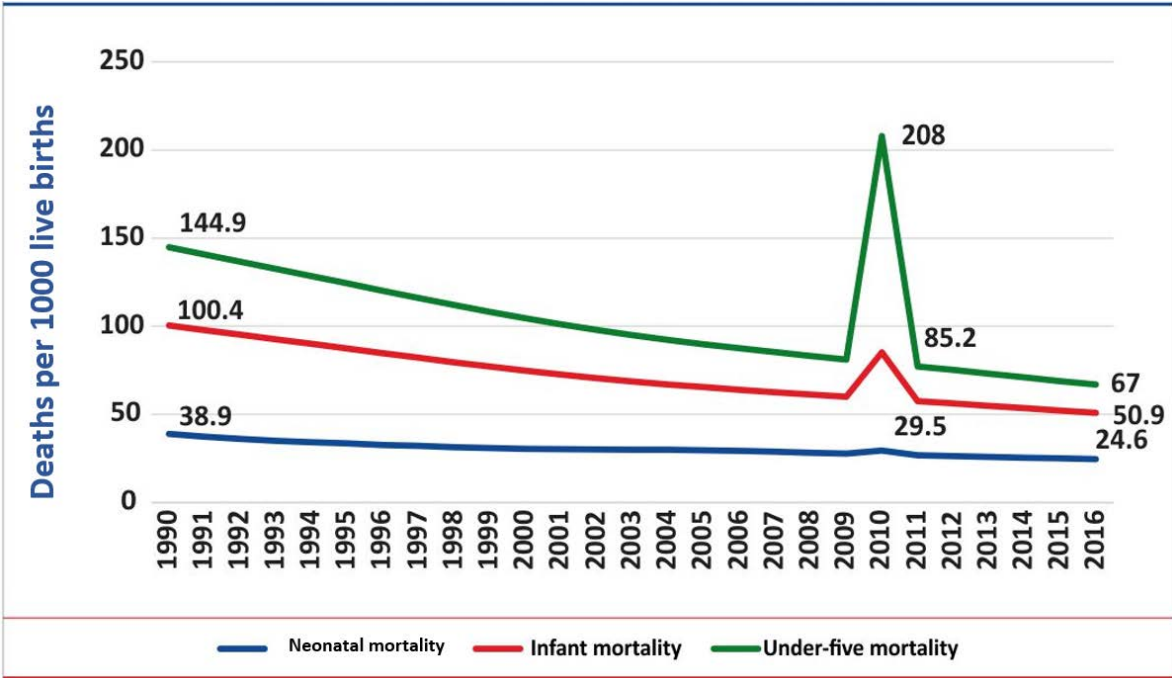
We also observed reductions in childhood mortality rates, using rates estimated by the UN Inter-agency Group for Child Mortality Estimation.²⁹ From 1990 to 2016, the neonatal mortality rate (NMR) decreased from 38.9 to 24.6 per 1,000 live births (a reduction of 36.8%), with an average absolute annual change of -0.29. The infant mortality rate (IMR) decreased by 49.3% from 100.4 to 50.9 per 1,000 live births during the same period, and the average absolute annual change was -1.50. The under-five mortality rate (U5MR) decreased from 144.9 in 1990 to 67.0 in 2016 (a reduction of 53.8%), with an average absolute annual change of -2.86. For both IMR and U5MR, there was a peak in 2010, caused by the powerful earthquake that led to the direct deaths of more than 200,000 people (Fig.13).

Figure 12: National time trends of under-five stunting prevalence: Haiti, 1994-2016.



Source: DHS.

Figure 13: National trends in neonatal, infant and under-five mortality rates: Haiti, 1990-2016



Source: The UN Inter-agency Group for Child Mortality Estimation.²⁹

3.2 TRENDS IN INEQUALITIES OF HEALTH SECTOR INDICATORS AND OF OUTCOMES

3.2.1 Trends in wealth-related inequalities

Modern contraceptive use and demand for family planning satisfied with modern methods showed good progress in terms of inequality reduction (Fig. 14). The coverage for the reproductive interventions

increased for the poorest from 1994 to 2016, with slower progress among the richest, consequently reducing the gap (Fig. 14). The absolute inequality, as measured by the SII, reduced from 29.9 p.p. to 7.6 p.p. in term of demand for family planning need satisfied with modern method (Table 3). However, in 2016, the proportion of the poorest women with family planning needs satisfied was still below 40%.

Regarding maternal and neonatal interventions, there was also progress in coverage and inequalities for 4 or more antenatal care visits. The SII reduced from 64.6 p.p. to 44.8 p.p. for at least 4 antenatal care visits, and from 33.3 p.p. to 13.1 p.p. for neonatal tetanus protection (Table 3). For antenatal care, the poorest quintile is just over 50% coverage.

Coverage of institutional delivery and SBA increased over time, but the gap between the richest and the poorest also increased (Fig. 14). The SII for institutional delivery increased from 63.7 p.p. to 69.6 p.p. and for SBA, it went up from 56.8 p.p. to 71.8 p.p. (Table 3), for the period 1994-2016.

Breastfeeding is not usually favored by the richest mothers, and Haiti is not an exception. Early initiation of breastfeeding has always been higher among the poorest, increasing from 37.7% in 1994 to 52.0% in 2016. The gap increased, since the improvement in coverage was larger among the poorest mothers. Exclusive breastfeeding among children under 6 months of age increased considerably for all subgroups from 1994 to 2016. Again, we do not see a clear socioeconomic pattern. In 2016 the group with the highest prevalence of exclusive breastfeeding was the middle wealth quintile, while the poorest, which started with the highest prevalence, is now relegated, showing the lowest prevalence (Fig. 15).

As observed in Fig. 15, except for the poorest, the percentage of children with suspected pneumonia taken to an appropriate health provider increased slightly for almost all subgroups from 1994 to 2016. The same trend was observed for diarrhea treatment with oral rehydration salts, except for the richest, and the gap between poorest and richest tended also to decrease over time.

As for the CCI, it increased by more than 50% in the poorest from 20.5% in 1994 to 44.5% in 2016, while in the richest it increased by 23% (from 53.4% to 69.5%), with a moderate decrease in the equity gap (Fig. 15).

Coverage with vaccines presented an overall pattern of increase, but the latest survey suggests a worrying trend of reduced coverages for the bottom three quintiles (Fig. 16). This resulted in increased absolute inequality. The SII for full immunization coverage increased from 31.8 p.p. to 39.0 p.p. from 1994 to 2016 (Table 3). Given the key role of vaccines in child health, this is a red alert to authorities in charge of immunization programs.

The percentage of poorest families with access to improved drinking water source varied from 3.4% in the poorest quintile to 66% in the richest quintile in 1994. In 2016, the poorest families with access to improved drinking water rose to 34.7%, while in the richest it increased to 98.1%. However, there is still a substantial remaining gap (Fig. 17). In contrast, the proportion of families with access to improved sanitation remained almost unchanged for the poorest from 1994 to 2016, while in the richest, it increased from 42.1% in 2000 to 70.7% in 2016, and thus the gap between the poorest and the richest increased over time. Likewise, the percentage of families using clean fuel for cooking remained very low for all subgroups, and some improvement from 2000 to 2016 was observed, but only among the richest (Fig. 17).

A similar picture was observed for the inequality trends of the outcomes. The under-five stunting prevalence decreased from 50.1% in 1994 to 34% in 2016 among the poorest, while it decreased from

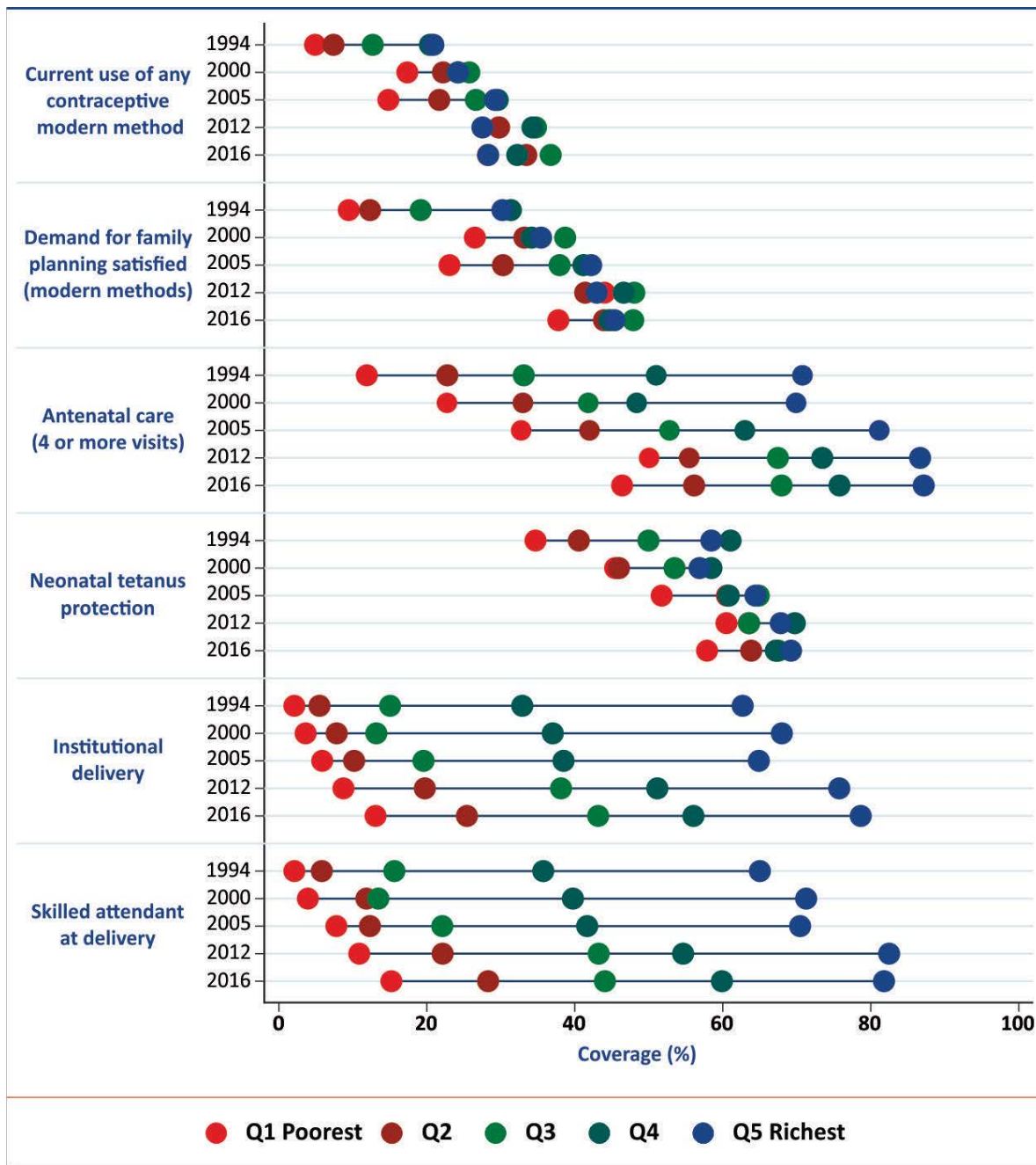
15.3% to 9.4% among the richest. The equity gap also decreased, with the poorest still lagging behind (Fig. 18).

NMR decreased slightly, particularly among the poorest, and by 2016 there was not a big difference between the poorest and the richest (Fig. 19).

By contrast, the reductions in IMR and U5MR were more pronounced for all subgroups. In the poorest, the IMR decreased from 93.6 in 1994 to 62.5 deaths per 1,000 live births in 2016, and in the richest from 73.8 to 48.2. U5MR also decreased from 163.4 to 93.1 among the poorest, and in the richest it decreased from 106.5 to 59.1. NMR and IMR present a linear inequality pattern in 2016, while for U5MR a top inequality pattern is evident, with the richest being well ahead of the other wealth quintiles (Fig. 19).

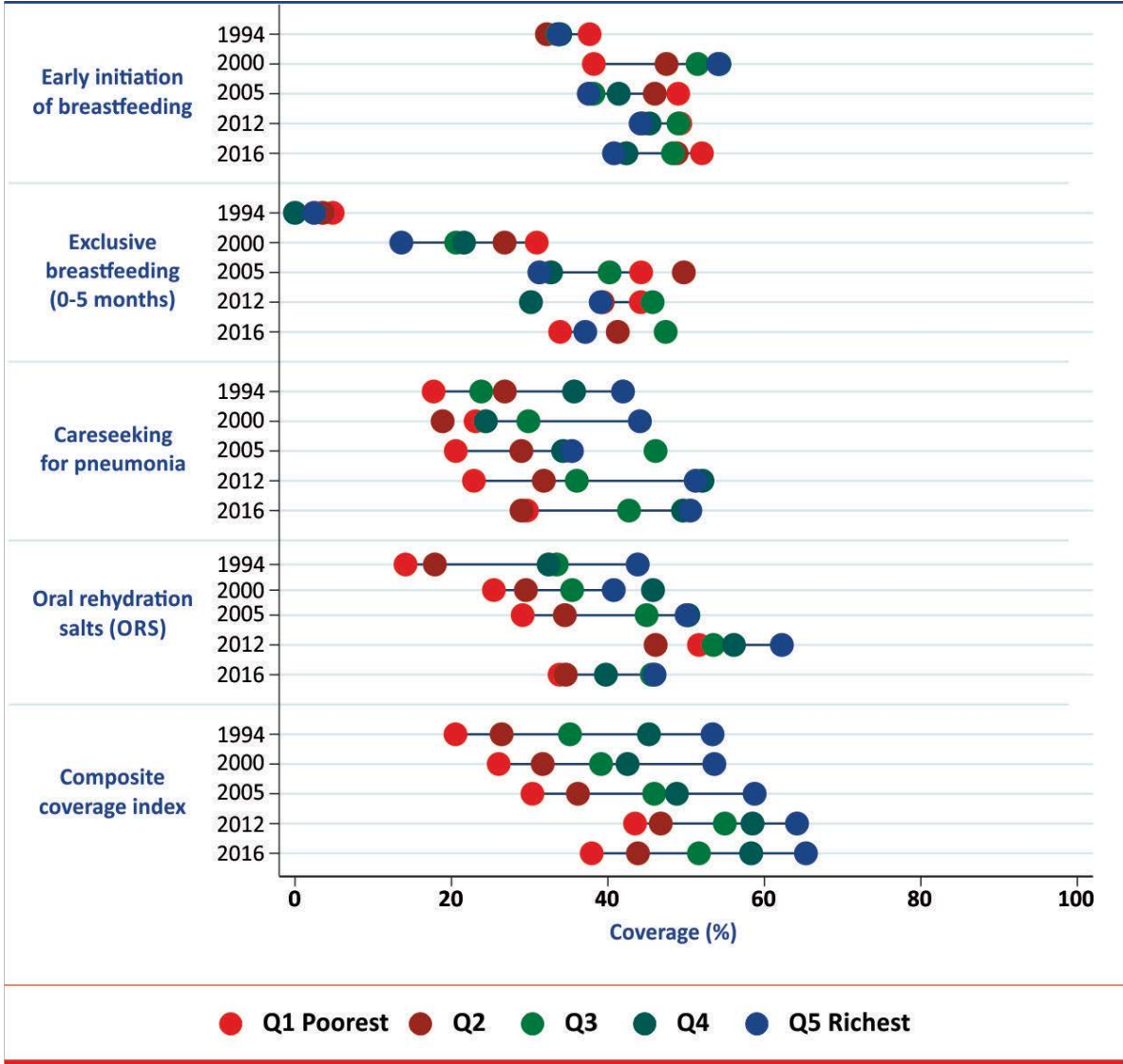
Regarding TFR, the number of children per woman in the poorest varied from 7.3 in 1994 to 5.6 in 2016, while in the richest it decreased from 2.7 to 1.7. The gap between the poorest and richest families remained almost unchanged (Fig. 20).

Figure 14: Inequality time trends of coverage of reproductive and maternal interventions, by wealth quintile: Haiti, 1994-2016.



