Unlocking Health Potential: Effects of Free Maternal and Child Health Program*

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July, 2025

We investigate the health impacts of Nigeria's free maternal and child health program (FMCHP), leveraging variation in exposure to the program across births to the same mother. Results show reduced under-five mortality, with effects more pronounced in disadvantaged populations and in areas with more healthcare services. Increased demand for preventive care likely drives improvements in mortality. The FMCHP prevents a child's death at approximately 54% of annual household expenditure. Our findings suggest that improving access to institutional healthcare during pregnancy improves maternal and child health outcomes in areas with low healthcare utilization. These conclusions are robust to various empirical checks.

JEL Classifications: H51, I12, O15, O55

Keywords: Africa, Free Healthcare, Child Mortality, Preventive Care

*We thank Alexander Ahammer, Salma Mohammad Ali, Prashant Bharadwaj, Alberto Chong, Anne Fitzpatrick, Lauren Hoehn-Velasco, Jafar Jafarov, Jessica Leight, James Marton, Stephen D. O'Connell, Ashley O'Donoghue, Ruth Uwaifo Oyelere, Tom Mroz, Michael Pesko, Mayra Pineda-Torres, Keith Teltser, and David Qihang Wu for their helpful comments and suggestions. We also thank many audience members at AHSEcon Annual Conference 2024, Andrew Young School of Policy Studies Lightning Talk, Atlanta Student Workshop, Virtual Economics of Poverty and Policy Seminar, and GSU Graduate Conference for Research, Scholarship and Creative Activity for their insightful feedback and comments. A previous version of this paper was circulated under the title "Is Zero Price No Price? Health Effects of Free Maternal and Child Health Care Program". All remaining errors are our own. Corresponding Author: Singh (email: tpratapsingh1@student.gsu.edu)

1 Introduction

Sub-Saharan Africa has the highest rate of under-five mortality, accounting for 52% of all deaths before the age of five globally. Many of these deaths are due to low vaccination rates (Ferede Zegeye, Kassa Mekonnen, Kindie, Shetie Workneh, Bihonegn Asmamaw and Tarik Tamir, 2024). As progress on improving child and maternal health across the world has stalled, increasing attention is being paid to programs that reduce medical costs. One such program is user fee elimination (WHO, 2023). Despite the importance of out-of-pocket (OOP) cost elimination programs, the existing literature can be characterized as conflictory at best. The conflicting evidence might be a result of insufficient statistical power to detect the effect on child mortality (Kremer, Luby, Maertens, Tan and Więcek, 2023).

In this paper, we study the impacts of a free maternal and child health program (FMCHP) on under-five mortality. Our setting is Nigeria, a West African country with some of the highest rates of child mortality and very low levels of institutional deliveries. The program we examine is rolled out in a staggered fashion across twelve out of 36 states in the country. Each phase is initiated in six distinct states. The first phase starts in October 2008 and the second phase in December 2009. Due to a funding crunch, FMCHP ceased to operate in December 2015, although the financial problems started to appear as early as 2013. FMCHP aims to provide free access to primary health facilities along with referral to general hospitals for complicated pregnancies. While pregnant mothers are eligible beneficiaries from the time of pregnancy confirmation to six weeks after the delivery, their children can avail of the program benefits till their fifth birthday.

We leverage multiple data sources to evaluate the health effects of FMCHP exposure on mothers and their children. We use three rounds of Demographic and Health Surveys (DHS). The respondents in these rounds are surveyed between 2003 and 2018. Although initially envisaged to be restricted to certain local government areas (LGA) in the states with the roll out, the program eventually enrolls all pregnant women as long as they can establish their residency in the state. Thus, we treat all women and children residing in a state where the program is rolled out to be potential beneficiaries. These data also provide us with information on individual and household characteristics that we use for various heterogeneity analyses. Additionally, information on preventive care is used to examine potential mechanisms driving the estimated changes in under-five mortality. We complement DHS data with the data on the universe of health facilities in Nigeria to examine if access to such facilities influences the health effects for the mother and her child due to FMCHP exposure.

To uncover causal estimates of FMCHP exposure on maternal and child health outcomes, we use a mother fixed-effects empirical specification. This approach allows us to account for time-invariant mother-level characteristics that determine exposure to FMCHP and at the same time influence health outcomes. Through a series of empirical checks, we establish the validity of our research design.

In particular, we show that our estimates are not subject to trends in the under-five mortality that differ across the births that are and are not exposed to the FMCHP. Our estimates are also robust to accounting for the staggered roll out of FMCHP where a conventional two-way-fixed-effects (TWFE) empirical specification is prone to "forbidden" comparisons between earlier and later treated units and heterogeneous treatment effects (de Chaisemartin and D'Haultfœuille, 2022; Roth, Sant'Anna, Bilinski and Poe, 2023).

We find that children born after the FMCHP roll out are more likely to survive beyond their fifth birthday. The decline in under-five mortality of 2.68 percentage points is large at approximately 14% of the pre-treatment mean for the treated group. The dynamics of improvement in child mortality accord well with the anecdotal evidence suggesting funding exhaustion in the last couple of years of FMCHP implementation as the decline in child mortality during these years is statistically less precise.

It might be the case that having access to health facilities affects the role of FMCHP exposure in improving child health outcomes. To shed more light on such pathways, we bring to the fore novel data on the universe of health facilities in Nigeria. Using these data we can ascertain the different types of facilities in the survey respondent's proximity. Our estimates show that reduction in under-five mortality is more pronounced in the states that are in the top half of health facilities, health personnel, and hospital beds per-capita distributions. Furthermore, improvements in under-five mortality are concentrated in states that are in the top half of the pediatric facilities per-capita distribution.

FMCHP may have reduced the existing disparities in child mortality. Our results differ significantly and are more pronounced for relatively disadvantaged subpopulations. The decline in under-five mortality is concentrated in those households that are in the bottom half of the wealth distribution, follow Islam, or reside in northern parts of the country. Steeper declines in under-five mortality among poorer groups are significant, given Nigeria's high obstetric care costs. Our estimates show households spend about 26% of their annual per-capita expenditure on emergency obstetric care.[1]

An increase in child immunization is a likely mechanism leading to improvements in under-five mortality. Existing studies point to the effectiveness of vaccines in preventing deaths before the age of five (Kolawole, Akinyemi and Solanke, 2023; McGovern and Canning, 2015; WHO, 2020). Across vaccines, we find that children exposed to FMCHP are more likely to be vaccinated than their non-exposed counterparts. Pre-delivery interaction through institutional and health personnel provided antenatal care along with dietary supplement receipt during pregnancy may have reduced existing mistrust with health personnel and medical providers leading to increased institutional delivery post-FMCHP, eventually maturing in women vaccinating their children. In the backdrop of FMCHP emphasizing com-

[1] Average total expenditure of $243.8 on emergency obstetric care is derived from Adamu Aisha, Adamu, Isa and Zubairu (2013). From Nigeria General Household Survey Wave One (2010-2011), we estimate that an average household expends $981 per-capita annually.

munity outreach and engagement to reduce the knowledge gap of women, these estimates allow us to trace out a causal pathway leading to improved child mortality beginning with actions that aim to educate pregnant women about the benefits of institutional care and child immunizations. We rule out improvements in acute care leading to a reduction in under-five mortality as children exposed to FMCHP are not more likely to seek treatment for acute ailments like fever or diarrhea.

Improvements in child mortality potentially through increased demand for institutional care take place without an increase in the number of primary health facilities in treated states relative to control states. This suggests that before FMCHP there was substantial slack capacity which was unused due to prohibitively expensive institutional healthcare. We find evidence for the reduction of financial barriers to accessing institutional care after the FMCHP roll out.

We subject our estimates to a back-of-the-envelope welfare analysis. We find that FMCHP may have saved $32,196$ child deaths before the age of five over six years. Using the program cost measures, we document a $\$2,565.23$ expense to avert the death of a child before they turn five. This cost estimate is equivalent to approximately 54% of annual average household expenditure in Nigeria.

We contribute to the existing literature examining the health impacts of medical cost reduction programs on multiple dimensions. While the existing literature uses empirical specifications that do not explicitly account for time-invariant unobservable characteristics of the pregnant women, our empirical specifications leverage changes in the exposure to FMCHP for different births experienced by the same women (Qin, Hone, Millett, Moreno-Serra, McPake, Atun and Lee, 2019; Renard, 2022). We also make progress on rationalizing conflicting evidence on health outcome changes due to user fee removals.

Fitzpatrick (2018) document an increase in cesarean sections, a decline in maternal mortality, and stagnation or worsening neonatal mortality in Sub-Saharan Africa. On the contrary, McKinnon, Harper, Kaufman and Bergevin (2014) find that there is no effect of user fee removal for facility-based delivery but a decline in neonatal mortality emanating from an increase in facility-based delivery. Lagarde, Lépine and Chansa (2022) find that when user fee was removed in Zambia, pregnant women were more likely to deliver in the health facility but there was no change in C-section rates or neonatal mortality. Using a randomized control trial that removed user fees for children under the age of five in Ghana, Ansah, Narh-Bana, Asiamah, Dzordzordzi, Biantey, Dickson, Gyapong, Koram, Greenwood, Mills and Whitty (2009) found no effect on various health outcomes of the exposed children. Leveraging variation in the access to free healthcare arising due to historical segregation in South Africa, Tanaka (2014) show that children exposed to user fee removal have better nutritional outcomes later in life. Utilizing several policy changes in Ghana, Friedman and Keats (2024) highlights the role of antenatal care, monetary costs of institutional deliveries, and post-natal care in reducing child mortality.[2]

[2]There is also work outside of Africa that has also found mixed evidence on child mortality resulting from reduction or

We show that access to health facilities drives a reduction in under-five mortality. Thus, differential access to health facilities could be the reason for the conflicting evidence in the existing literature. We shed light on potential mechanisms leading to improvements in under-five mortality highlighting the role of an increase in demand for preventive care. Finally, to the best of our knowledge, not only do we provide an estimate of the number of lives saved by FMCHP, but we are also the first to estimate the cost of averting the death of a child before they turn five due to user fee removals in a Sub-Saharan Africa context.