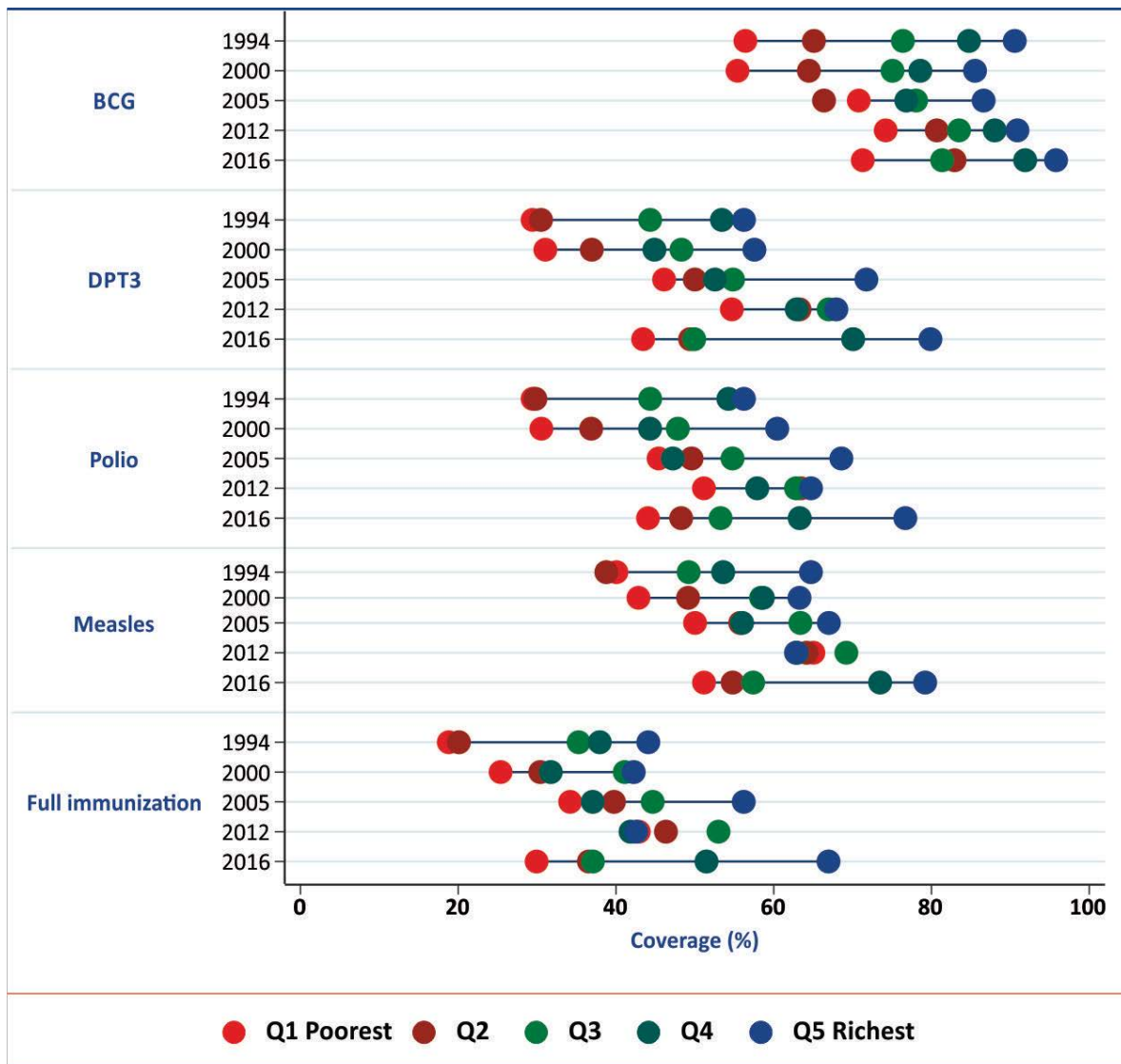
Source: DHS.

Figure 15: Inequality time trends of coverage of neonatal and child health interventions, by wealth quintile: Haiti, 1994-2016.



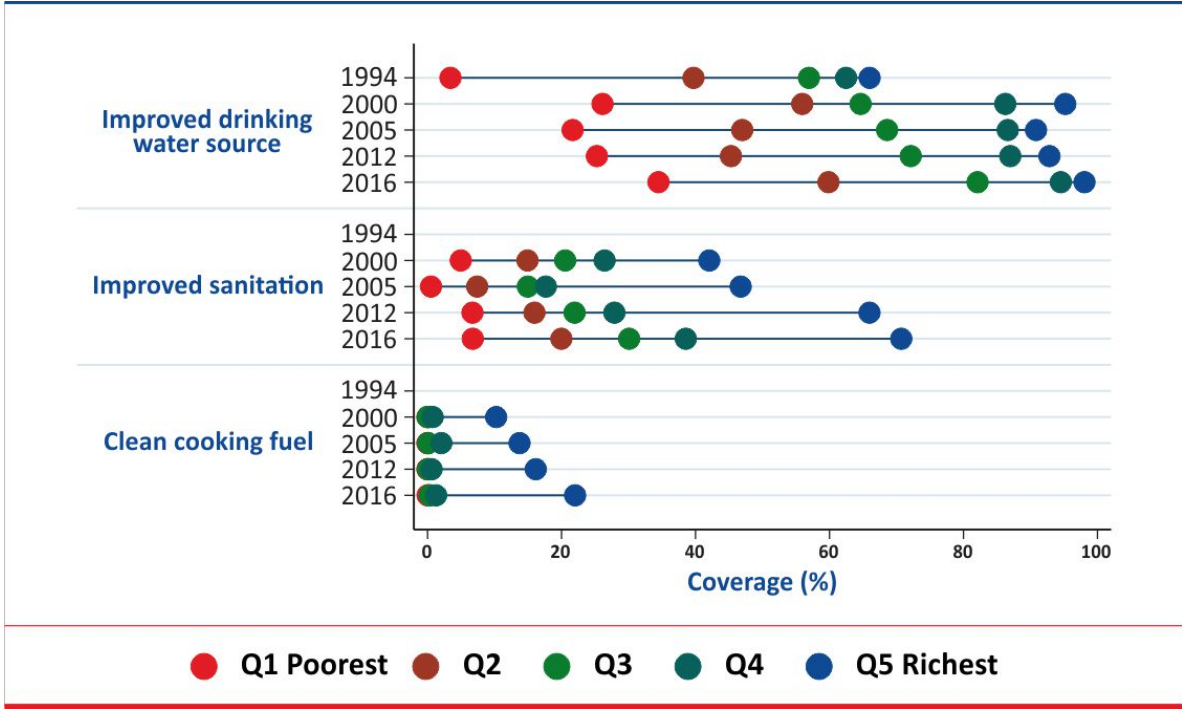
Source: DHS.

Figure 16: Inequality time trends of coverage of child health immunization interventions, by wealth quintile: Haiti, 1994-2016.



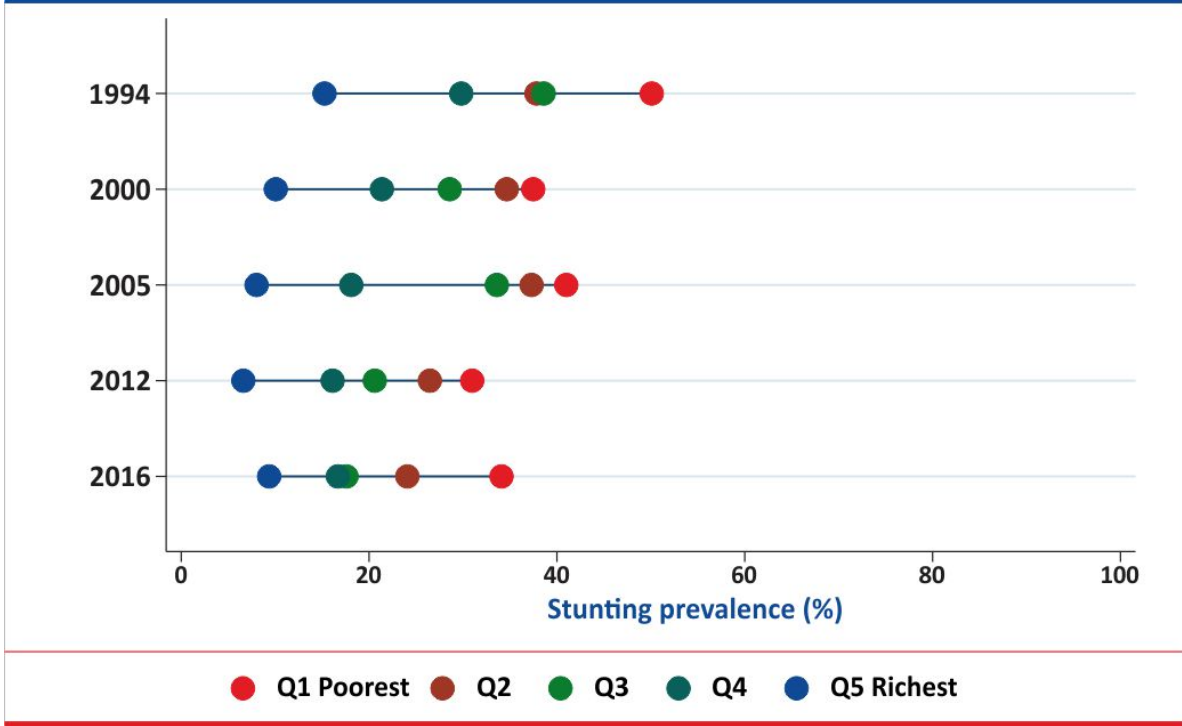
Source: DHS.

Figure 17: Inequality time trends of household water, sanitation and clean cooking fuel, by wealth quintile, Haiti: 1994-2016.



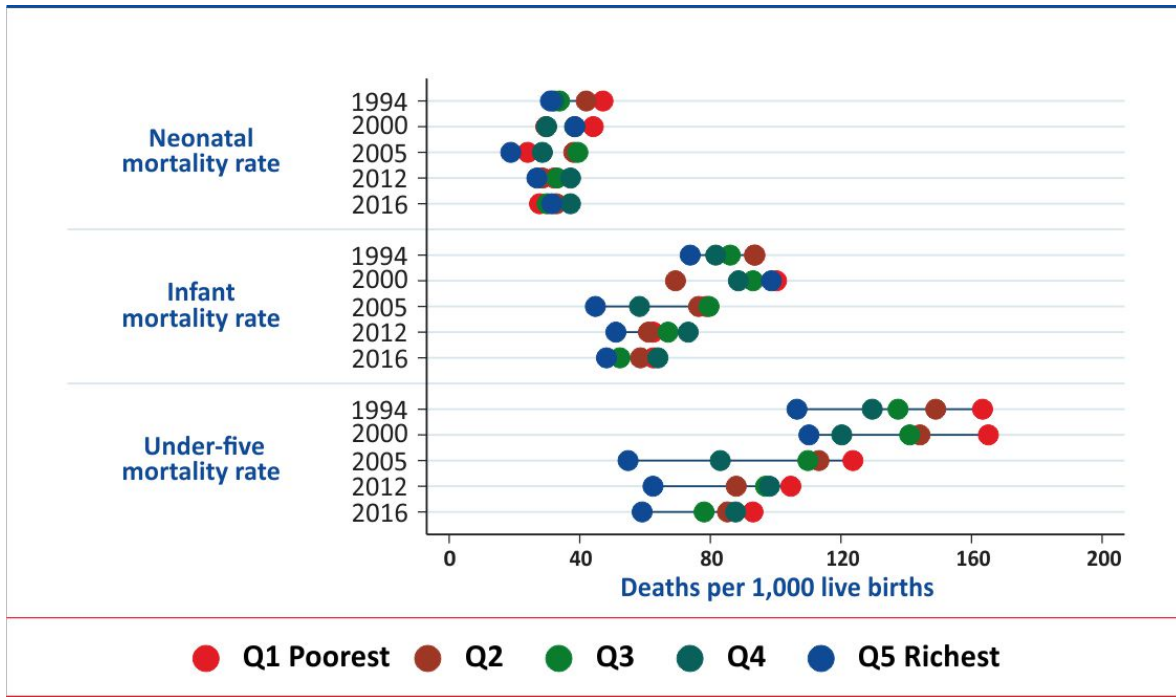
Source: DHS.

Figure 18: Inequality time trends of stunting prevalence, by wealth quintile, Haiti: 1994-2016.



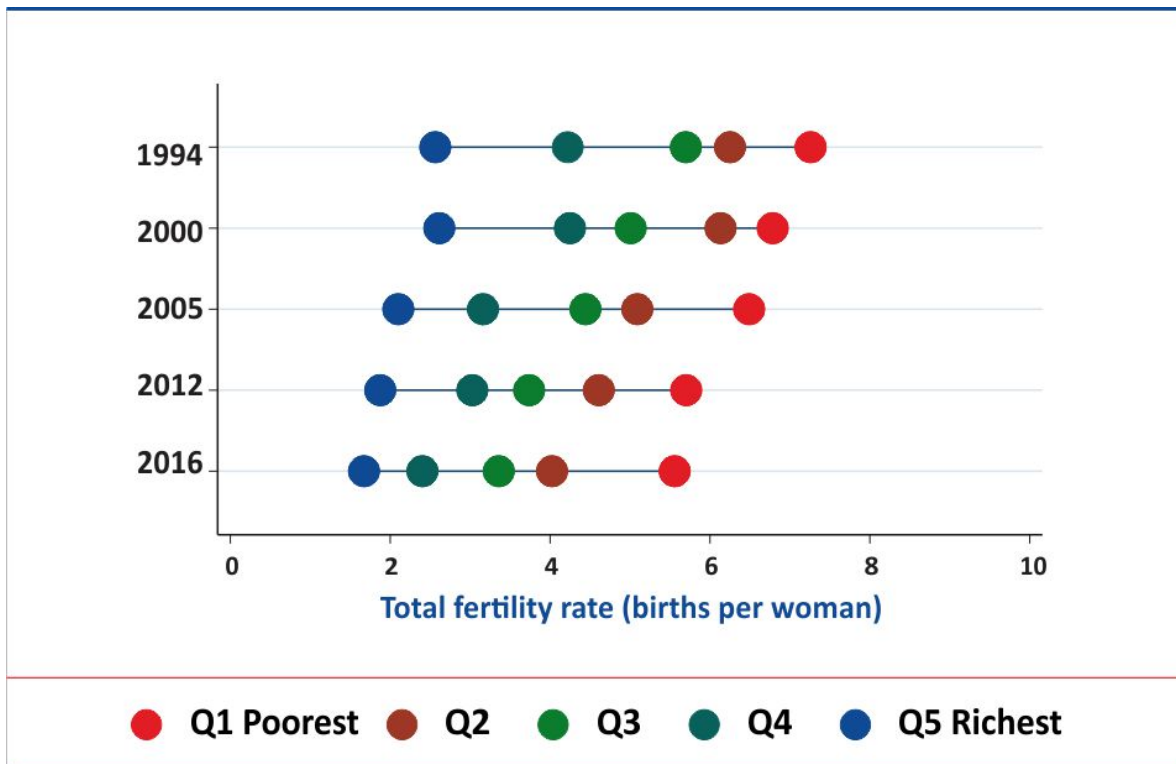
Source: DHS.

Figure 19: Inequality time trends of neonatal, infant and under-five mortality rate, by wealth quintile: Haiti, 1994-2016.



Source: DHS.

Figure 20: Inequality time trends in fertility rate, by wealth quintile: Haiti, 1994-2016.



Source: DHS.

To better understand whether changes in coverage indicators are accompanied by changes in inequality, we plotted the average absolute annual change in coverage against the average absolute annual change in SII (Fig. 21). The horizontal and vertical lines in zero (0) indicate no change in coverage or in inequalities. Positive values indicate increases in coverage or in inequalities, while negative values mean the opposite. The left quadrant in Fig. 21 shows interventions that increased in coverage and decreased in inequality. Four or more visits of antenatal care was the best performer, with an average increase of 1.4 p.p. per year in coverage and nearly 1 p.p. per year decrease in the SII. It is followed by coverage of demand for family planning need satisfied with modern methods, oral rehydration salts, and modern contraceptive use.

Exclusive breastfeeding was the indicator with the highest average increase in coverage, nearly 2 p.p. per year (although the increase was concentrated in the period 1994 to 2005) but had a slight increase in inequality. Access to improved sanitation showed the highest increase in absolute inequality.

The CCI, as an average of coverage, lies in an intermediate position regarding the individual indicators. But it is important to observe that it signals, on average, an increased coverage along with reduced inequalities.

Figure 21: Absolute annual change in coverage against absolute annual change in inequalities: Haiti, 1994-2016.

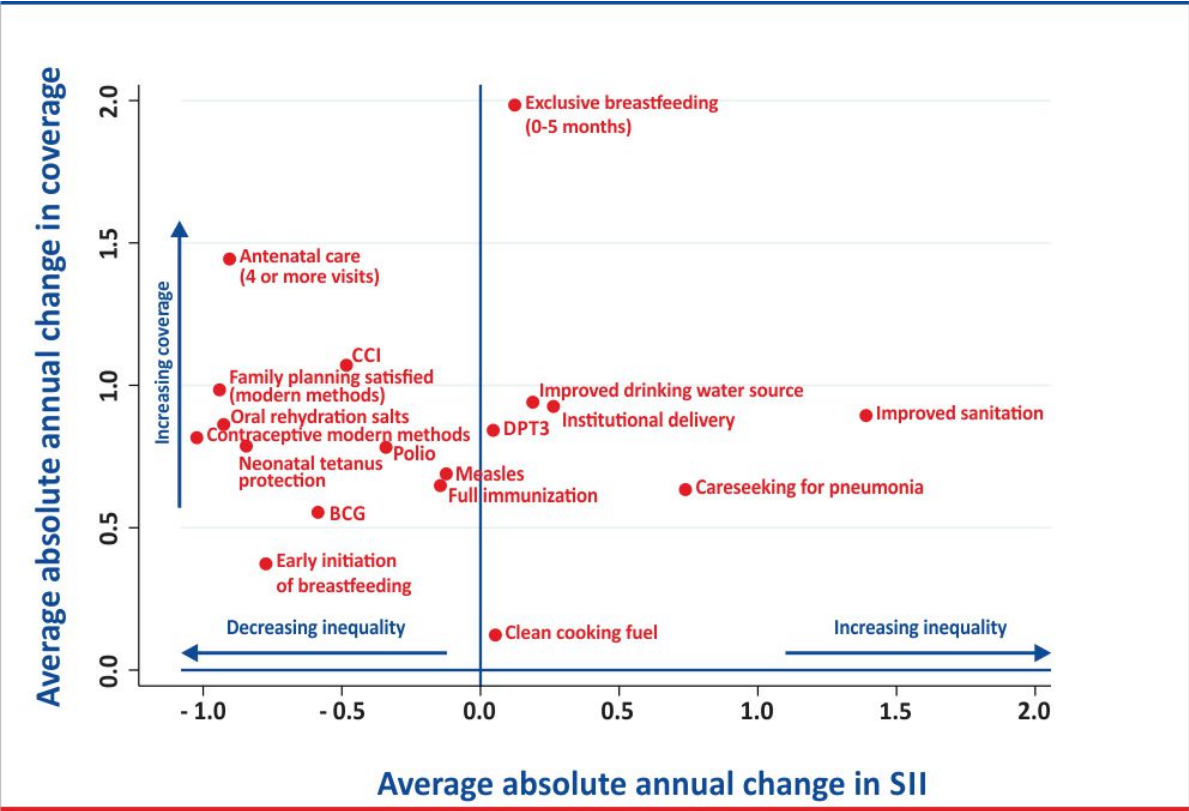


Table 3 shows the evolution of absolute and relative inequalities over time. Most of the indicators present a significant reduction in absolute and relative inequalities from 1994 to 2016. However, regarding immunization coverage, a remarkable reduction was also observed from 1994 to 2012, while from 2012 onward we observed a rapid increase in both relative and absolute inequality.

SBA and access to improved sanitation are two main indicators with an increase in both relative and absolute inequality over time. Inequality in use of clean fuels for cooking remained constant from 2000 to 2016.

Table 3: National trends in slope index of inequality (SII) and concentration index of inequality (CIX): Haiti, 1994-2016.

Indicator	Concentration index (SE)					Slope index of inequality (SE)				
	1994	2000	2005	2012	2016	1994	2000	2005	2012	2016
Current use of contraceptives (modern methods)	28.4 (3.4)	5.0 (2.7)	12.2 (2.0)	-0.6 (1.6)	-0.1 (1.5)	23.0 (2.8)	7.6 (3.8)	17.6 (2.9)	-0.9 (2.9)	-0.2 (2.7)
Demand for family planning satisfied (modern methods)	23.5 (3.3)	3.7 (2.4)	11.3 (1.8)	0.3 (1.3)	3.0 (1.3)	29.9 (4.0)	8.6 (4.6)	23.2 (3.8)	1.3 (3.5)	7.6 (3.3)
Antenatal care (4 or more visits)	31.1 (2.1)	19.9 (2.0)	18.0 (1.3)	11.2 (0.9)	11.8 (1.0)	64.6 (3.1)	50.5 (3.6)	53.3 (3.1)	43.2 (3.1)	44.8 (3.4)
Neonatal tetanus protection	11.8 (1.8)	5.4 (1.9)	3.8 (1.3)	2.7 (0.9)	3.6 (0.9)	33.3 (4.5)	17.4 (5.8)	12.9 (4.4)	10.4 (3.4)	13.1 (3.6)
Institutional delivery	54.9 (2.3)	50.8 (2.5)	45.7 (1.9)	36.6 (1.2)	32.6 (1.3)	63.7 (2.6)	69.5 (3.0)	63.1 (2.5)	70.4 (2.2)	69.6 (2.2)
Skilled attendant at delivery	22.2 (2.1)	49.3 (2.6)	45.2 (1.8)	36.3 (1.2)	32.1 (1.3)	56.8 (4.0)	69.5 (3.0)	65.5 (2.5)	72.4 (2.1)	71.8 (2.1)
Early initiation of breastfeeding	-2.2 (3.3)	7.1 (2.3)	-5.1 (2.0)	-1.3 (1.8)	-4.0 (1.6)	-3.6 (6.9)	19.2 (6.2)	-13.6 (5.2)	-4.1 (4.9)	-13.5 (4.4)
Exclusive breastfeeding (0-5 months)	-34.6 (17.7)	-11.2 (5.7)	-9.0 (4.0)	-3.7 (3.8)	2.5 (3.3)	-5.7 (3.6)	-16.9 (8.3)	-18.8 (9.5)	-9.6 (8.7)	4.8 (8.3)
Immunization – BCG	9.7 (1.9)	9.3 (2.1)	4.4 (1.5)	4.1 (1.1)	6.0 (1.1)	40.7 (7.1)	36.3 (7.4)	18.8 (6.4)	19.3 (5.3)	29.6 (5.1)
Immunization - DPT3	14.2 (3.5)	12.4 (4.4)	7.1 (2.4)	3.6 (1.8)	12.7 (1.8)	35.6 (7.3)	29.6 (12.4)	23.4 (7.3)	12.3 (6.9)	41.3 (5.6)
Immunization – Polio	14.5 (3.6)	13.2 (3.3)	5.7 (2.5)	3.0 (1.8)	10.9 (2.0)	36.5 (7.4)	31.4 (8.5)	18.5 (7.5)	9.9 (6.5)	35.8 (6.1)
Immunization – Measles	10.4 (3.1)	8.9 (2.5)	4.5 (2.3)	-0.7 (1.8)	9.5 (1.8)	28.1 (8.2)	24.7 (7.6)	16.2 (7.5)	-2.0 (7.1)	33.8 (6.0)
Full immunization coverage	17.2 (4.3)	9.7 (4.6)	7.2 (3.1)	-0.3 (2.5)	15.9 (2.7)	31.8 (6.8)	17.0 (10.1)	17.9 (7.3)	-1.2 (6.9)	39.0 (6.4)
Care-seeking for symptoms of pneumonia	14.8 (4.2)	10.1 (3.8)	13.7 (5.1)	15.7 (2.8)	14.1 (4.2)	24.1 (7.0)	16.5 (6.1)	23.6 (9.0)	36.8 (6.0)	29.7 (9.9)
Oral rehydration salts for children with diarrhea	21.2 (3.8)	11.8 (3.6)	13.8 (2.9)	4.1 (1.8)	5.8 (2.5)	32.9 (5.9)	24.1 (7.2)	29.0 (7.2)	13.2 (5.8)	13.5 (5.7)
Composite coverage index (CCI)	18.7 (3.6)	13.7 (3.1)	12.6 (2.9)	7.9 (1.9)	10.8 (2.1)	41.2 (0.8)	32.5 (2.1)	34.1 (1.4)	26.3 (1.1)	33.9 (0.4)
Improved drinking water source	24.7 (2.9)	21.1 (2.2)	23.7 (1.8)	22.8 (1.2)	18.3 (1.1)	65.3 (5.6)	76.5 (4.0)	79.2 (3.1)	79.1 (2.2)	75.5 (2.4)
Improved sanitation	-	33.9 (3.4)	50.5 (2.3)	40.2 (1.8)	37.3 (1.4)	-	42.7 (5.2)	53.3 (2.8)	62.5 (2.3)	67.2 (2.0)
Clean cooking fuel	-	88.8 (6.7)	84.7 (4.8)	90.9 (5.1)	86.1 (4.3)	-	30.6 (6.8)	32.0 (4.1)	46.9 (5.4)	30.9 (3.1)
Under-five stunting prevalence	-15.7 (1.5)	-10.8 (1.8)	-22.7 (2.0)	-20.8 (1.9)	-21.8 (1.7)	-32.7 (3.3)	-17.9 (3.0)	-38.3 (3.4)	-27.1 (2.8)	-28.7 (2.3)
Neonatal mortality rate	-9.1 (1.1)	-3.4 (4.3)	-1.9 (8.2)	0.5 (3.3)	3.0 (2.2)	-2.2 (0.2)	-0.8 (0.9)	-0.4 (1.4)	0.1 (0.6)	0.6 (0.5)
Infant mortality rate	-4.3 (1.3)	0.8 (3.5)	-8.5 (4.4)	-0.0 (3.6)	-2.7 (2.7)	-2.4 (4.7)	0.5 (1.9)	-3.8 (1.2)	0.0 (1.3)	-1.0 (0.8)
Under-five mortality rate	-7.0 (2.3)	-7.5 (1.8)	-11.9 (5.3)	-5.1 (4.5)	-5.5 (3.7)	-6.2 (0.8)	-6.5 (0.3)	-7.6 (1.8)	-3.0 (1.8)	-2.8 (1.4)

3.2.2 Trends in inequalities by area of residence

Coverage of reproductive interventions improved in urban and rural areas, with a higher increase in rural areas, so that inequality was reduced to near zero. Still, contraceptive use is below 40% (Fig. 22). Demand for family planning satisfied mirrors what we saw for contraceptive use, but the coverage is still lower than 50% of women in either urban or rural areas.

Regarding maternal and neonatal health interventions, coverage also increased in both urban and rural areas, with decrease in inequality for antenatal care with four or more visits and neonatal tetanus protection; and an increase in inequality for institutional deliveries and skilled birth attendance. As for early initiation of breastfeeding within the first hour of life and for exclusive breastfeeding from zero to five months of age, almost no inequality was observed between urban and rural areas (Fig. 23).

In both urban and rural areas, the CCI increased slightly, with little improvement in inequality. From 1994 to 2016, the CCI in urban areas varied from 46.8 to 58.3, while in rural areas it varied from 28.4 to 44.6. The gap between urban and rural areas in CCI varied from 20.4 p.p. in 1994 to 13.7 p.p. in 2016, corresponding to an absolute reduction of 6.7 p.p. during the same period. However, it seems that the gap between urban and rural areas was lower in 2012, as compared to 2016 (Fig. 23).

Child health interventions also showed an increase in coverage from 1994 to 2016, but with increased inequality, except for BCG immunization (Fig. 24).

Access to both improved drinking water source and sanitation increased in urban and rural households since 1994. In 2016, 95.7% urban households had access to improved water, compared to 59.7% for rural households. Access to improved sanitation was 46.9% in urban households and 24.4% in rural ones. Although coverage increased for all, the gaps increased over time (Fig. 25).

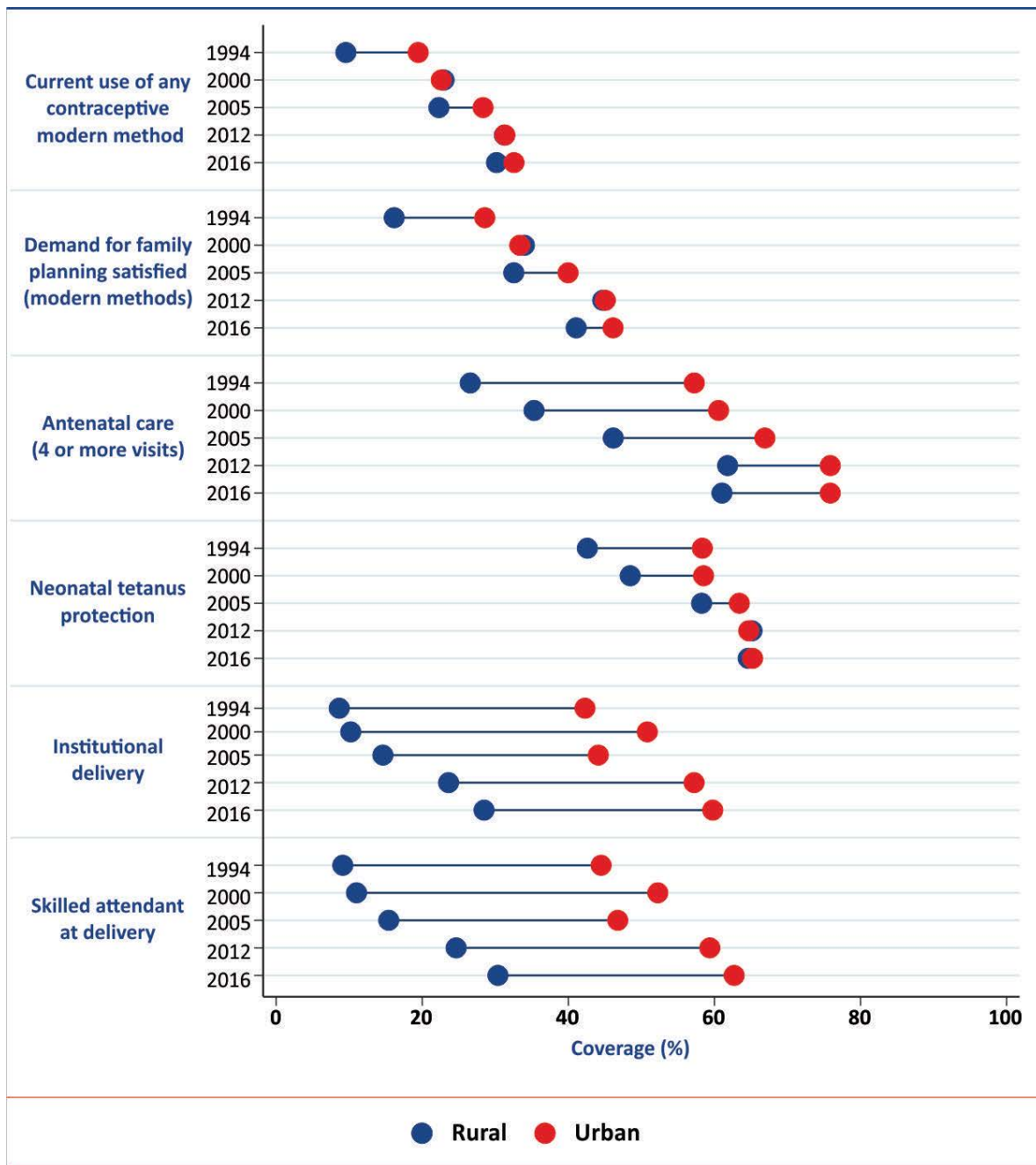
Reliance on clean cooking fuels is uncommon in Haiti in both urban and rural areas. Little change was observed in either settings, with a slight increase from 2012 to 2016 in urban areas. Still, only about 10% of households rely on clean fuels. Accordingly, the gap between urban and rural areas nearly doubled (Fig. 25).

Fig. 26 and 27 show trends in the outcomes by area of residence. The stunting prevalence in under-five children in urban areas declined from 28.4% in 1994 to 18% in 2018, while in rural areas it dropped from 40.3% to 23.9%. There was also a reduction in the gap between urban and rural areas during the same period (Fig. 26).

Likewise, progress was observed in NMR, IMR and U5MR where the gap between urban and rural areas practically closed (Fig. 27). In 2012, the level of mortality was higher in urban areas than in rural areas. This situation may be due in large part to a "surplus" of deaths caused by the earthquake of January 2010 which hit mainly the department of Aire metropolitaine/reste-Ouest and particularly the Metropolitan Area.