The rest of the paper proceeds as follows. We provide a brief background in Section 2. Discussion of data and empirical strategy is in Section 3 and Section 4, respectively. Main results, robustness checks, heterogeneities, mechanism analysis, and welfare estimates are presented in Section 5. Section 6 concludes.

2 Background

In this section, we provide a brief discussion of the healthcare landscape in Nigeria. Our focus, while providing this discussion, is centered around maternal and child health. We also provide details about the Free Maternal and Child Health Program (FMCHP).

2.1 Healthcare in Nigeria

Maternal mortality in Nigeria remains an area of concern, with an estimated 814 maternal deaths per 100,000 live births.[3] Also, Nigerian women face a significantly higher lifetime risk of maternal death compared to women in developed countries, with a 1 in 22 chance of dying during pregnancy-related events. Additionally, infant and under-five mortality rates have remained steady over the past five years, with 74 infant deaths and 117 under-five deaths per 1,000 live births. Mortality indicators are worse for children from the poorest households as they are twice as likely to die before their first or fifth birthday compared to children from the wealthiest households.[4] Under-five mortality rate in Nigeria is comparable to other Sub-Saharan African countries, reflecting the importance of our work for other similar settings. These depressing statistics underscore Nigeria's urgent need for improved maternal

elimination of out-of-pocket expenses. See for instance Bhalotra, Rocha and Soares (2019), Conti and Ginja (2023), Gruber, Hendren and Townsend (2014), Limwattananon, Neelsen, O'Donnell, Prakongsai, Tangcharoensathien, van Doorslaer and Vongmongkol (2015), Miller, Pinto and Vera-Hernández (2013) among others.

[3] More details on maternal and child mortality in Nigeria can be obtained at https://data.worldbank.org/indicator/SH.STA.MMRT?locations=NG.

[4] This figure is drawn from information available at https://www.unicef.org/nigeria/media/1636/file/Nigeria-equity-profile-health.pdf.pdf.

and child health outcomes.

Out-of-pocket (OOP) healthcare spending remains Nigeria's primary financing mechanism for health services. Across the years, OOP health expenditure consistently accounts for a substantial portion of total health spending, ranging from 60% to 75% (Aregbeshola and Khan, 2021). Reliance on OOP payments leads to significant challenges, including limited financial risk protection, unaffordability of healthcare services, and inadequate coverage across the population. Indeed, data from the demographic and health surveys (DHS) in Nigeria show that more than 8% of respondents report financial cost as an impediment for not delivering at a health institution (see Figure A1). Furthermore, when the respondent is sick, cost or other financial reasons make them less likely to seek healthcare in at least 60% of such instances (see Figure A2).

2.2 Free Maternal and Child Health Program (FMCHP)

Due to mounting debt problems in the 2000s, Nigeria was granted debt relief by the Paris Club under the World Bank's Heavily Indebted Poor Countries (HIPC) initiative. The relief was conditional as a significant proportion of it was to be allocated towards improving the welfare of vulnerable groups. Recognizing the poor health profile of the Nigerian population, especially women and children, the government strategically directed part of the HIPC funds towards health investments as part of their commitment to achieving the Millennium Development Goals (MDGs) (Onwujekwe, Obi, Ichoku, Ezumah, Okeke, Ezenwaka, Uzochukwu and Wang, 2019). The Free Maternal and Child Health Program (FMCHP) is part of this initiative.

The FMCHP is a program rolled out in two phases in twelve states in Nigeria. Phase one of the program started in October 2008, and phase two in December 2009. Figure A3 presents the timeline of the program. Both phases ended in 2015. The program was designed with a financing architecture intended to fully reimburse facilities and was planned to have more than two phases. However, the third phase did not start or materialize due to the lack of funds allocated to the program beginning in 2013 (Onwujekwe, Obi and Uzochukwu, 2016a). In Figure A4, we plot the boundaries of the states that constitute the treatment and control groups. The program was designed by the National Health Insurance Scheme (NHIS), a social health insurance program managed by the Federal Government of Nigeria to provide a complementary funding source to the health sector and improve healthcare access to Nigerians.

According to Onwujekwe et al. (2016a), the program received about 13 billion *Naira* ($\sim$ \$82,590,232 USD). The expenditure on the program is approximately 10% of the federal government health expenditure in 2005, which was 130.76 billion *Naira* ($\sim$ \$0.83 billion USD). The program envisaged

to provide free healthcare services to 600,000 women and children concurrently in each phase. Each phase of the program focuses on six states, providing healthcare coverage to a maximum of 100,000 individuals per state at any time totaling 1.2 million individuals (FMoH, 2010). The NHIS envisaged selecting states from each of the six geopolitical zones of the country and does not consider the disease burden or mortality rate in the selection of beneficiary states for program roll out (Briscombe and McGreevey, 2010; Onwujekwe et al., 2016a). The selection of states for the FMCHP, primarily driven by the NHIS-MDG initiative, was not determined by public health needs. Instead, the program's targeting was based on a partnership model contingent on three key factors: a state's demonstrated willingness to provide financial counterpart funding, adherence to a geopolitical quota system to ensure regional equity in the program's phased rollout, and sufficient political will at the state level to ensure implementation (Adewole and Osungbade, 2016). However, as we discuss in Section 3.3 FMCHP states have relatively worse child health indicators relative to non-FMCHP states.

The program provides access to essential primary maternal and child healthcare in selected states. These services include seeing a doctor for an ailment, vaccinations, and getting referred to general hospitals for complications that primary healthcare cannot address (Mohammed and Dong, 2012). The program focuses on eliminating financial barriers to access to health care for approximately 1.2 million pregnant women and children under five years of age. By providing a free maternal and child healthcare program, the program aims to reduce the national out-of-pocket expenses from 66 to 60 percent, a target set out in the National Strategic Health Development Plan (NSHDP) (FMoH, 2010). FMCHP also introduced interventions to facilitate the use of institutional healthcare. A key component of these interventions was community outreach aimed at informing and reducing the knowledge gap among potential beneficiaries (Ezenwaka, Abimbola and Onwujekwe, 2022; Onwujekwe et al., 2019). Before the rollout of the FMCHP, the official policy of free childhood vaccination frequently diverged from the reality experienced by caregivers, despite the stated policy. Evidence indicates that informal user fees for supplies and services associated with immunization were commonplace (Mohammed, Reynolds, Waziri, Attahiru, Olowo-okere, Kamateeka, Waziri, Garba, Corrêa, Garba, Vollmer and Nguku, 2024; Eboreime, Abimbola and Bozzani, 2015), effectively creating a financial barrier to access even when vaccines themselves were intended to be free (Onwujekwe, Dike, Uzochukwu and Ezeoke, 2010).

Women may enroll from when their pregnancy is confirmed by the medical examiner until six weeks after giving birth. On the other hand, children may register from birth until age five. Given this coverage duration and low incidence of infant mortality, our focal outcome variable is under-five mortality. Indeed, when we examine if FMCHP exposure affects the likelihood of child death before age one, we do not observe any statistically significant impact on infant mortality. We revisit this while presenting the mechanism through which FMCHP may impact under-five mortality in Section 5.4.

Initially, phase one of the project limited the enrollment of individuals to only three LGAs. However,

this restriction was later relaxed, starting with Oyo State, due to difficulties NHIS officials and health maintenance organizations (HMOs) encountered in achieving the target of 100,000 enrollees within such a limited pool. Expanding the number of LGAs was deemed necessary to facilitate achieving enrollment goals. Anecdotal evidence suggests that a similar situation arose in other states where FMCHP was rolled out (Green, 2012).

Our treatment group is the twelve states where FMCHP is rolled out in either phase (Dasgupta, Mao and Ogbuoji, 2022). Due to multiple reasons, we define treatment at the state level. First, we lack information on the identity of the LGAs that experienced the FMCHP roll out. Moreover, across LGA migration within the same state is high in Nigeria with almost non-existent across state migration (Ekpenyong, Bond and Matheson, 2019; Ekpenyong, Matheson and Serrant, 2022). As was discussed previously, low enrollment in the program may have led to women from all LGAs within the state to avail themselves of free healthcare services. The FMCHP includes social accountability initiatives, such as Health Facility Committees (HFCs), that monitor the eligibility for receiving free maternal and child healthcare services. A proof of tax payment restricts the use of free healthcare services to the residents of the state (Ogbuabor and Onwujekwe, 2018). Taken together, women residing in the state with an FMCHP roll out may have used the healthcare services provided by the program.

3 Data

To uncover the causal effect of the Free Maternal and Child Health Program (FMCHP) on health outcomes, we use multiple data sources. In this section, we describe each data source and provide descriptive statistics for the analytical sample.