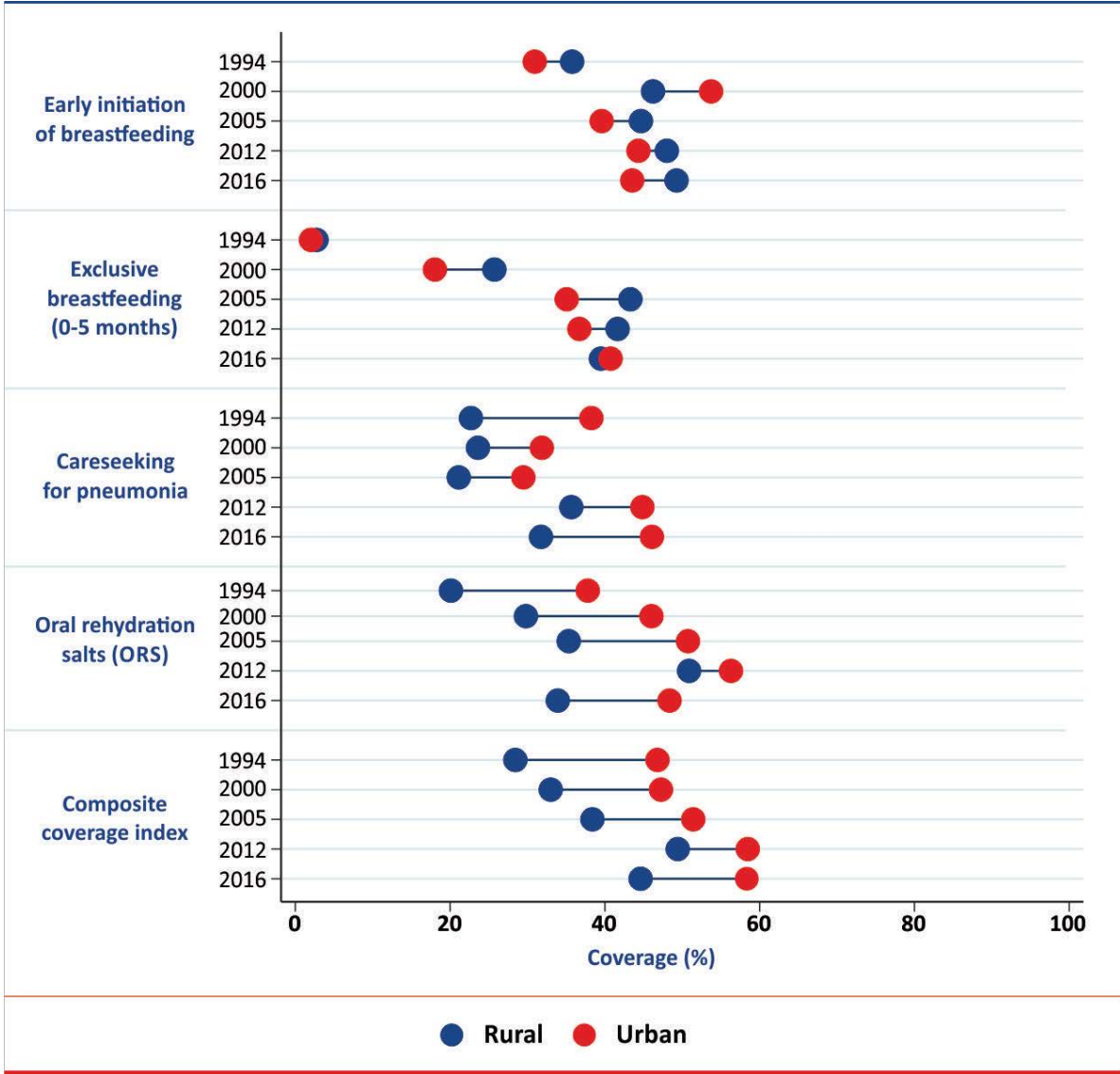
TFR decreased in both urban and rural areas. In urban areas it decreased from 3.5 children per woman in 1994 to 2.2 in 2016. In rural areas, it decreased from 6.1 to 3.9 during the same period. The absolute inequality was reduced from 2.6 children per woman in 1994 to 1.7 in 2016 (Fig. 28).

Figure 22: Inequality time trends of reproductive and maternal health interventions, by area of residence: Haiti, 1994-2016.



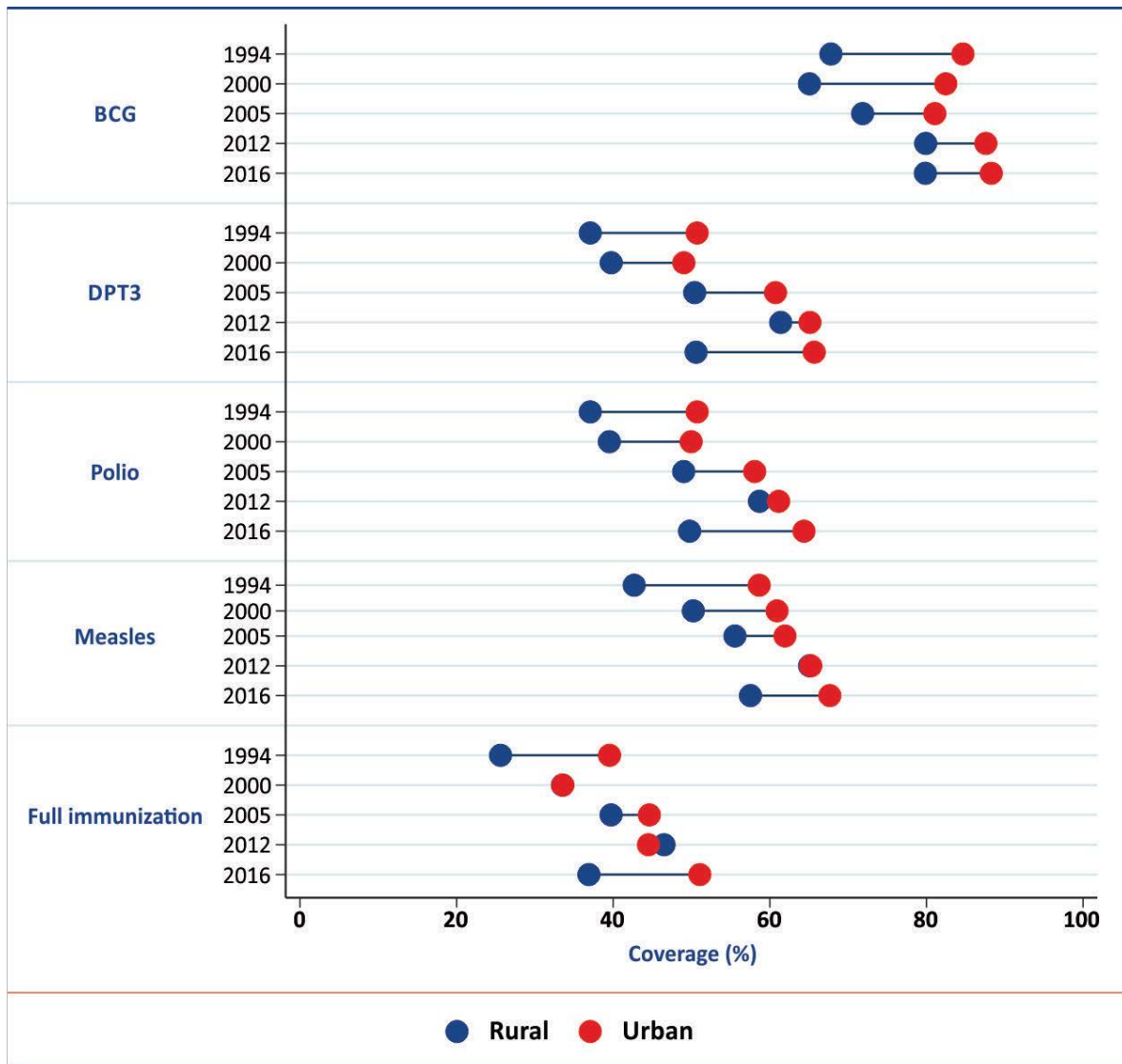
Source: DHS.

Figure 23: Inequality time trends of coverage of neonatal and child interventions, by area of residence: Haiti, 1994-2016.



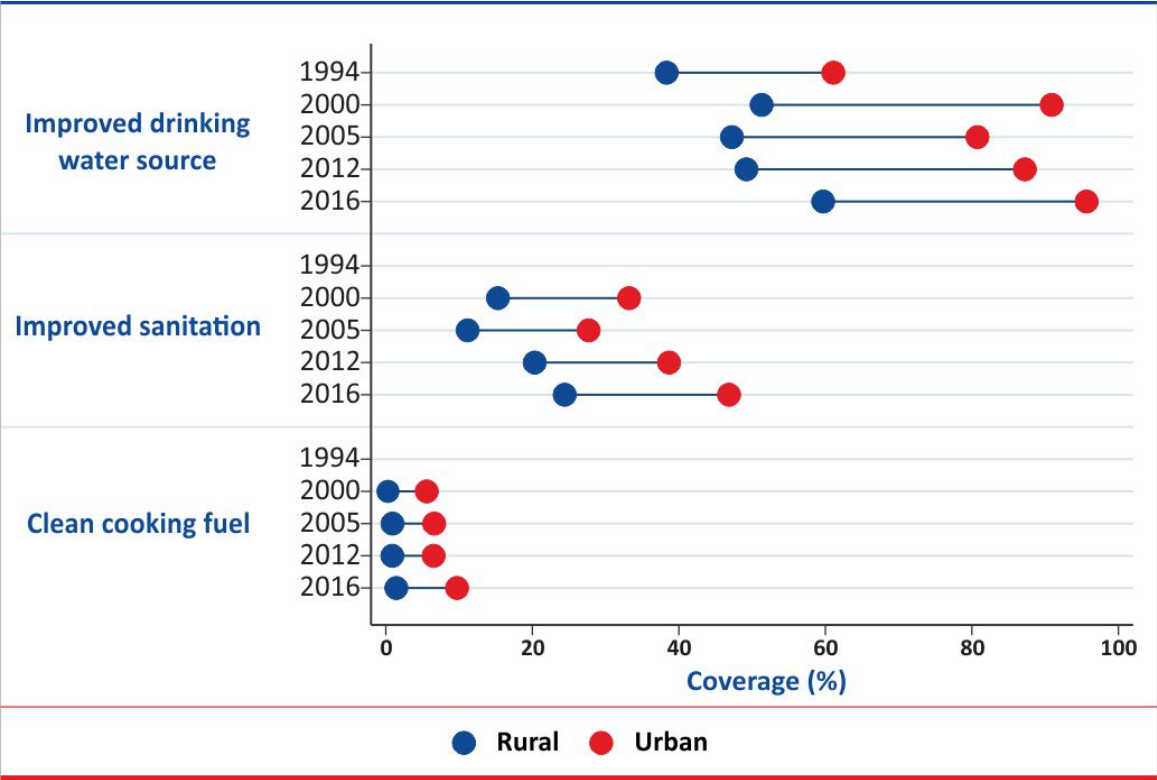
Source: DHS.

Figure 24: Inequality time trends of coverage of child health immunization, by area of residence: Haiti, 1994-2016.



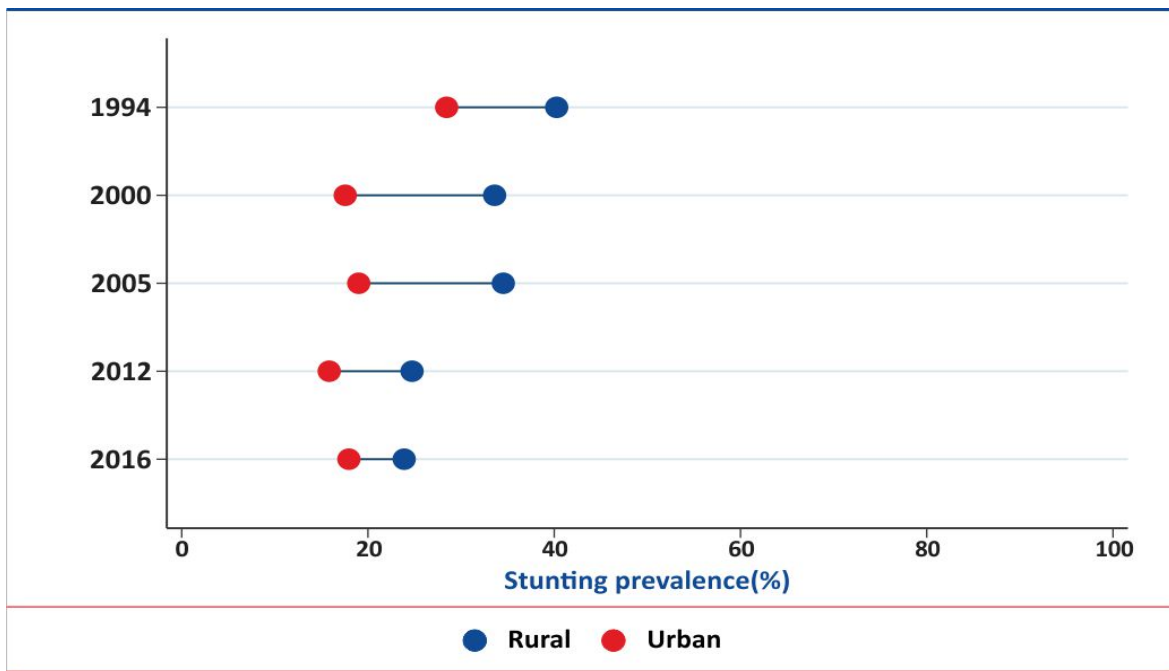
Source: DHS.

Figure 25: Inequality time trends in household water, sanitation and clean cooking fuel, by area of residence: Haiti, 1994-2016.



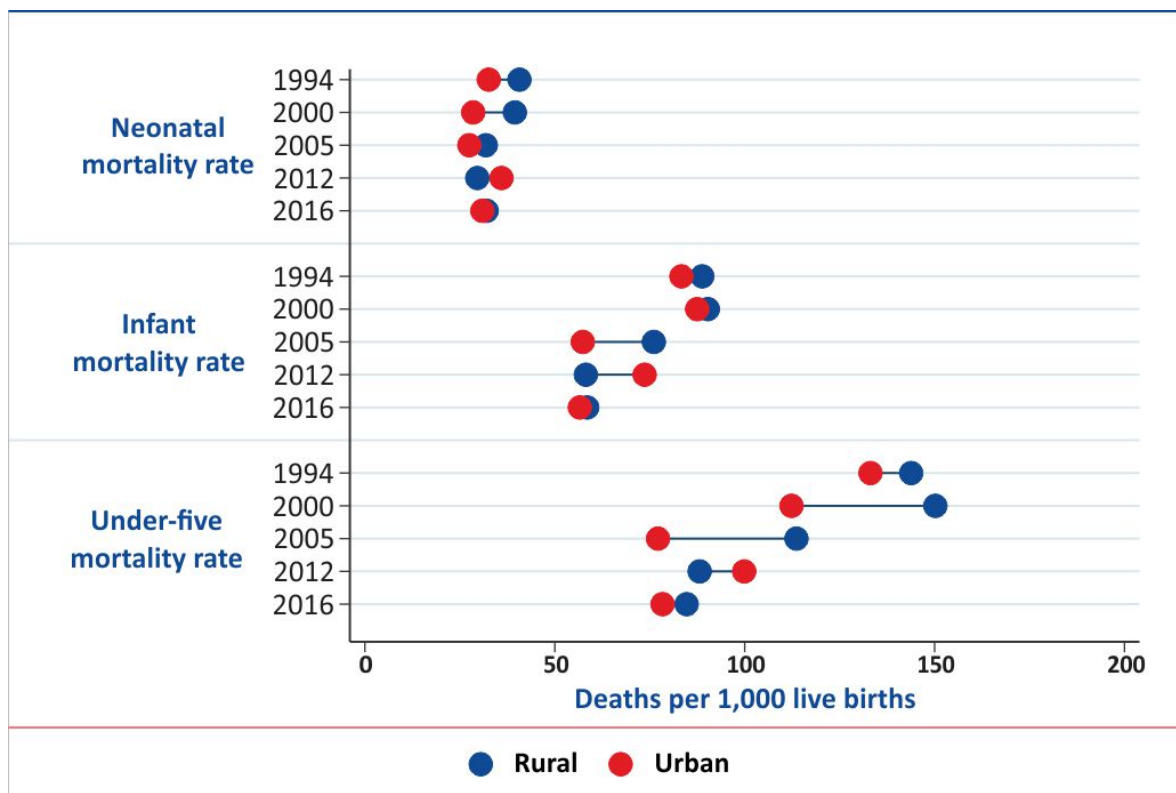
Source: DHS.

Figure 26: Inequality time trend of under-five stunting prevalence, by area of residence: Haiti, 1994-2016.



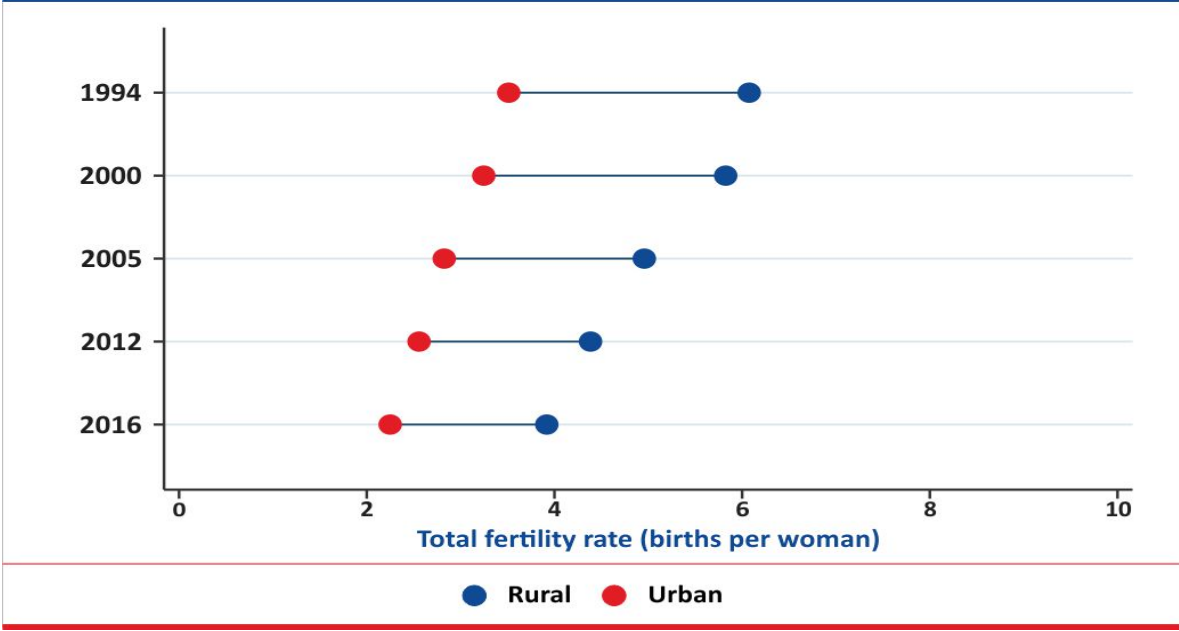
Source: DHS.

Figure 27: Inequality time trends of neonatal, infant and under-five mortality rate, by area of residence: Haiti, 1994-2016.



Source: DHS.

Figure 28: Inequality time trends in total fertility rate, by area of residence: Haiti, 1994-2016.



Source: DHS.

3.3 CORRELATIONS BETWEEN DETERMINANTS AND OUTCOMES AT NATIONAL LEVEL

Using the national level estimates of key determinants from various sources and the outcome estimates derived from each survey available, we calculated the Pearson’s correlation coefficient (r) for each pair of determinant and outcome over time. We focused this analysis on our key outcomes: stunting prevalence among children under five years of age and childhood mortality (neonatal, infant and under-five mortality rates).

Under-five stunting prevalence showed moderate to strong correlations (Table 4) with the different covariates of the conceptual model, except for log GDP per capita. Most of the correlations were statistically significant and in the expected direction. Only two determinants (absolute income and women’s employment) were not in the expected direction, but they were not statistically significant. Except for political stability, control of corruption and log GDP per capita, moderate to strong correlations were found between the determinants and NMR, IMR and U5MR, most of them statistically significant and in the expected direction (Table 4).

In cases where the determinants occur after the outcomes such as full immunization coverage and neonatal mortality, correlations were not estimated. Note that the estimated correlations are based on five data points only and because of that, even large correlation coefficients may not be significant, due to low statistical power.

Table 4: Correlations between determinants and outcomes at national level: Haiti, 1990-2016.

Socioeconomic and governance determinants	Under-five stunting	Neonatal mortality rate	Infant mortality rate	Under-five mortality rate
	r (p)	r (p)	r (p)	r (p)
Index of political stability	-0.52 (0.651)	-0.30 (0.806)	0.06 (0.963)	0.06 (0.962)
Index of control of corruption	-0.79 (0.425)	-0.61 (0.580)	-0.29 (0.811)	-0.29 (0.812)
GDP per capita in constant 2010 US\$ (Natural logarithm)	-0.27 (0.671)	-0.21 (0.735)	-0.11 (0.855)	-0.11 (0.856)
Life expectancy at birth	-0.95 (0.014)	-0.79 (0.209)	-0.98 (0.005)	-0.98 (0.005)
Household income	0.53 (0.354)	0.51 (0.385)	0.64 (0.267)	0.64 (0.244)
Urbanization	-0.95 (0.012)	-0.99 (0.001)	-0.99 (0.001)	-0.99 (0.001)
Total fertility rate	0.91 (0.033)	0.96 (0.008)	0.98 (0.004)	0.98 (0.004)
Human development index	-0.97 (0.026)	-0.99 (<0.001)	-0.99 (0.001)	-0.99 (0.001)
Women's schooling	-0.84 (0.072)	-0.92 (0.027)	-0.94 (0.019)	-0.94 (0.019)
Environmental determinants				
Improved drinking water source	-0.88 (0.047)	-0.90 (0.040)	-0.88 (0.046)	-0.88 (0.046)
Improved sanitation	-0.92 (0.078)	-0.93 (0.070)	-0.80 (0.198)	-0.80 (0.198)
Clean cooking fuels	-0.69 (0.312)	-0.88 (0.121)	-0.90 (0.090)	-0.90 (0.090)
RMNCH interventions				
Women's employment	0.88 (0.118)	0.96 (0.039)	0.99 (<0.001)	0.99 (<0.001)
Current use of contraceptive modern method	-0.99 (0.001)	-0.98 (0.002)	-0.98 (0.003)	-0.98 (0.003)
Demand for family planning satisfied (modern methods)	-0.99 (0.001)	-0.97 (0.005)	-0.97 (0.006)	-0.97 (0.006)
Antenatal care (4 or more visits)	-0.94 (0.016)	-0.96 (0.009)	-0.97 (0.005)	-0.97 (0.005)
Neonatal tetanus protection	-0.91 (0.033)	-0.94 (0.019)	-0.97 (0.005)	-0.97 (0.005)
Institutional delivery	-0.93 (0.021)	-0.97 (0.008)	-0.93 (0.023)	-0.93 (0.023)
Skilled attendant at delivery	-0.93 (0.024)	-0.97 (0.008)	-0.93 (0.022)	-0.93 (0.023)
Early initiation of breastfeeding	-0.84 (0.078)	-0.77 (0.132)	-0.74 (0.151)	-0.74 (0.151)
Exclusive breastfeeding (0-5 months)	-0.86 (0.064)	— *	-0.93 (0.021)	-0.93 (0.021)
DPT3 immunization	-0.83 (0.081)	— *	— *	-0.88 (0.051)
Measles immunization	-0.94 (0.015)	— *	— *	-0.94 (0.017)
Full immunization coverage	-0.83 (0.084)	— *	— *	-0.91 (0.029)
Careseeking for symptoms of pneumonia	-0.99 (0.079)	— *	— *	-0.88 (0.317)
Oral rehydration salts (ORS) treatment	-0.84 (0.073)	— *	— *	-0.81 (0.098)
Composite coverage index	-0.93 (0.023)	— *	— *	-0.96 (0.011)

Notes: r=Pearson's correlation coefficient; p = p-value, *We did not estimate the correlations where determinants may occur after the outcomes.

3.4 ANALYSES OF DETERMINANTS AT DEPARTMENTAL LEVEL

3.4.1 Time trends of contextual determinants at departmental level

Most variables from the different levels of our conceptual model showed improvement over time, across the departments. However, there was not a clear pattern showing any set of departments performing consistently better than others in terms of improvement in distal, intermediate and proximal determinants or in the outcomes of interest. We could not identify departments consistently lagging behind, either. This is corroborated by the average absolute annual change over the study period for each of the variables. Figures for all time trends and the corresponding annual change are included in the Appendix (Web appendix Figures & Tables at departmental level).

3.4.2 Correlations between determinants and outcomes at departmental level

As with the national level correlations, most of the departmental level correlations were significant and pointed in the expected direction. The highest correlations observed with stunting were women's schooling, the Human Development Index (HDI), antenatal care (4 or more visits) and total fertility rate. The latter presents a positive correlation given that, opposite to the other determinants, a higher fertility rate is associated with more stunting. The only determinant presenting a correlation opposite to the expected direction was natural disasters occurrence (Table 5). That may be because stunting is not an immediate outcome, but it takes time to occur. Additionally, disasters end up being drivers of more investment in health, which could mask the real association.

Correlations for both infant and under-five mortality rate with the determinants varied widely from low to high degree, and most of them were statistically significant and in the expected direction (Table 5). Again, the determinants with the highest correlations with mortality were, at a more distal level, women's schooling and fertility. Health interventions, such as contraceptive use, antenatal care (4 or more visits) and tetanus protection in pregnancy also presented a high correlation. The CCI, which represents a summary of health intervention coverage, also presented a correlation of -0.57, highlighting the importance of keeping an overall high coverage of health interventions. The association of HDI with mortality has to be interpreted with care, given mortality (i.e., life expectancy) is part of this indicator.

Please note that not all determinants in the conceptual model were evaluated here, since several of them were not available at departmental level (see Methods).

Table 5 - Correlations between determinants and outcomes at departmental level: Haiti, 1990-2018.

Socioeconomic and governance determinants	Under-five stunting	Neonatal mortality rate	Infant mortality rate	Under-five mortality rate
	r(p)	r(p)	r(p)	r(p)
Natural disasters occurrence	-0.47 (0.001)	-0.13 (0.393)	-0.36 (0.015)	-0.47 (0.001)
Urbanization	-0.49 (<0.001)	0.03 (0.850)	-0.03 (0.863)	-0.15 (0.313)
Absolute income	-0.18 (0.219)	0.33 (0.025)	0.16 (0.305)	0.14 (0.376)
Women's schooling	-0.85 (<0.001)	-0.27 (0.070)	-0.48 (0.001)	-0.69 (<0.001)
Human development index	-0.83 (<0.001)	(-0.32 (0.103)	-0.48 (0.012)	-0.66 (<0.001)
Total fertility rate	0.81 (<0.001)	0.27 (0.074)	0.50 (<0.001)	0.64 (<0.001)
Environmental determinants				
Improved drinking water source	-0.75 (<0.001)	-0.16 (0.301)	-0.23 (0.130)	-0.38 (0.010)
Improved sanitation [£]	-0.63 (<0.001)	0.00 (0.982)	-0.37 (0.025)	-0.44 (0.006)
Clean cooking fuels [£]	-0.49 (0.002)	0.27 (0.103)	0.10 (0.545)	-0.09 (0.597)
RMNCH interventions				
Current use of any contraceptive (modern methods)	-0.66 (<0.001)	-0.24 (0.110)	-0.46 (0.002)	-0.52 (<0.001)
Family planning needs satisfied (modern methods)	-0.62 (<0.001)	-0.21 (0.175)	-0.42 (0.004)	-0.48 (0.001)
Antenatal care (4 or more visits)	-0.83 (<0.001)	-0.34 (0.021)	-0.59 (<0.001)	-0.74 (<0.001)
Neonatal tetanus protection	-0.65 (<0.001)	-0.48 (0.002)	-0.63 (<0.001)	-0.68 (<0.001)
Institutional delivery	-0.76 (<0.001)	-0.17 (0.271)	-0.29 (0.052)	-0.47 (0.001)
Skilled attendant at delivery	-0.74 (<0.001)	-0.11 (0.501)	-0.32 (0.057)	-0.48 (0.002)
Early initiation of breastfeeding	-0.45 (0.002)	-0.49 (<0.001)	-0.51 (<0.001)	-0.50 (<0.001)
Exclusive breastfeeding	-0.43 (0.003)	-*	-0.42 (0.006)	-0.48 (<0.001)
Immunization-DPT3	-0.39 (0.008)	-*	-*	-0.45 (0.002)
Immunization-Measles	-0.32 (0.031)	-*	-*	-0.36 (0.016)
Full immunization coverage	-0.26 (0.08)	-*	-*	-0.37 (0.012)
Careseeking for symptoms of pneumonia	-0.46 (0.002)	-*	-*	-0.38 (0.011)
Oral rehydration salts (ORS)- Diarrhea treatment	-0.63 (<0.001)	-*	-*	-0.48 (0.001)
Composite coverage index	-0.70 (<0.001)	-*	-*	-0.57 (<0.001)

Notes: r = Pearson's correlation coefficient; p = p-value, *We did not estimate the correlations where determinants may occur after the outcomes, £ estimate was not available for 1994

3.4.3 Potential determinants of under-five stunting at departmental level

This section presents the results of the multilevel mixed-effects linear regression run at departmental level, adjusted by time and confounding, to explore potential drivers during the period 1994-2016. These analyses were done for stunting only, given the fact that mortality in health surveys is measured retrospectively (see more details in the Methods section).

Table 6 presents time-adjusted, and time-and-confounder-adjusted results. Most of time-adjusted regressions presented a significant association with under-five stunting prevalence over time, except for natural disasters occurrence, urbanization, family planning needs satisfied, exclusive breastfeeding, DPT3, measles, and care-seeking for pneumonia. Time- and confounding-adjusted regressions, run according to the conceptual framework hierarchy, showed that women's schooling, access to improved drinking water sources and antenatal care with four or more visits had a significant association with under-five stunting prevalence (Table 6). Women's schooling had the highest effect, as each additional percentage point in coverage was associated with a reduction in stunting prevalence of 0.27 percentage points.

We found an unexpected result for the adjusted effect of institutional delivery. From a protective crude effect, the adjusted effect turned into a risk factor. The coefficient implies that for each additional percentage point in institutional delivery coverage, stunting prevalence increases by 0.24 percentage points. Taking a closer look at the effect of adjusting for each of the other determinants we realized that institutional delivery is only statistically significant when antenatal care is in the model, and its inclusion flips the effect of institutional delivery. We therefore consider this result an artifact derived from the analysis being carried out at departmental level and the high correlation between all predictors, and especially between institutional delivery and antenatal care.

A similar analysis with CCI was also carried out and is presented in the appendix (Web Appendix Table. A3).

Table 6 - Multilevel linear regression analysis for under-five stunting prevalence at the departmental level: Haiti

Hierarchical level of the determinants	Determinants	Time-adjusted regression coefficient	95% CI	p-value	Time and confounder -adjusted regression coefficient	95% CI	p-value
Disasters vulnerability	Occurrence of natural disasters	-1.70	-4.70, 1.29	0.265			
Socioeconomics determinants	Urbanization	-0.12	-0.23, 0.00	0.050			
	Women's schooling	-2.82	-3.97, -1.68	<0.001	-1.67	-3.32, -0.02	0.047
	Absolute income	-0.01	-0.02, 0.00	0.038	-0.01	-0.01, 0.00	0.155
	Total fertility rate	3.42	1.41, 5.44	0.001	1.60	-0.78, 3.99	0.188
Environmental determinants	Access to improved drinking water source	-0.20	-0.29, -0.11	<0.001	-0.16	-0.26, -0.07	0.001
RMNCH interventions variables	Family planning need satisfied (modern methods)	-0.17	-0.35, 0.01	0.060			
	Antenatal care (4 or more visits)	-0.31	-0.47, -0.15	<0.001	-0.31	-0.45, -0.16	<0.001
	Institutional delivery	-0.25	-0.44, -0.07	0.007	0.24	0.05, 0.42	0.012
	Exclusive breastfeeding	0.03	-0.08, 0.13	0.550			
	Immunization-DPT3	-0.01	-0.14, 0.12	0.914			
	Immunization-Measles	-0.01	-0.15, 0.14	0.941			
	Oral rehydration salts (ORS) for diarrhea	-0.12	0.25, 0.00	0.041			
	Care-seeking for symptoms of pneumonia	-0.01	-0.19, 0.16	0.870			
	Time (year)	-0.71	-0.85, -0.56	<0.001	0.04	-0.22, 0.31	0.750

* Units of analysis are 45 (9 departments × 5 years). Variables in each group are adjusted for all other variables at the same level and above.