3.1 Demographic and Health Surveys

We use multiple rounds of Demographic and Health Surveys (DHS) to obtain data on the outcomes of interest as well as other covariates that we use in our various specifications and for uncovering the potential mechanisms driving the main results. We combine three DHS waves: three, four, and five. The third survey wave was conducted in 2008 while the following two waves were conducted in 2013 and 2018, respectively. For our main estimation sample, we exclude all the observations for which the birth year is after 2015 as FMCHP ceased to operate after 2015. We further note that dropping post-2015 births does not affect our estimates as our main empirical strategy, discussed in Section 4, leverages variation in births exposed to FMCHP for the same mother. As we do not observe any woman having births before FMCHP roll out and seven years post-FMCHP, we do not loose information by

dropping births after 2015

DHS is a nationally representative survey that provides detailed information on maternal health outcomes for women aged 15 to 49. Furthermore, for all the births that the surveyed women experienced in the five years preceding the survey, detailed information on the health outcomes of the offspring is also provided. We examine if FMCHP affects under-five mortality. Under-five mortality refers to the event of the child dying before their fifth birthday. Using the birth history of each woman surveyed, we can obtain information on child survival for all births experienced by the respondent women.

DHS also provides detailed information on the individual and household characteristics. This allows us to undertake heterogeneity analysis along with studying potential mechanisms that drive the change in health outcomes documented in Section 5. A potential mechanism that may impact child health outcomes that we focus on is preventive care. We describe the construction of the variables used for the mechanism analysis when we discuss these estimates in Section 5.

3.2 Nigeria Health Facility Registry

We derive detailed health facility data from Nigeria's health ministry. Health facility data contains information on the universe of health facilities in Nigeria. These data provide information on the location of the health facilities. The health facility geolocation permits the assignment of facilities to the residence states of DHS respondents. Additionally, in these data, we also observe the date the facility started to provide services. Information on the services rendered and health professionals is also available. We scraped these data in December 2023. We use these data to document the role of health facility access in influencing the impact of FMCHP exposure on under-five mortality. Specifically, we use all primary health facilities that started rendering their services before the FMCHP was rolled out to construct measures of access to health facilities, health personnel (doctors, nurses, and midwives), hospital beds, and facilities providing pediatric services.

3.3 Descriptive Statistics

We present descriptive statistics and balance of covariates in the pre-treatment and post-treatment periods in Table A1. Each observation is a mother-child pair. The post-treatment period is determined by the timing of FMCHP roll out across states. For states where FMCHP is rolled out in the first phase, all births after October 2008 are classified as occurring in the post-treatment period. On the other hand, all births after December 2009 in the states where FMCHP is rolled out in the second phase are classified as post-treatment.

In Table A1, we also present the difference between the treatment and control births in the pre-treatment period. The estimates in Table A1 show that the states where FMCHP is rolled out are negatively selected on the health outcomes in the pre-treatment period. The treatment group states have higher rates of child mortality and have worse child development indicators relative to the control group states. Figure 1 suggests that under-five mortality is trending similarly across control and treatment states before the FMCHP roll out. Our empirical strategy investigates whether these differences in the health outcomes between treatment and control states persist after the roll out of FMCHP.

4 Empirical Strategy

This paper aims to identify the causal effect of the Free Maternal and Child Health Program (FMCHP) on child health outcomes. Our data precludes us from estimating the average treatment effect on the treated (ATT) as we lack information on the respondents' takeup of FMCHP. Our empirical strategy, therefore, estimates intention-to-treat (ITT) effects. In the case of universal takeup, our ITT estimates will coincide with the ATT as long as the identifying assumptions of the empirical framework are satisfied. We return to these assumptions below and discuss why they are likely to be satisfied in our setting.

As is discussed extensively in Section 2, all pregnant mothers residing in a state where FMCHP is rolled out are eligible to be program beneficiaries. Therefore, we designate all births that happen after the FMCHP is rolled out in mothers' residence state to be potential beneficiaries of the program.

Our main empirical specification is the following.

$$y_b = \alpha_{m(b)} + \alpha_{MoB(b),YoB(b)} + \beta \left[\mathbb{1}\left\{ Treat_{s(b)} \right\} \times \mathbb{1}\left\{ Post_{MoB(b),YoB(b)} \right\} \right] + \mathbf{X}_b \gamma + \varepsilon_b \tag{1}$$

In Equation 1, y_b is the outcome for birth b experienced by mother m. Equation 1 also controls for observable characteristics of the birth, denoted by $\mathbf{X}_b$. The characteristics that we account for are birth order, an indicator for whether the birth is a multiple birth, and an indicator for the sex of the child. In Equation 1, we also control for month-year fixed-effects corresponding to the date-of-birth of the child. These are denoted by $\alpha_{MoB(b),YoB(b)}$, where $MoB(b)$ is the month and $YoB(b)$ is the year in which the mother gives birth. These fixed-effects account for time-specific unobservable shocks that are common across treated and control states.

The empirical specification in Equation 1 also controls for fixed-effect specific to each mother. We denote these fixed-effects as $\alpha_{m(b)}$ in Equation 1. These fixed-effects account for time-invariant unobservable characteristics of the mother such as their health behaviors that do not differ across multiple

births experienced by the mother. Including these fixed-effects implies that the identification of the ITT effect is based on differential exposure to FMCHP across pregnancies of the same mother.

ε_b is the idiosyncratic error terms that we cluster at the local government area-level to account for correlation across mothers in the same local government area (Abadie, Athey, Imbens and Wooldridge, 2022; MacKinnon, Ørregaard Nielsen and Webb, 2023). We do not cluster standard errors at the state-level as there are too few clusters for the inference with this level of clustering to be reliable. However, with the wild cluster bootstrap inference, the p-value for the null hypothesis test of the β in Equation 1 to be equal to zero is 0.076.[5] Abadie et al. (2022) show that when cluster sizes are large and treatment varies within clusters, cluster standard errors can be considerably larger than necessary. Given that we use all the births from the three DHS survey rounds, the loss of statistical precision for the under-five mortality variable might be driven by the standard error inflation causes identified by Abadie et al. (2022).

The parameter of interest in Equation 1 is β. The estimate of β is the marginal effect of FMCHP exposure on the outcome of interest. It is the marginal effect of the interaction of an indicator for the birth b occurring in the treatment state, $\mathbb{1}\left\{Treat_{s(b)}\right\}$, and an indicator for the birth b occurring in the post-treatment period, $\mathbb{1}\left\{Post_{MoB(b),YoB(b)}\right\}$. As we are unable to ascertain individual takeup, this marginal effect is an estimate of the ITT effect of FMCHP exposure.

We note that the specification in Equation 1 is akin to a difference-in-differences empirical framework. Consequently, to interpret estimates from this specification causally, we need certain assumptions to be satisfied. First, we need to ensure that the outcomes for the treatment and control births are trending similarly in the pre-treatment period.

To this end, we present event-study estimates in Figure A6. The event-study estimates are from the estimation of a specification similar to Equation 1 where we replace the interaction of the indicator for the birth occurring in a treatment state and the indicator for the birth occurring in the post-treatment period with multiple indicators for each period pre- and post-treatment in our analytical sample. All the estimates are relative to the second period immediately preceding the first post-treatment period which is denoted by zero in both figures. This specification is as follows.

(2)

$$y_b = \alpha_{m(b)} + \alpha_{MoB(b),YoB(b)} + \sum_{i=-7, i\neq -2}^{4} \beta_i \left[\mathbb{1}\left\{Treat_{s(b)}\right\} \times \mathbb{1}\left\{YoB\,(b) - TreatYear_{s(b)} = i\right\}\right] + \mathbf{X}_b\gamma + \delta_b$$

In Equation 2, all the parameters are the same as in Equation 1, except that the single interaction of the indicator for the treatment status of the state and the indicator for the post-treatment

[5] We use default options in Stata's `wildbootstrap` command along with mammen distribution.

period is replaced with the interaction of treatment status of the state indicator, $\mathbb{1}\left\{Treat_{s(b)}\right\}$, and the indicator for the difference between the birth year, $YoB(b)$, and the treatment year for the birth state, $TreatYear_{s(b)}$, to be from -7 to 4. In Equation 2, we denote this interaction as $\left[\mathbb{1}\left\{Treat_{s(b)}\right\} \times \mathbb{1}\left\{YoB(b) - TreatYear_{s(b)} = i\right\}\right]$.

In Equation 2, $\beta_i, \forall i \in \{-7, .., 4\}, i \neq -2$ is relative to β_{-2} which is the marginal effect of FMCHP exposure on outcome variable in the second year immediately preceding the first year of treatment, $i = 0$. This choice is governed by the fact that the likely mechanism leading to the decline in under-five mortality is increased vaccination, as discussed in Section 5.4. As we report in Figure A5 all but one vaccine is administered beyond the first year of life of the child in Nigeria. Therefore, we expect the children who are less than a year old when FMCHP is rolled out in their mother's residence state to be partially impacted by FMCHP exposure driven increased immunization and thus less likely to die before their fifth birthday. The outcomes for the treatment and control births are trending similarly in the pre-treatment period if $\beta_i = 0, \forall i \in \{-7, -5, .., -1\}$ in Equation 2.

Note that the specification in Equation 1 is a two-way-fixed-effects (TWFE) specification. Recent literature has highlighted that in the presence of staggered treatment adoption along with dynamic and heterogeneous treatment effects, TWFE estimates are biased (de Chaisemartin and D'Haultfœuille, 2022; Roth et al., 2023). This bias arises due to "forbidden" comparisons where an earlier treated unit serves as a counterfactual unit for a later treated unit. As FMCHP is rolled out across Nigerian states over two phases, the specification in Equation 1 is potentially subject to this bias.