4 LESSONS LEARNED

During the period 1990 to 2018 Haiti was able to reduce its neonatal mortality rate by 37%, from 38.9 to 24.6 per 1,000 livebirths, its infant mortality rate by 49%, from 100.4 to 50.9 per 1,000 live births, and its under-five mortality rate by 48%, from 144.9 to 67.0 per 1,000 live births. Likewise, it reduced under-five stunting prevalence by 40%, from 36.8% in 1994 to 21.9% in 2016. Use of modern contraceptive methods, family planning needs satisfied, antenatal care visits, institutional deliveries and skilled birth attendance were all interventions whose coverage increased substantially from 1994 to 2016. These achievements have to be praised, although they were not enough to meet the specific goals set up by the MDGs, which Haiti had also adopted.

These RMNCH improvements were accomplished within a context of moderate reduction of poverty, a rather stagnant economy, and an increase of income inequality. By contrast, life expectancy and women's schooling increased during the study period, there was a decline in fertility rate, and access of families to improved drinking water and basic sanitation improved. Furthermore, the efforts to improve maternal and child health occurred in a politically unstable country with low levels of governance, continuously hit by natural disasters, and struggling to build a public sector able to fulfill their citizens' expectations of gaining access to basic services and to coordinate the activity and agenda of numerous NGOs operating since a long time in Haiti.

The possibilities of concerted multisectoral action, which showed to be a powerful driver of RMNCH progress in other settings^{15, 86-89}, were rather limited in Haiti, given the low strength and governance levels characterizing the public sector in this country. Additionally, the financing lines for different RMNCH programs were far from predictable and thus they compromised the sustainable implementation of interventions over time.

A number of programs and policies have been implemented in Haiti with the aim of improving RMNCH. However, they fell short of continuity across different governments. They also faced the lack of a proper information system to track their implementation adequacy, particularly before 2010, which hampered our efforts to identify the key programs and policies most instrumental to the achieved RMNCH improvements.

The national coverage of RMNCH interventions across the continuum of care showed an increasing trend, and the magnitude of increase was moderate for most of them. An evidence-based explanation of the key drivers of this progress in RMNCH interventions is difficult to ascertain, yet, we know that this resulted from the combined efforts between the public sector, the NGOs and the multilateral agencies. Moving forward, to ensure that these gains are maintained, it is essential that there is an effective transfer of capabilities and an optimal level of coordination between the present NGOs and the government, to ensure that the NGOs' agendas are properly aligned with the country's priorities.

In terms of the health system, Haiti has struggled to attract and retain qualified and motivated human resources, particularly in rural areas. This picture has been compounded by a chronic low budget allocated to the health sector and by its dependence on external aid for the implementation of most programs. To date, the country does not have a health system able to guarantee free access to all citizens, at least for an essential set of health interventions. Not even the most deprived segments of the population have free access to basic interventions guaranteed. Public health services are not free of charge in the country, and out-of-pocket health expenditure still accounts for over 30% of the total health expenditure.

Of note, the implementation of programs to improve social determinants, and both health and out-of-health sector interventions did not follow a consistently equitable pattern in Haiti. In particular, the gap between urban and rural areas and between the richest and the poorest quintiles of the population remained the same or even increased. This includes access to safe drinking water and improved sanitation and facility-based health interventions such as institutional delivery and skilled attendant at delivery. By contrast, inequalities decreased for interventions delivered at community level such as modern contraception and ORS for children with diarrhea. The need to put a particular emphasis on an equity lens in the implementation of RMNCH interventions has a particular sense of urgency in a country that is the poorest in the region.

According to key informants from diverse sectors and to the literature and desk reviews, the RMNCH improvements observed are the result of a series of strategies implemented in Haiti during the last decades, that resulted from the concerted efforts of the government, NGOs and multilateral agencies.⁹⁰ Among them, we can highlight the improvement in women's education, which has surely played a role in a better care of children and contributed to the improved child outcomes described above.

Similarly, Haiti was able to increase the deployment of human resources for health, specifically doctors, nurses and midwives. Although further efforts are needed to reach international standards in terms of density of these frontline health professionals, this increase most likely contributed for the RMNCH progress achieved. A specific strategy that was considered key by the informants was the implementation of the compulsory social service program for recently graduated doctors, to guarantee their deployment in remote areas of the country. The "*Cooperación Haitiano-Cubana*" for training health professionals was also listed as very important.

The training and deployment of more community health workers was also emphasized as a particularly important strategy in Haiti, especially as part of outreach services and as part of strategies to cover rural and remote areas, through the provision of preventative and curative health services.

Likewise, increased access to free contraception and vaccination were also pointed out by informants as important contributors to the achievement of better child health. The reduction of women's fertility rate leads to a decrease in the number of children cared for in the family and increase in spacing between pregnancies, both important factors to improve children's nutrition and health.

Furthermore, informants highlighted the increased quality and quantity of care provided by nutrition programs for undernourished children both at facility and community levels, which may have contributed to the reduction of under-5 mortality. Since the earthquake in 2010, UNICEF in Haiti has made nutrition one of its three priorities, providing technical and financial support to the MOH. This contributed to a better management of severely malnourished children and to the provision of micronutrient supplementation and vitamin A to under-five children and pregnant women⁶⁸

The implementation of basic emergency obstetric care was considered by the informants as an important factor for the reduction of preventable maternal and newborn deaths, along with the increase in coverage of antenatal care, institutional delivery and skilled attendance at delivery.

Informants also emphasized the input of multilateral organizations to implement RMNCH interventions at both national and departmental level, as well as the contribution of NGOs like GHESKIO and Zanmi Lasante through deployment of health care facilities that provide quality health care to the most deprived segments of the Haitian population.

Several key bottlenecks were also highlighted. The first is related to the low budget available to public health, which does not allow the MOH to respond in an adequate and timely way to the health needs of the population. This is aggravated by a lack of leadership within the sector, and by low levels of governance and accountability, and the need to better coordinate the actions of hundreds of NGOs active in the country. Also, although the deployment of frontline health workers, including community health workers, has increased over time in Haiti, the chronic shortage of qualified health personnel remains an issue, and it is particularly dramatic in the most remote areas of the country. Lack of an adequate health infrastructure is also an important limitation. Even in populous urban settings, health institutions often face availability crises of equipment, drugs and human resources. According to the MOH, the urban areas alone account for about 88% of doctors, nurses and midwives, compared to only 12% in rural areas. This is further compounded by repeated strikes, due to delayed salary payments and to low wages. As an illustration of the human resources paradox in Haiti, a recent MOH report⁹¹ showed that health training institutions in the country graduate, on average, 352 doctors, 4,234 nurses and 75 midwives annually. Out of those, nearly 24% of doctors, 87% of nurses and 59% of midwives fail to enroll a job in the country, and many end up looking for job opportunities abroad. This is due to a mix of lack of posts, low salaries and poor working conditions.

The low levels of education, and the lack of women's empowerment also constitute a barrier to health care use in the country. The informants pointed out the need of a greater government effort to improve education and promote women's empowerment, which would increase the level of information about available health interventions and care, and the autonomy of women to take their children to health services.

Finally, other key limitations noted by informants in the interviews included the dependence on external aid by the government in general and by the MOH in particular, the political and social instability affecting Haiti chronically, the varied cultural practices related to antenatal and child health care that need an intercultural and rights-based approach, and the frequency of natural disasters in the country that should be faced in a more effective way.

We carried out departmental level analyses with the aim to identify specific patterns, strengths and weaknesses. However, we could not identify a consistent pattern of best performers and of departments lagging behind in terms of the rate of progress of different indicators at different levels of our study conceptual framework. That is, those departments that achieved the highest gains in social determinants and out-of-health sector factors were not necessarily the same ones that achieved the highest gains in the coverage of RMNCH interventions or in the improvement of the outcomes of interest, namely mortality rates and stunting prevalence. This was due largely to the lack of good and regular information on health programs and interventions at departmental level and also probably due to the different NGOs that are active in each area, with their different priorities and levels of effectiveness.

Our quantitative approach to identify drivers of change for stunting was based on multilevel linear regression analyses at departmental level. It showed that women's schooling, access to improved drinking water source and antenatal care with four or more visits were the most important interventions for the reduction of under-five stunting. This does not mean that other interventions are not important. Better women's education may allow a better understanding of health messages and may be associated with women's empowerment, better living conditions including access to water and sanitation, improved childcare practices, and increased utilization of health care services like antenatal care and institutional

delivery. This highlights the paramount importance of intersectoral efforts in the improvement of population health.

We faced several limitations in our effort to identify key factors related to stunting. As mentioned earlier, many contextual determinants proposed for the multilevel analysis were not available at departmental level, such as GDP per capita, income inequality and poverty. Other determinants, even when available at departmental level, did not coincide with the same DHS time points such as density of health workforce and density of health infrastructure. More efforts are necessary from both local and international actors involved in the collection of information to make sure they can be disaggregated at departmental level.

We also faced difficulties related to availability and access to information. Bureaucracy was an obstacle, making it difficult to get access to available information. The policy and program analysis was hampered by the scarcity of institutional documents showing meaningful design, implementation and programmatic information, making it difficult to identify and characterize key policies and programs.

Although Haiti has made some progress in RMNCH from 1990 to 2018, there is still much to be done and achieved. We illustrated in this report how health interventions coverage and child health outcomes changed during this period at national and subnational level, highlighting which groups need more attention, which were the key drivers of change, and which were the main bottlenecks. Addressing the signaled limitations in different governmental sectors and at different levels will surely help pave the way for a more effective multisectoral implementation of policies, programs and interventions; increase country leadership and investment in health; as well as the community engagement that may help to accelerate progress across the SDGs, specifically SDG3.1 and 3.2, and achieve universal health coverage as proposed by the Global Strategy for Women's, Children's and Adolescents' Health until 2030.³

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6 APPENDIX

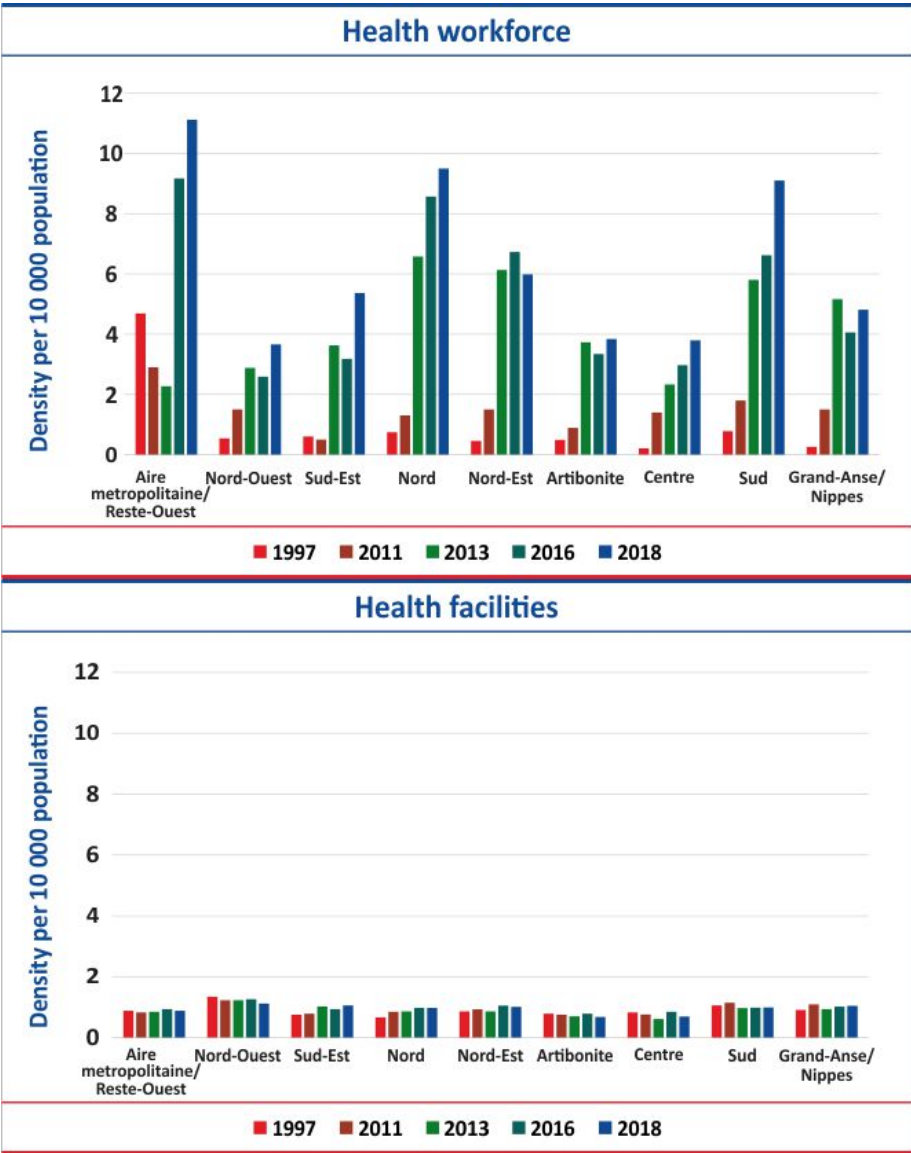
This section includes the results of the analyses at departmental level. Figures A1-A2 show the descriptive analyses of the contextual determinants (socioeconomic determinants, density of health workforce and health facilities), while Figures A3-A5 show descriptive analyses of coverage indicators as well as of environmental determinants overtime. In Table A1, we present average absolute annual change of the determinants overtime. From Figures A6 to A9, we present time trends analyses of the outcomes (under-five stunting prevalence and child mortality) following by Table A2 where the departments were ranked according to the average absolute annual change in the outcomes. Finally, in Table A3, we present an alternative model of multilevel linear regression analysis for under-five stunting prevalence using composite coverage index.

Figure A1: Time trends in socioeconomic determinants at departmental level: Haiti, 1994-2016.