In Figure A6 we present estimates from the estimator proposed in Sun and Abraham (2021). This estimator removes contamination arising due to "forbidden" comparisons. We observe that under-five mortality is trending similarly for children in the control and treatment group before FMCHP is rolled out. We note that the p-value of the joint test for all pre-treatment parameters to be zero is 0.3825. Thus, we do not reject the null hypothesis that under-five mortality is trending similarly for the children in treatment and control states in the pre-treatment period.

In addition to the outcome for treated and control children trending similarly in the pre-treatment period, we also need to ensure that there is no anticipation for the mothers who eventually are exposed to FMCHP. We verify that there is no change in fertility due to exposure to FMCHP. The point estimate from the specification where the dependent variable is respondents' realized fertility is 0.0116 with a standard error 0.019667. The realized fertility is for those women who have completed their fertility. We further demonstrate that there are no abrupt changes in the number of new primary health facilities that begin operation in the treated states after FMCHP is rolled out. The point estimate on the interaction of post-treatment period indicator variable and treatment state indicator is 0.34 with a standard error of 0.46. This specification has the number of health facilities in the state as the dependent variable with the fixed-effects for state and year-month. Thus, there is neither anticipation on the part of

healthcare suppliers nor they are incentivized to begin operation in the aftermath of the FMCHP roll out.

Further, we also establish that there is no significant change in the composition of mothers in the treatment and control states after FMCHP is rolled out. Table A2 presents these estimates. The first two outcome variables that we examine are related to the education of mothers. We create an indicator variable for whether the mother is illiterate and reports having no education. Point estimate in column (1) and column (2) of Table A2 does not suggest that mothers in states with FMCHP are more likely to report being illiterate or having no education attainment in the period after FMCHP is rolled out relative to the period before the roll out when compared to their counterparts during the same period in states where FMCHP is not rolled out.

We reach the same conclusion for the next three variables examined in column (3) to column (5) of Table A2. The first of these variables is an indicator variable for whether the household wealth index is in the top two quintiles of wealth distribution. DHS constructs the household wealth index by taking into account the household's asset ownership, materials used for housing construction along with information on access to sanitation and water access facilities. The point estimate in column (3) of Table A2 is small in magnitude and not statistically significant.

The next two columns of Table A2 are indicator variables for whether the mother reports being currently married and whether her spouse has no educational attainment. For both these indicator variables, we do not find any evidence that the mothers in treated states differ statistically significantly from their counterparts in control states in the period post-FMCHP roll out relative to the period before the roll out of FMCHP. We reach the same conclusion for indicator variables related to health insurance coverage of the mother and urban residence of the household. Taken together the results from Table A2 establish that our empirical design is not plagued by changes in the composition of mothers in the states where FMCHP is rolled out after the program is initiated.

To the best of our knowledge, there is no other program that was rolled out during our sample period that specifically targeted pregnant mothers and their children in states where FMCHP is rolled out in either phase. It is often the case that health policies in Nigeria are operationalized for the entire country concurrently (Ezenwaka et al., 2022). Our empirical design secures contamination from the effects of such policies as they are likely to affect treatment and control group births similarly.

We conclude this section by emphasizing that the specifications in Equations 1 and 2 account for potential endogenous takeup of FMCHP by the exposed mothers as we leverage variation across births to the same mother in exposure to the FMCHP. In Appendix Section B, we report estimates from the specifications that leverage variation in FMCHP exposure within the mother's residence states and across all birth cohorts. Furthermore, we restrict the analytical sample in Appendix Section B to

first births only. The estimates in Appendix Section B are larger than those reported in Section 5.1 suggesting that the mothers who takeup FMCHP benefits are more likely to benefit from the program.

5 Results

In this section, we present results for under-five mortality discussed in Section 3.1. We report estimates from the specification in Equation 1. Through multiple empirical checks, we establish the robustness of our main results. We then examine if the main effects vary across different subpopulations. We end this section by highlighting mechanisms that may lead to documented changes in health outcomes due to Free Maternal and Child Health Program (FMCHP) exposure and quantifying the cost of FMCHP in terms of deaths averted before the age of five.

5.1 Main Results

We begin by examining under-five mortality. Table 1 reports point estimates from the specification in Equation 1. We observe that relative to children born before FMCHP is rolled out, children born after the program roll out are 2.68 percentage points less likely to die before age five. Quantitatively the decline in the under-five mortality is large at approximately 14% of the pre-treatment mean in the treated group. The decline in under-five mortality is not sensitive to controlling for a child's observable characteristics.

Figure A6 reports event-study estimates from the specification in Equation 2. We are not able to reject the null hypothesis that all of the pre-treatment parameter estimates are zero. p-value from a Wald test of the null hypothesis that all pre-treatment estimates are zero for under-five mortality is 0.383. Under-five mortality declines from the second post-treatment period and this decline persists for the rest of the post-treatment period albeit with some loss of statistical precision in the last two post-treatment periods. We note that during these two post-treatment periods, FMCHP had started to experience funding issues.

The lack of a statistically significant decline in the mortality for children who are more than a year old at the time of roll out of FMCHP in their mother's residence state is expected. This is because in Section 5.4 we show that the increased immunization for FMCHP exposed children drives the decline in under-five mortality. Since all but one vaccines are administered within the child's first year of birth (Figure A5), we do not expect those older than one year to reap the benefits of increased immunization during the first year of life driven by FMCHP.

In the next subsection, we present various empirical checks to establish the robustness of the conclusions in this subsection. We establish that our main findings are unaltered when we change the estimating specification, modify the analytical sample, or use alternate FMCHP exposure measures, in addition to other modifications to our baseline empirical framework.

5.2 Robustness Checks

We next turn to establish the robustness of our estimates presented in Table 1. We conduct a series of robustness checks in Table 2.

The first column of Table 2 replicates column (2) of Table 1. In column (2), we classify all births to be exposed to FMCHP based on their date-of-conception (DoC). We define date-of-conception as nine months before the reported date-of-birth of the child. The point estimate with this redefined FMCHP exposure for under-five mortality is not statistically different from the baseline point estimate.

Column (3) of Table 2 adds Local Government Area (LGA) linear time trends to the specification in Equation 1. This allows LGAs to trend differently over the sample period. If the specification in Equation 1 is unable to account for time-varying unobservables at the LGA-level, then we expect the main effects to be biased. Reassuringly, the point estimate when allowing for LGA time trends is unaltered lending credence to the assumption of the absence of time-varying unobservables that may conflate our point estimates.

In column (4), we drop the two most populated states: Lagos and Abuja. This change to the estimation sample does not alter the improvement in under-five mortality with the difference not being statistically significantly different from zero.

In column (5) and column (6) of Table 2, we constrain the size of the estimation sample. Column (5) drops all mothers who are above the age of 40 at the time of birth of their child. In column (6), we drop all states from the estimation sample that may have had an operational FMCHP before 2008.[6] Improvement in child health from the estimation sample where mothers over the age of 40 are excluded is not statistically significantly different from that reported in the first column of Table 2. Under-five mortality estimate is not qualitatively altered when we constrain the estimation sample by dropping the states that may have had an operational FMCHP before 2008. The point estimates for under-five mortality are larger in magnitude with the constrained analytical sample and we can reject the null hypothesis that the two estimates are not different.

[6] We have not been able to ascertain whether some states had an operational FMCHP before the program that we have examined in this paper. However, existing work suggests that some states may have had FMCHP in place before 2008. Identification of such states is based on Okonofua, Lambo, Okeibunor and Agholor (2011).

In Table 3, we show that our main results are not driven by birth at a particular birth order. For none of the subsamples, we can reject the null hypothesis of equality of estimates between the baseline sample and the subsample of concern. Excluding all the households that have more than one child that could have potentially benefited from the FMCHP results in qualitatively similar estimates to those from the baseline specification and analytical sample. A child is a potential beneficiary of the FMCHP if their age during the post-treatment period is five or less. Restricting the analytical sample by excluding such households reduces the estimation sample by up to 8%. The point estimate and associated standard error for under-five mortality are -0.02536 and 0.0067, respectively.

Under-five mortality might be subjected to right censoring as some of the children that are part of our estimation sample have not yet turned five. Approximately 80% of child deaths in our estimation sample happen before children turn two. When we drop children who are younger than two years of age, our estimates are extremely similar to the baseline estimate reported in Table 1. The point estimate from this considerably reduced analytical sample is -0.022 with a standard error of 0.011. Furthermore, estimates from a specification with residence state and child's year-month-of-birth fixed-effects estimated through the Cox proportional hazard model suggest a marked decline in the under-five mortality with a hazard ratio estimate of 0.868 and associated standard error 0.036.

DHS provides information on whether respondent reports being away from the current residence for more than a month during the preceding 12 months from the survey date. When we restrict the analytical sample to those respondents who don't report such short-term migration, our estimates are larger in magnitude than the baseline estimates reported in Table 1. The point estimate from the specification in Equation 1 is -0.032 with a standard error of 0.0093. Therefore, it is unlikely that our control group is contaminated by the strategic relocation of the unexposed respondents.

Overall results in this subsection show that exposure to FMCHP leads to a decline in under-five mortality for potentially exposed children. This conclusion is robust to multiple sensitivity checks related to empirical specification, analytical sample, and treatment variable definitions. In the next subsection, we examine if FMCHP affects various population subgroups differentially.