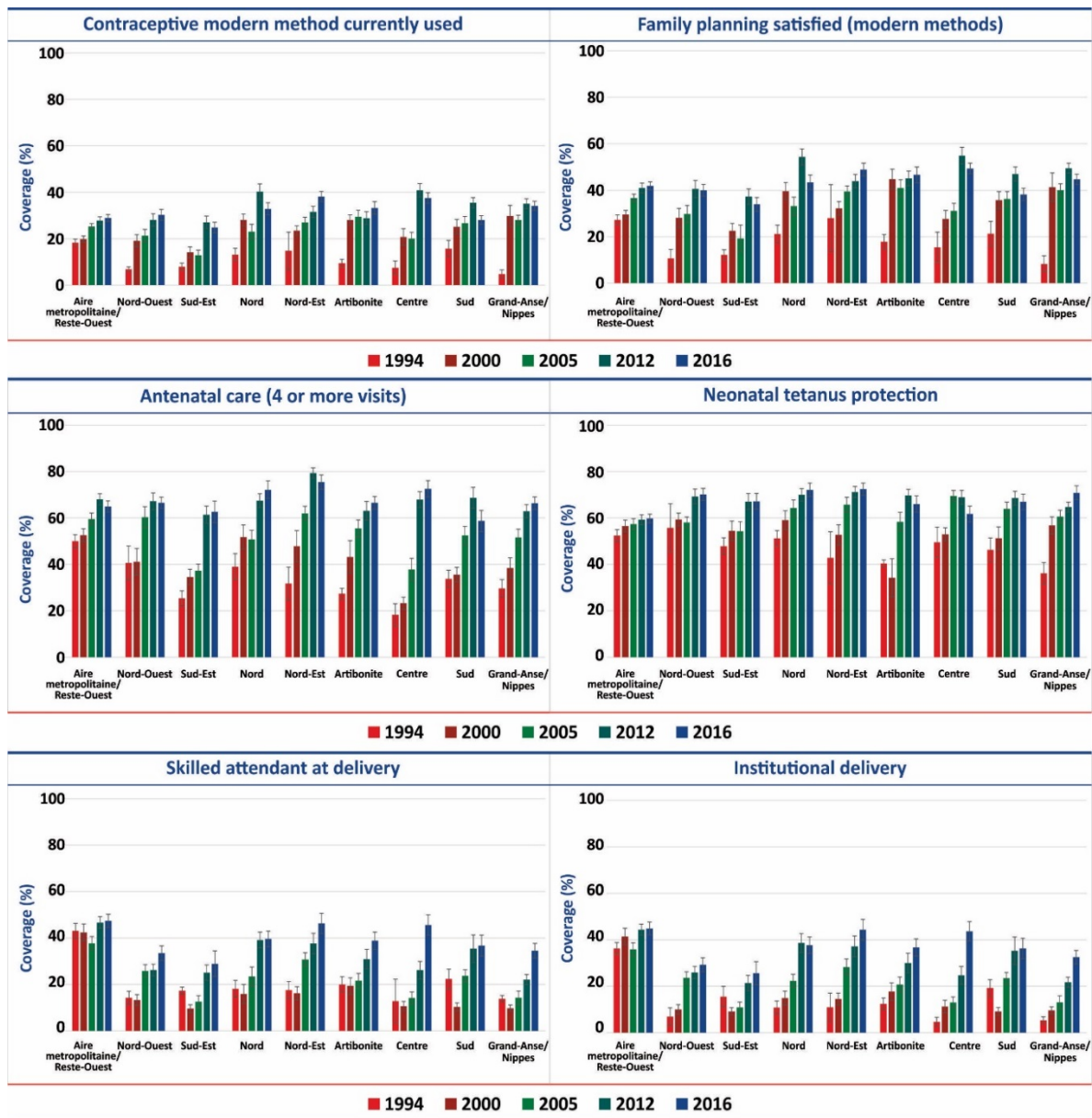
Various sources: Absolute income: Fink et al., Human development index: UNDP. Poverty line: IHSI. Women's schooling: DHS. Urbanization: IHSI. Fertility rate: DHS.

Figure A2: Time trends in health workforce and health infrastructure at departmental level: Haiti, 1997-2018.



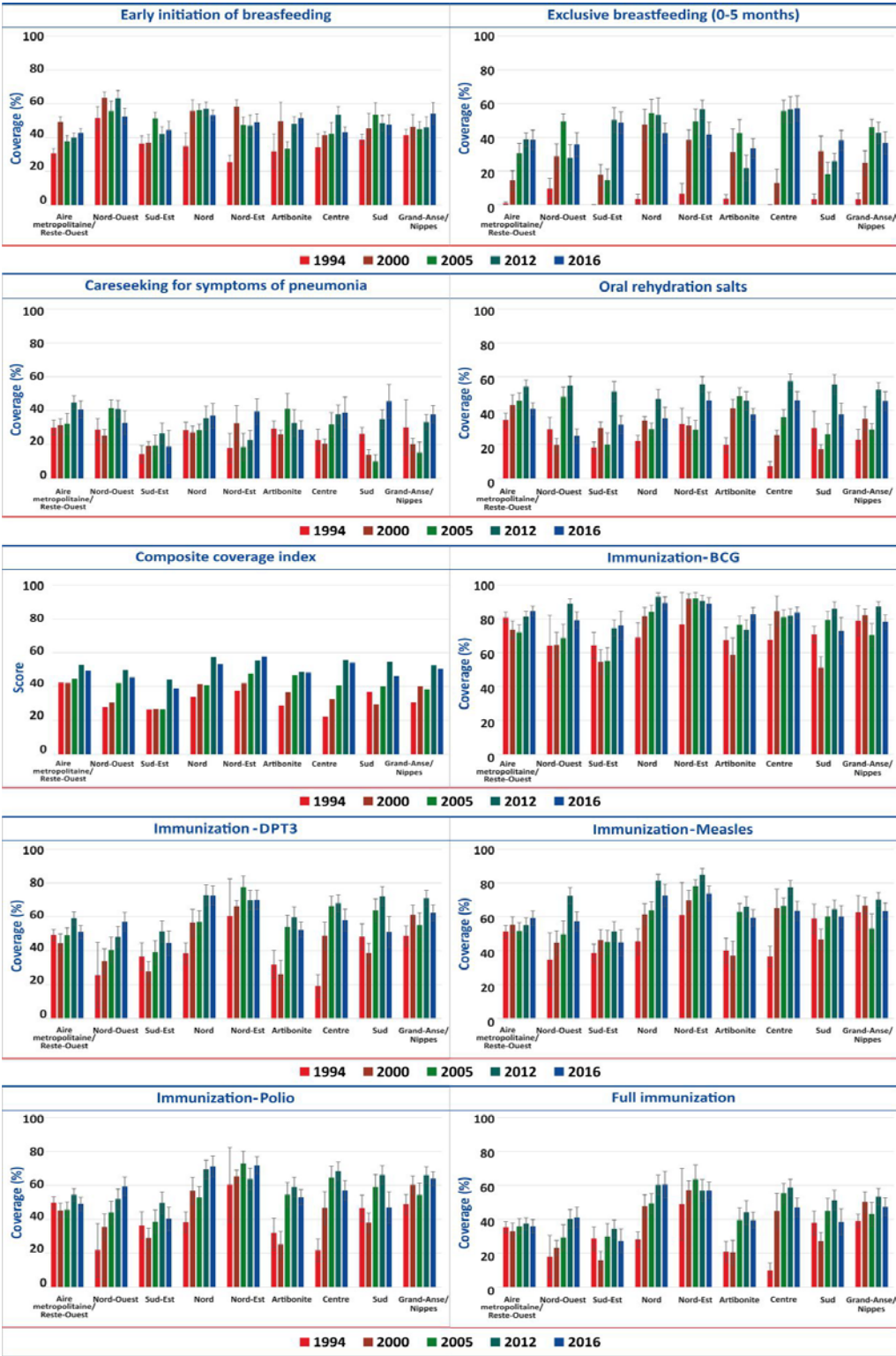
Source: DHS.

Figure A3: Time trends in coverage of reproductive and maternal health interventions at departmental level: Haiti, 1994-2016.



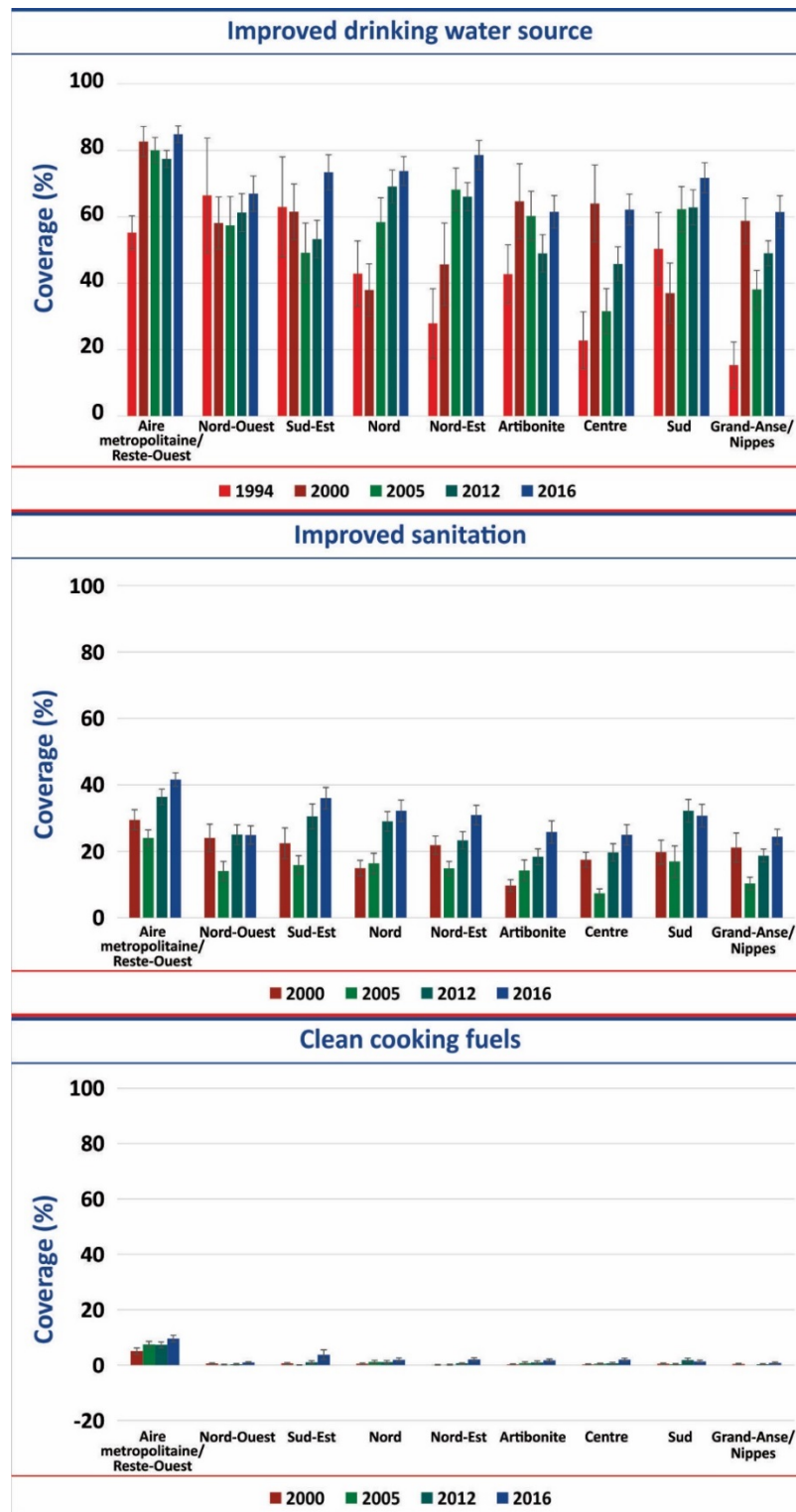
Source: DHS.

Figure A4: Time trends in coverage of newborn and child health interventions at departmental level: Haiti, 1994-2016.



Source: DHS.

Figure A5: Time trends in improved drinking water source, improved sanitation and clean cooking fuels at departmental: Haiti, 1994-2016.



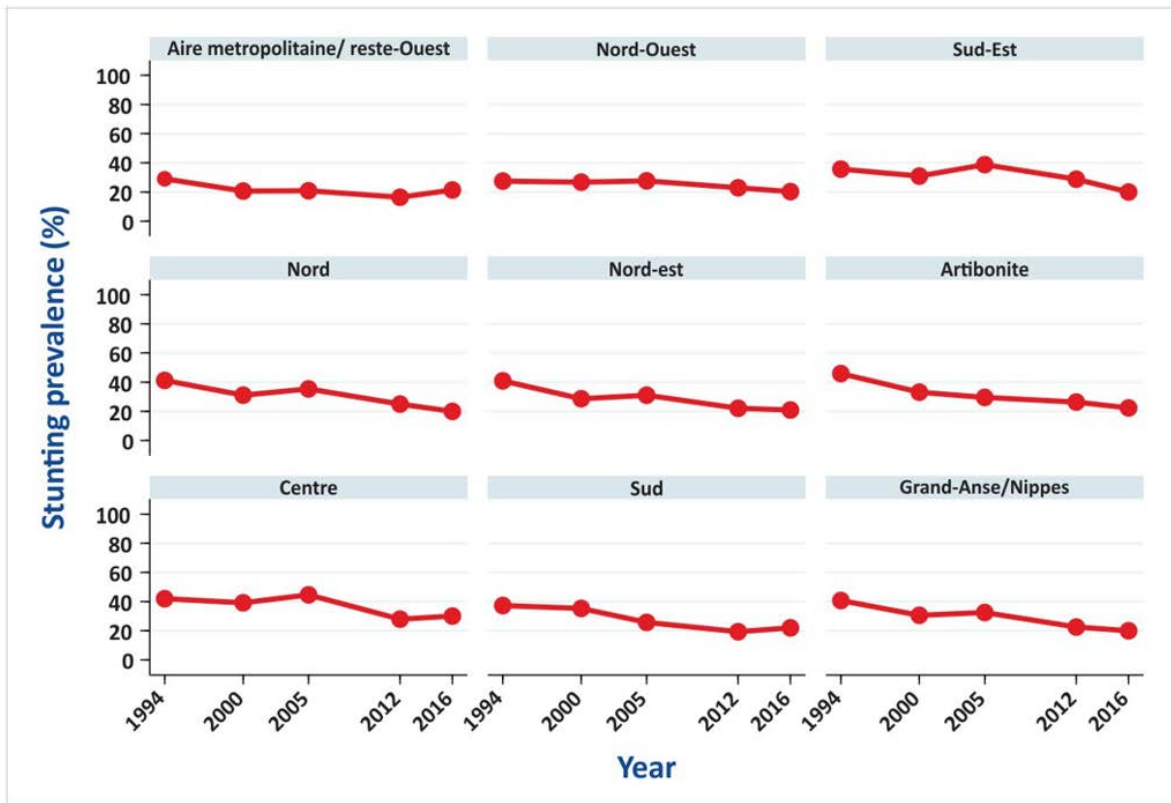
Sources: DHS.

Table A1: Average absolute annual change of the determinants at departmental level: Haiti, 1994-2016.