5.3 Heterogeneity

In this subsection, we present estimates for various subpopulations that constitute the estimation sample. We start by making extensive use of the health facility registry data to study if differential access to health facilities exacerbates how FMCHP affects the under-five mortality of children potentially exposed to FMCHP. Then, we stratify the estimation sample by various socioeconomic characteristics of the respondents.

In the first column of Table 4, we examine if the state with above median health facilities per-capita where FMCHP is rolled out experiences a larger decline in under-five mortality, relative to their counterparts with below median health facilities per-capita. Estimates in Table 4 are constructed using the Nigeria Health Facility Registry (HFR) data. Since the finest geographical unit observed in the DHS is the state, we are only able to categorize the population based on facilities in the state. While DHS provides local government area (LGA) codes, there is no concordance between the LGA codes and names. Therefore, we are unable to ascertain the residence LGA for respondents that constitute our estimation sample. Furthermore, due to random displacement of cluster locations which may make the cluster cross the LGA boundaries, we are unable to use the cluster geocodes to map the respondents to LGAs.

Only primary facilities are used to derive these subpopulations. This is because FMCHP envisaged providing free healthcare in such facilities (Onwujekwe et al., 2019). As facility exposure may change depending on whether the state rolls out FMCHP or not, we rely on facility data before 2008 during which the first phase of FMCHP started. To designate the respondents to be residing either below or above the median of the distribution of the measure per-capita used for stratification, we use population counts at the state-level from the 2006 Nigeria Population and Housing Census.

We observe that for states with a relatively higher number of health facilities per-capita, relative to births that occur before FMCHP is rolled out, births occurring after the roll out are less likely to result in the death of the child before their fifth birthday. We can reject the null hypothesis that the estimates are the same across the two subgroups based on the number of health facilities per-capita in the state. Indeed, quantitatively the decline in under-five mortality in states that provide more access to primary health facilities is substantial at approximately 22% of the pre-treatment mean for the treated group.

We reach similar conclusions for subpopulations defined based on access to health professionals (doctors, nurses, and midwives) per-capita in the residence state. These estimates are reported in the second column of Table 4. Offspring of pregnant mothers residing in states with more access to health personnel are more likely to survive beyond their fifth birthday after potential exposure to FMCHP. We can reject the null hypothesis that the two estimates are the same across the two population subgroups.

Lending further credence to the conclusion that more access to healthcare services accentuates the effect of FMCHP exposure on child health outcomes are estimates reported in the third column of Table 4. In this column, we stratify the population by whether the residence state of the mother and child is either below or above the median per-capita number of beds in the primary health facilities. We find that children born to mothers residing in states with FMCHP roll out are less likely to die before their fifth birthday if the state is above the median of the number of beds per-capita distribution. We can reject the null hypothesis that the estimates are not statistically different across the two subpopulations.

The last column of Table 4 presents estimates from subpopulations that have access to either below or above the median per-capita number of primary health facilities providing pediatric services. We expect to see a more pronounced decline in under-five mortality in the states where children have more access to pediatric services health facilities. Children born after the FMCHP roll out and residing in states with more pediatric services are more likely to survive beyond their fifth birthday relative to their pre-treatment counterparts. We can also reject the null hypothesis that these child health outcomes are the same across the two population subgroups.

Estimates in the last column of Table 4 provide evidence for the role of having more pediatric services in influencing child health outcomes. More access to pediatric services leads to better survival chances for newborns. Building on these estimates in the last column, the first three columns highlight the role of more access to health facilities and health personnel on under-five mortality.

Table 5 presents estimates from Equation 1 for various subpopulations. The estimates in this table show that FMCHP has a more pronounced impact in reducing under-five mortality for children born in less wealthy households, households residing in the Northern part of the country, and Islam-following households.

Column (1) and column (2) of Table 5 report estimates by whether the household is classified as having below or above median wealth level. We note that the classification of households in these two categories is based on the wealth distribution in the round that they were surveyed. Relatively poorer households see improvement in under-five mortality of children potentially exposed to FMCHP. Indeed the decline in the under-five mortality is concentrated only in the relatively less affluent subgroup.

Column (3) and column (4) of Table 5 report estimates for subpopulations defined by respondents' religion. We classify respondents as following Islam based on their reported religion. Existing work provides evidence that households following Islam are less likely to vaccinate their children and more likely to refuse cesarian-section (Antai, 2009; Ugwu and de Kok, 2015). FMCHP exposure leads to a lower likelihood of death before the fifth birthday of the child born to women following Islam. Indeed, the decline in under-five mortality for the women who follow Islam is statistically different from those women who follow Christianity.

In the next two columns of Table 5, we stratify the estimation sample by whether the household resides in the northern or southern region of Nigeria. Existing evidence points to wide socioeconomic disparities between these two regions of the country. The northern part of Nigeria is disadvantaged across multiple dimensions related to human development, including access to healthcare services (Abegunde, Kabo, Sambisa, Akomolafe, Orobaton, Abdulkarim and Sadauki, 2015; Adeyanju, Tubeuf and Ensor, 2017; Ajisegiri, Abimbola, Tesema, Odusanya, Peiris and Joshi, 2022; Gage, Ilombu and Akinyemi, 2016). These healthcare services disparities reflect a higher concentration of hospitals and

formal health structures in the southern region despite the northern region having a larger population (Abubakar, Dalglish, Angell, Sanuade, Abimbola, Adamu, Adetifa, Colbourn, Ogunlesi, Onwujekwe et al., 2022; Birchall, 2019). Post the FMCHP roll out, the northern part of Nigeria experiences improvements in child health outcomes. Indeed, our point estimates are statistically significant at the conventional levels of statistical significance only for the northern part of the country. We note that children are more likely to survive beyond their fifth birthday if they are potentially exposed to FMCHP and reside in the northern region of Nigeria. We can also reject the null hypothesis that the estimates for under-five mortality are the same for the northern and southern regions of Nigeria. We do not find that the reduction in under-five mortality differs across the other demographic groups examined in Table A3.

Overall, estimates in Table 5 suggest that FMCHP may have reduced the existing disparities in the child health outcomes for the relatively worse-off subpopulation (those households who are relatively poorer, reside in the northern part of Nigeria, or follow Islam). Results in this subsection paint a consistent picture of FMCHP closing existing socioeconomic disparities in child survival in Nigeria. We establish the role of FMCHP in improving child health outcomes for socioeconomically disadvantaged subgroups of the population. We also demonstrate the importance of having access to health facilities and personnel in improving child mortality. Our results show that having wider access to pediatric services improves child health outcomes. In the next subsection, we highlight mechanisms that might be leading to the improvement in under-five mortality in the states where FMCHP is rolled out.

5.4 Mechanisms

In this subsection, we examine potential mechanisms that might lead to a reduction in the under-five mortality that we document in Section 5.1. We highlight the role of the increase in demand for preventive care in facilitating the improvement in child mortality.

We examine if children potentially exposed to FMCHP are more likely to be immunized. We establish that FMCHP exposed children are more likely to be vaccinated but no more likely to seek institutional care for acute ailments relative to their non-exposed counterparts. By ruling out the increase in acute care takeup, we provide evidence for preventive care manifested through increased vaccination being the likely channel through which children are more likely to survive beyond their fifth birthday.

In the pre-treatment period, approximately 23% of mothers respond that the child is not vaccinated for fear of side-effects or contracting disease. Together, fear of side-effects and fear that the child may get the disease are the reasons for 22.897% of children not being vaccinated in the pre-treatment period of our sample in the states where FMCHP is rolled out. We report these statistics in Figure A7 and

Figure A8, with the latter being only for vaccinations related to polio. Lack of information, however, is a big reason why women are potentially not vaccinating their children. Approximately 18.5% of the mothers report that they did not vaccinate their child due to a lack of information.

Table 6 studies the likelihood of routine immunization of children.[7] In particular, we look at Bacillus Calmette-Guérin (BCG), measles, Diphtheria-Pertussis-Tetanus (DPT), and polio vaccinations. As information on vaccination is only available for children born in the five years preceding the survey, there is a decline in the analytical sample size. For all vaccinations, we designate the child as vaccinated if they receive at least one dose of the vaccine. Except for BCG, we find a quantitatively large and highly statistically significant increase in the likelihood of being vaccinated for children who are born after their residence state rolls out FMCHP. The increase in vaccination for children exposed to FMCHP is between 4% to 17% of the pre-treatment mean for the states where FMCHP is rolled out. This finding concurs with the existing work documenting the beneficial effects of childhood vaccination on mortality (McGovern and Canning, 2015).

This conclusion is also applicable to the last column of Table 6, where we use a standardized weighted index constructed from the individual indicator variables in the first four panels. Using this index allows us to address the potential false rejection of the null hypothesis of no statistically significant change in immunization, which results from evaluating multiple outcome variables. Overall, the estimates in Table 6 suggest preventive care as a likely mechanism for the reduction in under-five mortality of children potentially exposed to FMCHP.

We revisit the lack of statistical significance for infant mortality as was reported in Section 2.2. The effect of vaccines lasts longer leading to a higher magnitude of decline in the under-five mortality. As complete immunization takes at least a year, the effects of vaccination in reducing child death are unlikely to appear in the first year of life. As we highlighted in Section 4, the immunization schedule in Nigeria is not complete before the child turns one. Therefore, given that FMCHP increased the likelihood of exposed children being immunized the lack of statistical significance on infant mortality is expected.