Determinants	Average absolute annual change of the determinants from 1994 to 2016								
	Aire metropolitaine/ reste-Ouest	Nord-Ouest	Sud-Est	Nord	Nord-Est	Artibonite	Centre	Sud	Grande-Anse/ Nippes
Household income (Thousand US\$)	3.95 (10.0)	-7.61 (4.88)	-4.01(6.42)	8.92 (13.24)	-4.81 (6.35)	-11.38 (7.04)	-12.42 (6.75)	2.26 (10.04)	-9.58 (15.44)
Poverty line*	-1.63	-0.99	-2.01	-1.47	-1.34	-2.59	-0.96	-2.02	-1.29
Extreme poverty line*	-2.21	-2.62	-3.62	-2.82	-3.6	-4.13	-2.5	-3.94	-3.05
Human development index**	0.00 (0.00)	0.01 (0.00)	0.00 (0.00)	0.01 (0.00)	0.00 (0.00)	0.01 (0.00)	0.00 (0.00)	0.01 (0.00)	0.00 (0.00)
Women's schooling	0.19 (0.03)	0.19 (0.03)	0.17 (0.04)	0.20 (0.02)	0.22 (0.03)	0.23 (0.02)	0.21 (0.03)	0.16 (0.06)	0.23 (0.01)
Urbanization	1.45 (0.03)	0.48 (0.01)	0.26 (0.01)	0.87 (0.02)	0.84 (0.02)	0.74 (0.02)	0.35 (0.01)	0.39 (0.01)	0.35 (0.07)
Total fertility rate	-0.05 (0.01)	-0.13 (0.01)	-0.11 (0.03)	-0.10 (0.01)	-0.09 (0.01)	-0.11 (0.01)	-0.09 (0.06)	-0.13 (0.03)	-0.12 (0.01)
Health facilities¥	0.00 (0.00)	-0.01 (0.00)	0.01 (0.01)	0.02 (0.00)	0.01 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Health workforce¥	0.23 (0.24)	0.13 (0.04)	0.19 (0.10)	0.41 (0.16)	0.30 (0.11)	0.16 (0.07)	0.16 (0.03)	0.36 (0.13)	0.22 (0.08)
Improved drinking water source	0.96 (0.54)	0.06 (0.29)	0.19 (0.6)	1.65 (0.4)	2.15 (0.45)	0.36 (0.57)	1.09 (1.00)	1.20 (0.54)	1.48 (0.87)
Improved sanitation*	0.90 (0.42)	0.28 (0.49)	1.03 (0.49)	1.19 (0.21)	0.65 (0.47)	0.93 (0.16)	0.65 (0.57)	0.92 (0.39)	0.34 (0.55)
Clean cooking fuel	0.23 (0.08)	0.02 (0.03)	0.18 (0.1)	0.07 (0.03)	0.11 (0.05)	0.80 (0.02)	0.90 (0.04)	0.08 (0.04)	0.02 (0.03)
Contraceptive modern method uses	0.52 (0.07)	1.00 (0.15)	0.86 (0.20)	0.96 (0.37)	0.97 (0.09)	0.86 (0.35)	1.46 (0.29)	0.65 (0.27)	1.17 (0.45)
Family planning satisfied (modern methods)	0.73 (0.09)	1.29 (0.26)	1.07 (0.28)	1.11 (0.48)	0.95 (0.07)	1.05 (0.50)	1.74 (0.32)	0.84 (0.36)	1.48 (0.63)
Antenatal care (4 or more visits)	0.82 (0.16)	1.39 (0.32)	1.83 (0.27)	1.48 (0.20)	2.15 (0.33)	1.76 (0.24)	2.75 (0.36)	1.51 (0.43)	1.75 (0.13)
Neonatal tetanus protection	0.31 (0.06)	0.70 (0.16)	0.93 (0.15)	0.94 (0.08)	1.39 (0.22)	1.55 (0.48)	0.73 (0.41)	1.05 (0.23)	1.38 (0.32)
Institutional delivery	0.37 (0.18)	1.08 (0.20)	0.58 (0.31)	1.40 (0.20)	1.58 (0.16)	1.08 (0.10)	1.61 (0.37)	1.07 (0.40)	1.18 (0.19)
Skilled attendant at delivery	0.23 (0.21)	0.90 (0.21)	0.69 (0.35)	1.19 (0.28)	1.39 (0.24)	0.87 (0.22)	1.41 (0.48)	0.96 (0.43)	0.94 (0.34)
Early initiation of breastfeeding	0.27 (0.42)	0.07 (0.37)	0.36 (0.34)	0.69 (0.45)	0.65 (0.69)	0.68 (0.47)	0.57 (0.30)	0.37 (0.27)	0.44 (0.17)
Exclusive breastfeeding	1.78 (0.30)	-0.11 (0.99)	2.44 (0.83)	1.53 (1.04)	0.37 (0.76)	0.86 (0.82)	2.40 (1.32)	1.14 (0.58)	1.52 (0.70)
Immunization-BCG	0.26 (0.31)	1.02 (0.38)	0.79 (0.49)	0.96 (0.23)	-0.19 (0.06)	0.78 (0.39)	0.53 (0.33)	0.71 (0.75)	0.11 (0.39)
Immunization-DPT3	0.35 (0.29)	1.37 (0.08)	0.72 (0.40)	1.54 (0.26)	0.05 (0.46)	1.34 (0.57)	1.76 (0.80)	0.74 (0.75)	0.69 (0.36)
Immunization-Polio	0.15 (0.22)	1.63 (0.12)	0.53 (0.38)	1.42 (0.30)	0.14 (0.44)	1.37 (0.59)	1.69 (0.73)	0.56 (0.65)	0.67 (0.26)
Immunization-Measles	0.28 (0.14)	1.36 (0.48)	0.34 (0.23)	1.37 (0.38)	0.40 (0.58)	1.21 (0.53)	1.23 (0.68)	0.37 (0.38)	0.13 (0.41)
Full immunization coverage	0.10 (0.08)	1.14 (0.10)	0.29 (0.41)	1.40 (0.30)	-0.15 (0.30)	1.10 (0.38)	1.61 (0.86)	0.48 (0.52)	0.38 (0.30)
Care-seeking for symptoms of pneumonia	0.64 (0.21)	0.44 (0.40)	0.32 (0.22)	0.46 (0.14)	0.57 (0.52)	0.09 (0.37)	0.90 (0.20)	1.06 (0.73)	0.51 (0.53)
Diarrhea treatment: Oral rehydration salts	0.47 (0.38)	0.54 (0.94)	0.94 (0.66)	0.76 (0.40)	1.40 (0.77)	0.74 (0.60)	2.01 (0.48)	1.03 (0.73)	1.20 (0.40)
Composite coverage index	0.45 (0.15)	0.99 (0.25)	0.79 (0.31)	1.01 (0.24)	0.96 (0.05)	0.91 (0.22)	1.58 (0.19)	0.81 (0.40)	0.96 (0.21)

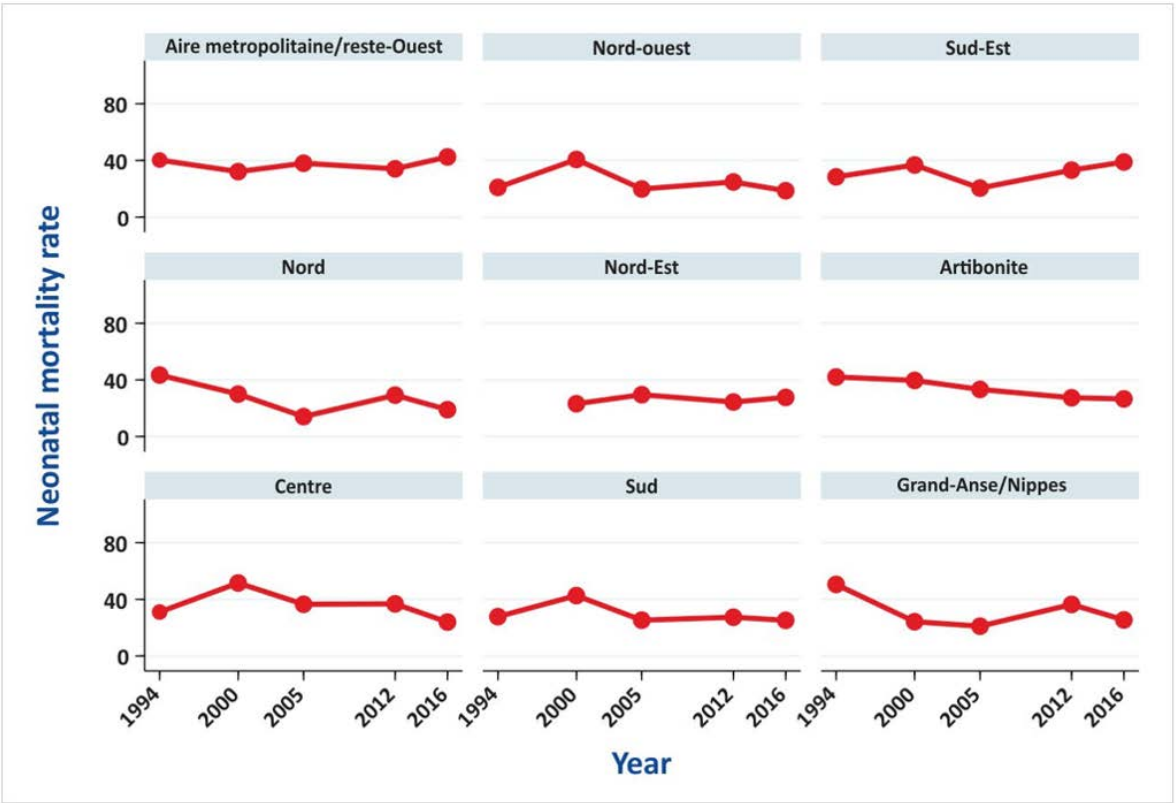
Notes: *Estimate calculated for the period between 2001 to 2012; ** Estimate calculated for the period between 2000 to 2015; ¥ Estimate calculated for the period between 1997 to 2018.

Figure A6: Time trends in under-five stunting prevalence at departmental level: Haiti, 1994-2016.



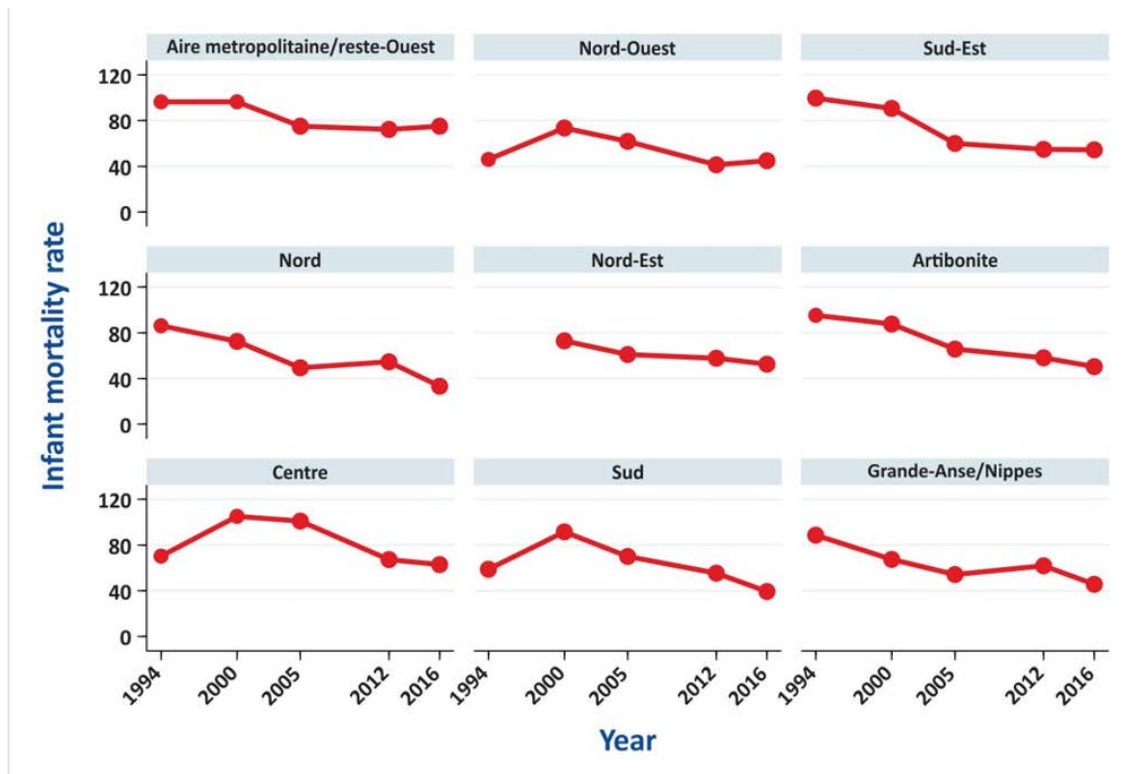
Source: DHS.

Figure A7: Time trends in Neonatal mortality rate (deaths per 1000 live births) at departmental level: Haiti, 1994-2016.



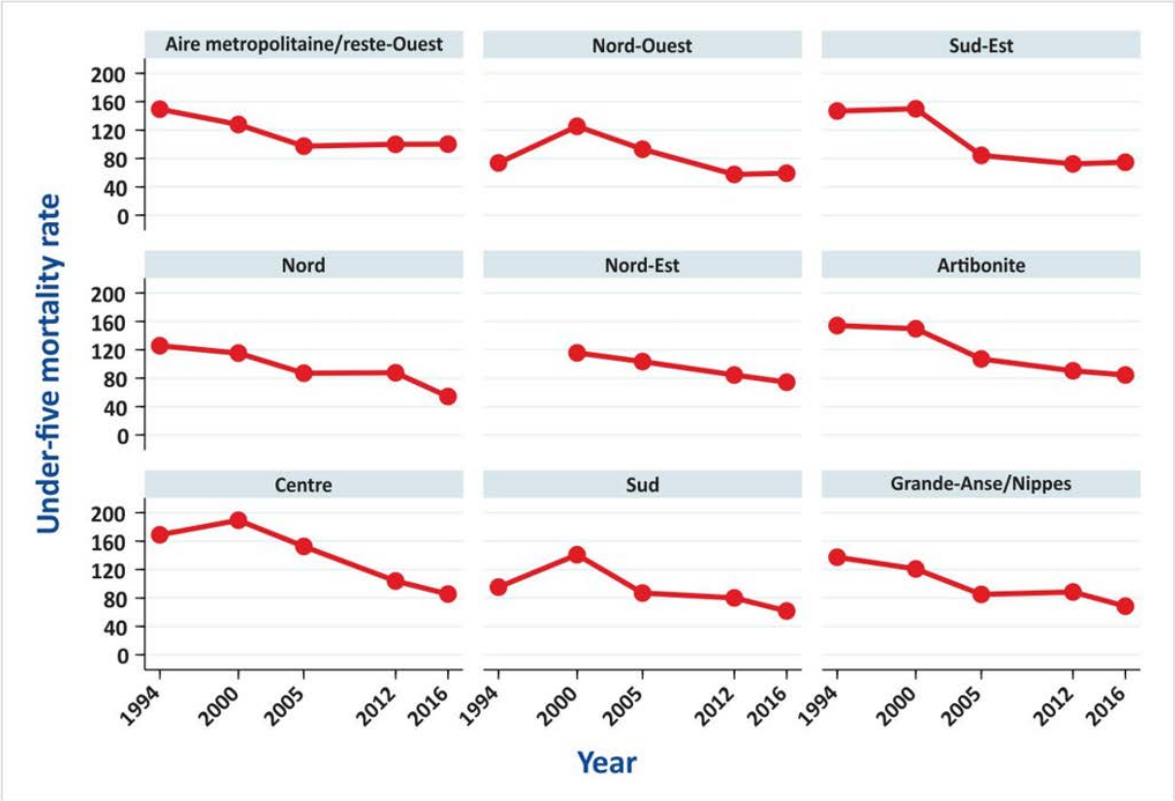
Source: DHS.

Figure A8: Time trends in infant mortality rate (deaths per 1000 live births) at departmental level: Haiti, 1994-2016.



Source: DHS.

Figure A9: Time trends in under-five mortality rate (deaths per 1000 live births) at departmental level: Haiti 1994-2016.



Source: DHS.

Table A2: Ranking of departments in Haiti according to the average absolute annual change in the outcomes.

Rank	Department	Stunting	
		Beta	SE
1	Artibonite	-0.96	0.18
2	Grand-Anse/Nippes	-0.89	0.16
3	Nord	-0.87	0.21
4.5	Nord-Est	-0.84	0.19
4.5	Sud	-0.84	0.19
6	Centre	-0.65	0.30
7	Sud-Est	-0.59	0.32
8	Aire metropolitaine/reste-Ouest	-0.37	0.21
9	Nord-Ouest	-0.33	0.10
Neonatal mortality			
1	Nord	-0.85	0.55
2	Artibonite	-0.77	0.08
3	Grand-Anse/Nippes	-0.65	0.69
4	Centre	-0.47	0.60
5	Sud	-0.35	0.43
6	Nord-Ouest	-0.34	0.56
7	Aire metropolitaine/reste-Ouest	0.09	0.27
8	Nord-Est	0.12	0.28
9	Sud-Est	0.32	0.44
Infant mortality			
1	Sud-Est	-2.25	0.52
2	Nord	-2.16	0.49
3	Artibonite	-2.12	0.27
4	Grand-Anse/Nippes	-1.60	0.51
5	Sud	-1.30	1.01
6	Nord-Est	-1.16	0.27
7	Aire metropolitaine/reste-Ouest	-1.12	0.40
8	Centre	-0.95	1.18
9	Nord-Ouest	-0.63	0.81
Under-five mortality			
1	Centre	-4.50	1.19
2	Sud-Est	-3.96	1.15
3	Artibonite	-3.54	0.62
4	Grand-Anse/Nippes	-3.00	0.62
5	Nord	-2.97	0.6
6	Nord-Est	-2.60	0.03
7	Aire metropolitaine/reste-Ouest	-2.26	0.73
8	Sud	-2.22	1.43
9	Nord-Ouest	-1.74	1.52

Table A3. Multilevel linear regression analysis for under-five stunting prevalence (Alternative model with composite coverage index): Haiti.

Hierarchical level of the determinants	Determinants	Time-adjusted regression coefficient	95% CI	p-value	Time and confounder-adjusted regression coefficient	95% CI	p-value
Disasters vulnerability	Occurrence of natural disasters	-1.70	-4.70, 1.29	0.265			
	Urbanization	-0.12	-0.23, 0.00	0.05			
Socioeconomics determinants	Women's schooling	-2.82	-3.97, -1.68	<0.001	-1.67	-3.32, -0.02	0.047
	Absolute income	-0.01	-0.02, 0.00	0.038	-0.01	-0.01, 0.00	0.155
	Total fertility rate	3.42	1.41, 5.44	0.001	1.60	-0.78, 3.99	0.188
Environmental determinants	Access to improved drinking water source	-0.20	-0.29, -0.11	<0.001	-0.16	-0.26, -0.07	0.001
RMNCH interventions variables	Composite coverage index	-0.26	-0.51, -0.02	0.036	-0.15	-0.35, 0.05	0.132
	Time (year)	-0.71	-0.85, -0.56	<0.001	-0.14	-0.44, 0.15	0.344