Seeking healthcare at a health institution for acute ailments can be beneficial in managing the symptoms and preventing triggering life-threatening complications. We study if this is the case in our context. In Table A4, we report no statistically significant change post the FMCHP roll out in the treatment of diarrhea, fever/cough, or either of these two ailments at a health institution. There is a statistically significant increase in the likelihood of the child having diarrhea in the two weeks preceding the survey date. The statistically significant change in this outcome variable, however, could be driven by the false discovery resulting from multiple hypothesis testing. At the same time, respondents may be inclined to

[7] We note that the reduction in sample size for estimates in Table 6 is due to vaccination information being available for only those births that happened within the five years preceding the date the mother is surveyed.

report diarrhea incidence due to improved knowledge about health ailments. Furthermore, we also fail to detect any statistically significant change in the likelihood of taking any drug as part of the treatment regimen for fever or cough. This indicates that acute care changes are not driving the better survival odds of the children exposed to FMCHP.

Recent work by Archibong and Annan (2021) shows that in the wake of failed antibiotic human trials in Nigeria, medical mistrust developed in the affected Muslim community. This mistrust in healthcare providers led not only to a decline in child vaccination but also to reduced prenatal care by the mothers. As the post-FMCHP period is within a decade of the disclosure of the failed trial, continuous interaction with healthcare providers during pregnancy (pre-delivery) and delivery may have helped in rebuilding trust with medical providers, underscoring the emphasis put on community outreach by FMCHP. We provide evidence for this increased interaction in Table A5 and Table A6.

Table A5 reports estimates from the standardized weighted index constructed using various pre-delivery interaction indicator variables. We also report the estimates for the components that are used to construct the weighted index. The estimates in this table show a large increase in the pre-delivery interaction with medical providers by pregnant mothers exposed to FMCHP. The increased pre-delivery interaction due to FMCHP exposure gains added significance when we situate it in the context of arguably large potential mistrust between medical providers and potential beneficiaries before the FMCHP roll out. Table A6 shows that this increased pre-delivery interaction matures in FMCHP exposed women more likely to deliver at a health institution with the delivery assisted by a health personnel. The increase in health institution delivery is driven by a one-to-one substitution away from home delivery.

Overall, the estimates in this subsection show that a reduction in the likelihood of children in the states where FMCHP is rolled out is driven by an increase in immunization as the interaction with the healthcare providers during pregnancy and delivery reduces the existing mistrust between them and FMCHP beneficiaries. We speculate that FMCHP's initiatives that include extensive use of community health workers may have played a role in educating and convincing pregnant mothers about the benefits of institutional healthcare during pregnancy and delivery (Ezenwaka et al., 2022; Oguntunde, Surajo, Dauda, Salihu, Anas-Kolo and Sinai, 2018; Onwujekwe, Onoka, Nwakoby, Ichoku, Uzochukwu and Wang, 2018; Onwujekwe et al., 2019).

We conclude this subsection by showing that FMCHP, through eliminating out-of-pocket expenditures, reduced financial barriers to access to healthcare for FMCHP exposed women. As FMCHP eliminated out-of-pocket healthcare expenditures sought by pregnant women, we may expect them to experience a lower incidence of financial hardship when seeking treatment or medical advice on account of their being sick. In Table A7, we study if this is the case for pregnant women exposed to FMCHP. We find that women who are exposed to FMCHP are less likely to report money being a big problem when

seeking medical advice or treatment during their sickness in the post-FMCHP period. This conclusion is unaltered when we restrict the estimation sample to those women who are pregnant at the time of the survey. Taken together, the reduction in financial hurdles in accessing medical care suggests that initial low levels of demand are due to prohibitively expensive institutional care.

5.5 Quantifying the Costs and Benefits

In this subsection, we provide back of the envelope estimate of the welfare benefits and costs of the Free Maternal and Child Health Program (FMCHP). To estimate these benefits and costs, we rely on multiple data sources each of which we discuss in great detail below.

FMCHP reached approximately 1.2 million children. Recall that our estimate of the reduction in the under-five mortality is 0.02683 (see column (2) of Table 1). Thus, the number of child deaths before the age of five averted in the states where FMCHP is rolled out in the post-roll out period is $32,196$. Evaluating multiple interventions related to health and nutrition in Niger, Amouzou, Habi and Bensaïd (2012) find that these programs reduced child deaths annually by $58,795$. Our estimates suggest a lower annual child lives saved estimate of $5,366$. Nonetheless, Amouzou et al. (2012) evaluates a confluence of policies not all of which are intended to provide free healthcare for the mothers and the child. Furthermore, the absence of program costs precludes these authors from estimating the cost per life saved of a young child.

We obtain the total expenditure incurred on FMCHP from Onwujekwe, Obi and Uzochukwu (2016b). FMCHP disbursed $13,237,031,694.03$ *Naira* to the states where FMCHP was rolled out between November 2008 and September 2014. To translate this expense to U.S. dollar value, we use the Central Bank of Nigeria's exchange rate for the period 2009 to 2015. The estimated expenditure on FMCHP in U.S. dollars is $82,590,232$ or \$0.08259023 billion. Combining the number of child deaths averted before age five with the total expenditure on FMCHP, we estimate that it costs approximately $\$2,565.23$ to save a child's life before their fifth birthday.

Another way we can think of the welfare cost of averting the death of a child under the age of five is to estimate what fraction of annual household expenditure is the amount incurred to save this life. To make progress in this direction, we use Nigeria General Household Survey Wave One (2010-2011). Specifically, we use post-harvest household data on expenditures incurred on meals away from home, food expenditures, and non-food expenditures. Our estimates suggest that an average household expends $\$4,777$ annually. Therefore, we estimate that FMCHP saves the life of a child under the age of five for 53.70% of annual expenditure for an average household.

6 Discussion and Conclusion

In this paper, we study the health effects of a free maternal and child health program in Nigeria. We leverage variation in program implementation timing along with variation across states in program exposure. We show that children potentially exposed to FMCHP are more likely to survive beyond their fifth birthday. The improvements in the health outcomes are more pronounced for relatively more disadvantaged subpopulations. We shed light on the crucial role of health facility access in moderating the changes in health outcomes due to FMCHP exposure. An increase in child immunizations is the mechanism we highlight as the driving force behind the observed improvement in health outcomes. Our back-of-the-envelope estimates suggest that FMCHP may have saved over $32,000$ lives for children under the age of five over six years.

Our work has multiple takeaways for policymakers working on expanding healthcare access for mothers and their children in a low-middle-income country. Reducing financial barriers to access healthcare services not only improves the survival likelihood of children, it also induces more intense utilization of institutional facilities by women. These changes in demand for healthcare, however, depend crucially on access to healthcare facilities. This suggests that without supply-side changes, programs that aim to stimulate healthcare demand may not achieve their stated objectives. As programs that reduce the financial costs of healthcare are inherently costly, policymakers can prioritize those subpopulations that have low baseline rates of healthcare use or are socially and economically disadvantaged. As of this writing, Mali and Zimbabwe are deliberating a similar roll out.[8] The policymakers have much to learn from our work to improve the effectiveness of their program.

This work has several limitations. The health outcomes we observe are short- to medium-run in nature. Failure to account for life-cycle changes in health outcomes might lead us to underestimate the cost-to-benefit ratio of the program. We also do not observe other outcomes that may have been impacted by the program exposure, such as educational attainment. Not having information on the specific community engagement practices precludes us from delving into the role of such outreach campaigns on healthcare utilization. As the program puts great emphasis on these activities, having evidence about the precise components that help facilitate the change in health outcomes might be informative for policymakers. We hope future work can address some of these shortcomings.

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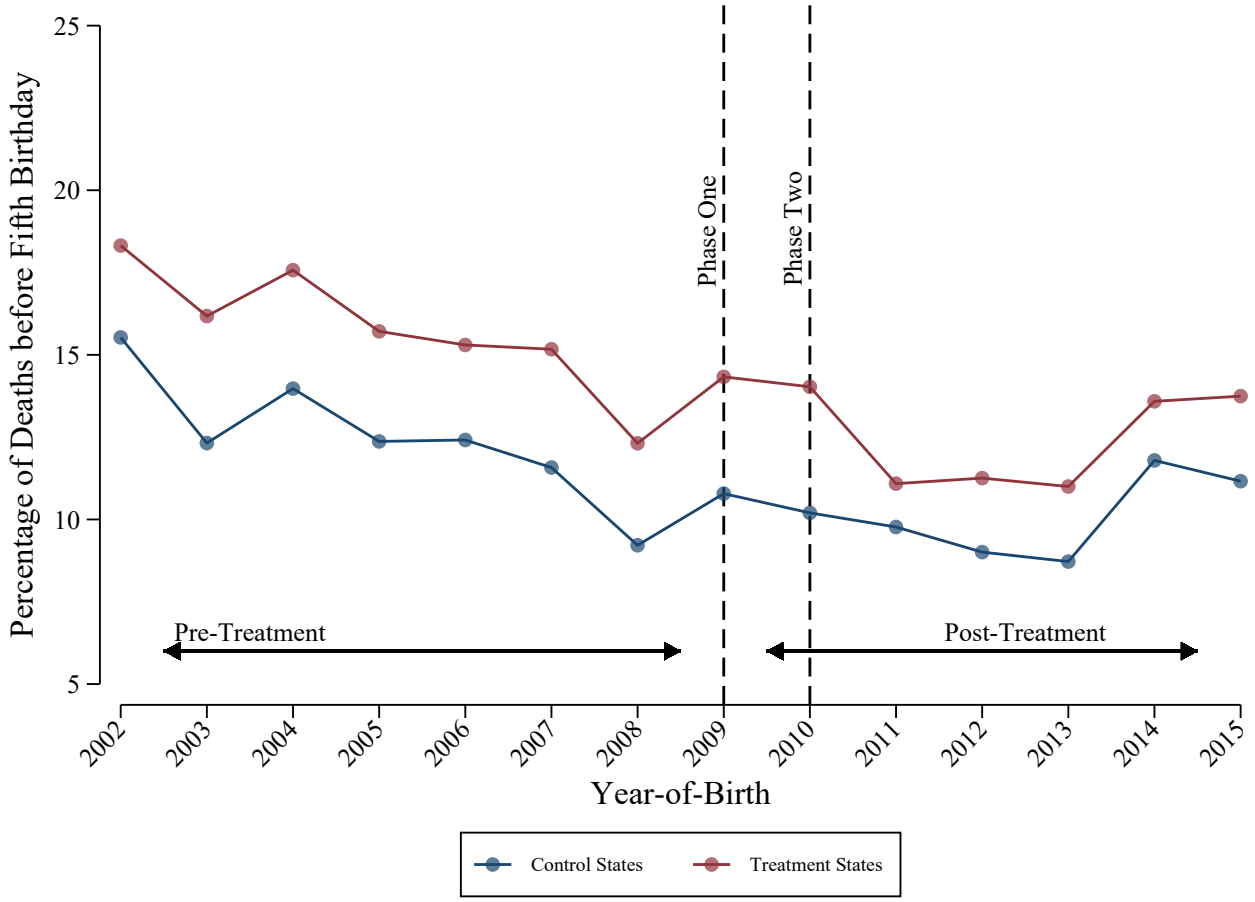
Figure 1: Temporal Variation in Deaths before Fifth Birthday



Note: Data from Demographic Health Survey 2008, 2013, and 2018 rounds. Survey weights are used to aggregate individual births to the year-level. These weights account for complex survey design. Two vertical dashed rounds indicate the beginning of two phases of the Free Maternal and Child Health Program (FMCHP).

Table 1: Main Effects: Under-five Mortality

	(1)	(2)
$\mathbb{1}\left\{Treat_{s(b)}\right\} \times$	-0.02904***	-0.02683***
$\mathbb{1}\left\{Post_{MoB(b),YoB(b)}\right\}$	(0.00905)	(0.00879)
$\frac{\text{Coefficient}}{\text{Pre-treatment Mean in Treatment Group}} \times 100$	-15.0	-13.9
Adj. R^2	0.115	0.126
N	224,194	224,194
Mother FEs	Yes	Yes
Year × Month FEs	Yes	Yes
Controls	No	Yes

Notes: Heteroskedasticity robust standard errors clustered by the local government area in parentheses. (* p<.10 ** p<.05 *** p<.01). The treated group comprises all states where the Free Maternal and Child Health Program (FMCHP) is rolled out. Each column is a separate estimation of Equation (1). Each specification includes mother fixed-effects and child's month- and year-of-birth fixed-effects. To the specification in column (1), column (2) adds an indicator for multiple births, birth order, and an indicator for sex of the child. The dependent variable in each column is under-five mortality. Refer to Section 3.1 for the definition of each dependent variable. The Independent variable in each cell is the interaction of an indicator variable for mothers' residence state ever having FMCHP rollout and an indicator for the birth to be after FMCHP is rolled out. All births after 2015 are dropped from the analytical sample. Exposure to the Free Maternal and Child Health Program (FMCHP) is determined based on the child's month- and year-of-birth. The data comes from the Demographic and Health Survey (DHS). Waves three to five of DHS are used. The respondents in these waves were interviewed between 2003 and 2018.

Table 2: Robustness Checks

	Baseline	Date of Conception	Add LGA Time Trends	Drop Lagos and Abuja	Drop Above 40 Mothers	Drop Existing FMCHP States
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbb{1}\{Treat_{s(b)}\} \times$	-0.02683***	-0.02780***	-0.02814***	-0.02578***	-0.02979***	-0.03234***
$\mathbb{1}\{Post_{MoB(b),YoB(b)}\}$	(0.00879)	(0.00878)	(0.00880)	(0.00906)	(0.01042)	(0.00935)
p-value $(H_0 : \text{Baseline} = \text{Coefficient})$		0.575	0.222	0.182	0.451	0.020
$\frac{\text{Coefficient}}{\text{Pre-treatment Mean in Treatment Group}} \times 100$	-13.9	-14.5	-14.6	-13.3	-15.6	-16.4
Adj. R^2	0.126	0.128	0.126	0.127	0.126	0.127
N	224,194	220,824	224,194	215,201	224,194	200,931
Mother FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year × Month FEs	Yes	Yes	Yes	Yes	Yes	Yes
LGA Time Trends	No	No	Yes	No	No	No
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Heteroskedasticity robust standard errors clustered by the local government area in parentheses. (* p<.10 ** p<.05 *** p<.01). Each cell is a separate estimation of Equation 1. Column (2) determines treatment based on the date-of-conception. Date-of-conception is nine months preceding the date-of-birth. In column (3), Local Government Area (LGA) linear time trends are added. In column (4), all respondents whose residence state is either Lagos or Abuja are dropped from the analytical sample. In column (7), treatment is determined based on the months of exposure to FMCHP. In column (5), all women who are over 40 years of age at the time of birth are dropped from the analytical sample. In column (6), all states where FMCHP may have existed before 2008 are dropped from the analytical sample. These states are derived from Okonofua et al. (2011). The dependent variable in each column is under-five mortality. The Independent variable in each cell is the interaction of an indicator variable for mothers' residence state ever having FMCHP rollout and an indicator for the birth to be after FMCHP is rolled out. All births after 2015 are dropped from the analytical sample. Each specification also includes indicators for multiple births, birth order, sex of the child, and mother fixed-effects. Exposure to FMCHP is determined based on the date-of-birth of the child except in column (2). The date-of-conception in column (2) is defined as nine months before the reported date-of-birth. These data come from the Demographic and Health Survey (DHS). Waves three to five of DHS are used. The respondents in these waves were interviewed between 2003 and 2018.

Table 3: Dropping Different Birth Order

	Baseline	Drop First Birth	Drop Second Birth	Drop Third Birth	Drop Fourth Birth
	(1)	(2)	(3)	(4)	(5)
$\mathbb{1}\left\{Treat_{s(b)}\right\} \times$	-0.02683***	-0.02880***	-0.02620***	-0.02827***	-0.03048***
$\mathbb{1}\left\{Post_{MoB(b),YoB(b)}\right\}$	(0.00879)	(0.01033)	(0.00976)	(0.00929)	(0.00929)
p-value $(H_0 : \text{Baseline} = \text{Coefficient})$		0.584	0.848	0.602	0.239
$\frac{\text{Coefficient}}{\text{Pre-treatment Mean in Treatment Group}} \times 100$	-13.9	-14.7	-13.3	-14.4	-15.6
Adj. R^2	0.126	0.124	0.116	0.114	0.119
N	224,194	172,992	181,029	188,579	195,829

Notes: Heteroskedasticity robust standard errors clustered by the local government area in parentheses. (* p<.10 ** p<.05 *** p<.01). Each cell is a separate estimation of Equation 1. Column header denote the analytical sample. The dependent variable in each column is under-five mortality. The Independent variable in each cell is the interaction of an indicator variable for mothers' residence state ever having FMCHP rollout and an indicator for the birth to be after FMCHP is rolled out. All births after 2015 are dropped from the analytical sample. Each specification also includes indicators for multiple births, birth order, sex of the child, and mother fixed-effects. Exposure to FMCHP is determined based on the date-of-birth of the child. These data come from the Demographic and Health Survey (DHS). Waves three to five of DHS are used. The respondents in these waves were interviewed between 2003 and 2018.

Table 4: Heterogeneity: Health Facilities

	Health Facilities Per-capita		Health Personnel Per-capita		Beds Per-capita		Pediatric Facilities Per-capita	
	Below Median (1)	Above Median (2)	Below Median (3)	Above Median (4)	Below Median (5)	Above Median (6)	Below Median (7)	Above Median (8)
$\mathbb{1}\{Treat_{s(b)}\} \times$	-0.00788	-0.04302***	-0.00728	-0.04052***	-0.00128	-0.05214***	-0.00757	-0.05063***
$\mathbb{1}\{Post_{MoB(b),YoB(b)}\}$	(0.01160)	(0.01056)	(0.01296)	(0.01092)	(0.01133)	(0.01227)	(0.01338)	(0.01411)
	p-value $(H_0$: Equal Coeff.$) = .013$		p-value $(H_0$: Equal Coeff.$) = .07$		p-value $(H_0$: Equal Coeff.$) = .001$		p-value $(H_0$: Equal Coeff.$) = .007$	
$\frac{\text{Coefficient}}{\text{Pre-treatment Mean in Treatment Group}} \times 100$	-4.229	-21.688	-3.539	-28.485	-0.718	-25.209	-3.939	-25.504
Adj. R^2	0.129	0.125	0.133	0.094	0.131	0.122	0.133	0.111
N	106,334	117,860	138,096	86,098	110,475	113,719	127,002	97,192

Notes: Heteroskedasticity robust standard errors clustered by the local government area in parentheses. (* p<.10 ** p<.05 *** p<.01). Each cell in all columns is a separate estimation of Equation (1). Each specification includes an indicator for multiple births, birth order, and an indicator for sex of the child, mother fixed-effects, and child's month- and year-of-birth fixed-effects. The dependent variable in each column is under-five mortality. The subpopulation that constitutes the estimation sample is denoted in the column header. All subpopulations are constructed using the Nigeria Health Facility Registry (HFR) data. Only primary facilities are used to construct subpopulations. Health personnel consist of doctors, nurses, and midwives. A facility is designated to provide pediatric services if they report providing any pediatric care service. Population data at the state-level is derived from the population and housing census conducted in 2006. The Independent variable in each cell is the interaction of an indicator variable for mothers' residence state ever having Free Maternal and Child Health Program (FMCHP) rollout and an indicator for the birth to be after FMCHP is rolled out. All births after 2015 are dropped from the analytical sample. Exposure to the FMCHP is determined based on the child's month- and year-of-birth. The data comes from the Demographic and Health Survey (DHS). Waves three to five of DHS are used. The respondents in these waves were interviewed between 2003 and 2018.

Table 5: Heterogeneity: Wealth, Religion, and Region

	Wealth		Religion		Region	
	Below Median	Above Median	Islam	Non Islam	North	South
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbb{1}\{Treat_{s(b)}\} \times$	-0.0296***	-0.0020	-0.0245**	0.0024	-0.0302***	-0.0008
$\mathbb{1}\{Post_{MoB(b),YoB(b)}\}$	(0.0104)	(0.0070)	(0.0107)	(0.0100)	(0.0108)	(0.0100)
	p-value $(H_0$: Equal Coeff.$) = 0.003$		p-value $(H_0$: Equal Coeff.$) = 0.017$		p-value $(H_0$: Equal Coeff.$) = 0.021$	
$\frac{\text{Coefficient}}{\text{Pre-treatment Mean in Treatment Group}} \times 100$	-12.796	-1.535	-11.223	1.972	-13.682	-0.702
Adj. R^2	0.136	0.090	0.141	0.082	0.137	0.075
N	112,107	112,087	127,098	96,426	151,044	73,150

Notes: Heteroskedasticity robust standard errors clustered by the local government area in parentheses. (* p<.10 ** p<.05 *** p<.01). Each cell in all columns is a separate estimation of Equation (1). Each specification includes an indicator for multiple births, birth order, an indicator for sex of the child, mother fixed-effects, and child's month- and year-of-birth fixed-effects. The dependent variable in all columns is under-five mortality. Refer to Section 3.1 for the definition of the dependent variable. The subpopulation that constitute the estimation sample is denoted in the column header. All subpopulations are constructed using the reported data in the DHS. Wealth distribution in the respective survey round is used to designate a household to be either below or above median of the wealth distribution. Households are designated to be residing in the southern region if they reside in Oyo, Osun, Ekiti, Ondo, Edo, Anambra, Enugu, Ebonyi, Cross River, Akwa Ibom, Abia, Imo, Rivers, Bayelsa, Delta, Lagos, or Ogun. The Independent variable in each cell is the interaction of an indicator variable for mothers' residence state ever having Free Maternal and Child Health Program (FMCHP) rollout and an indicator for the birth to be after FMCHP is rolled out. All births after 2015 are dropped from the analytical sample. Exposure to the FMCHP is determined based on the child's month- and year-of-birth. The data comes from the Demographic and Health Survey (DHS). Waves three to five of DHS are used. The respondents in these waves were interviewed between 2003 and 2018.

Table 6: Mechanisms: Vaccination

	BCG	Measles	DPT	Polio	Vaccination Index
	(1)	(2)	(3)	(4)	(5)
$\mathbb{1}\left\{Treat_{s(b)}\right\} \times$	0.00860	0.05007***	0.02411**	0.02398***	0.07062***
$\mathbb{1}\left\{Post_{MoB(b),YoB(b)}\right\}$	(0.01042)	(0.01312)	(0.01196)	(0.00828)	(0.01870)
$\frac{\text{Coefficient}}{\text{Pre-treatment Mean in Treatment Group}} \times 100$	2.525	16.986	7.136	4.136	30.226
Adj. R^2	0.771	0.627	0.745	0.709	0.761
N	53,745	53,455	53,640	53,743	53,989

Notes: Heteroskedasticity robust standard errors clustered by the local government area in parentheses. (* p<.10 ** p<.05 *** p<.01). Each cell in all columns is a separate estimation of Equation (1). Each specification includes an indicator for multiple births, birth order, and indicator for sex of the child, mother fixed-effects, and child's month- and year-of-birth fixed-effects. The dependent variable is displayed in the column header. The child is designated to have received the BCG vaccine if they receive the first BCG vaccine. Similarly, the child is designated to have received DPT and Polio vaccines if they receive the first dose of these vaccines. The child is designated to have received the measles vaccine if they report receiving the measles vaccine. The dependent variable in the last column is a standardized weighted index of multiple indicator variables using a GLS weighting procedure as described in Anderson (2008). The indicator variables used for the construction of this index are reported in the first four columns. The Independent variable in each cell is the interaction of an indicator variable for mothers' residence state ever having FMCHP rollout and an indicator for the birth to be after FMCHP is rolled out. All births after 2015 are dropped from the analytical sample. Exposure to the Free Maternal and Child Health Program (FMCHP) is determined based on the child's month- and year-of-birth. The data comes from the Demographic and Health Survey (DHS). Waves three to five of DHS are used. The respondents in these waves were interviewed between 2003 and 2018.

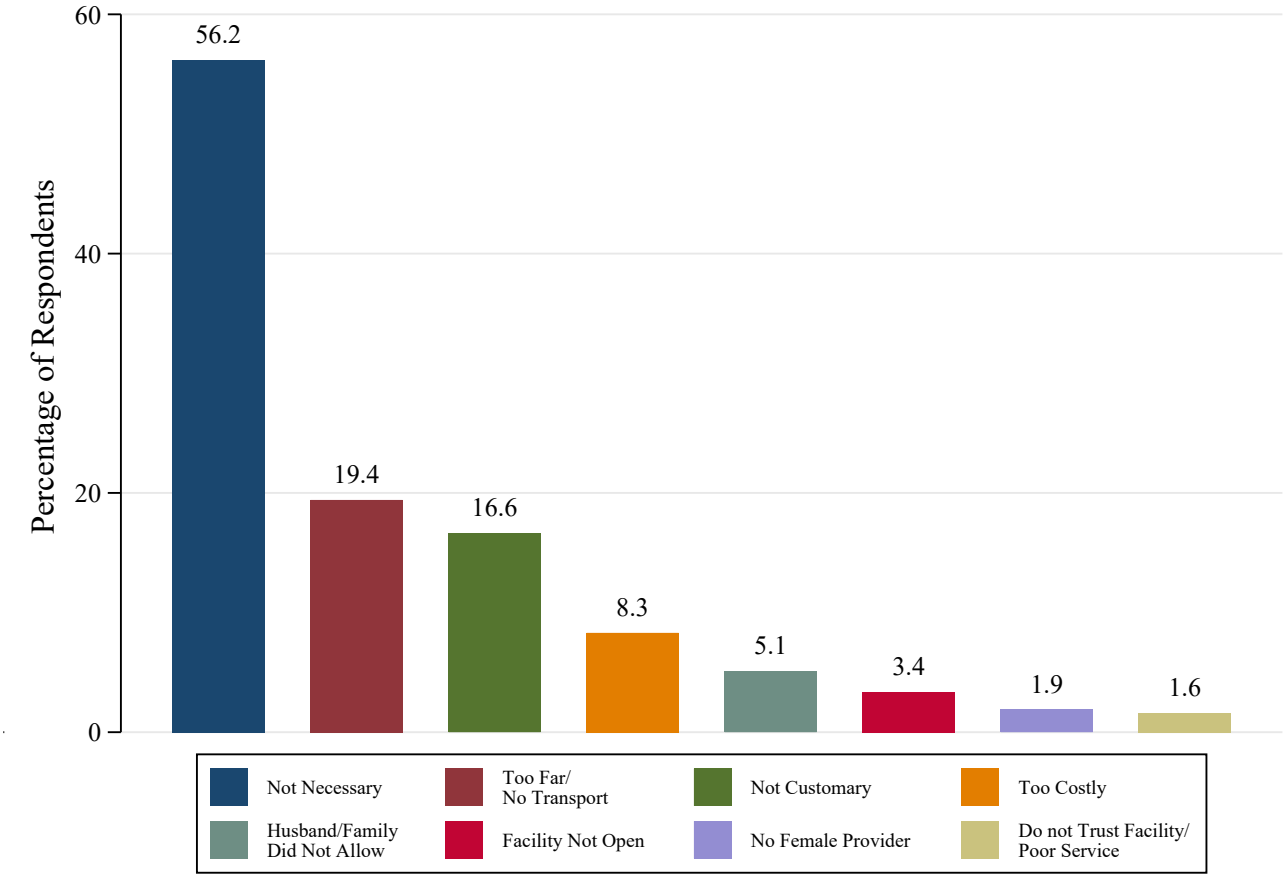
Online Appendix for Unlocking Health Potential: Effects of Free Maternal and Child Health Program

Tejendra P. Singh and Olanrewaju Yusuff

July, 2025

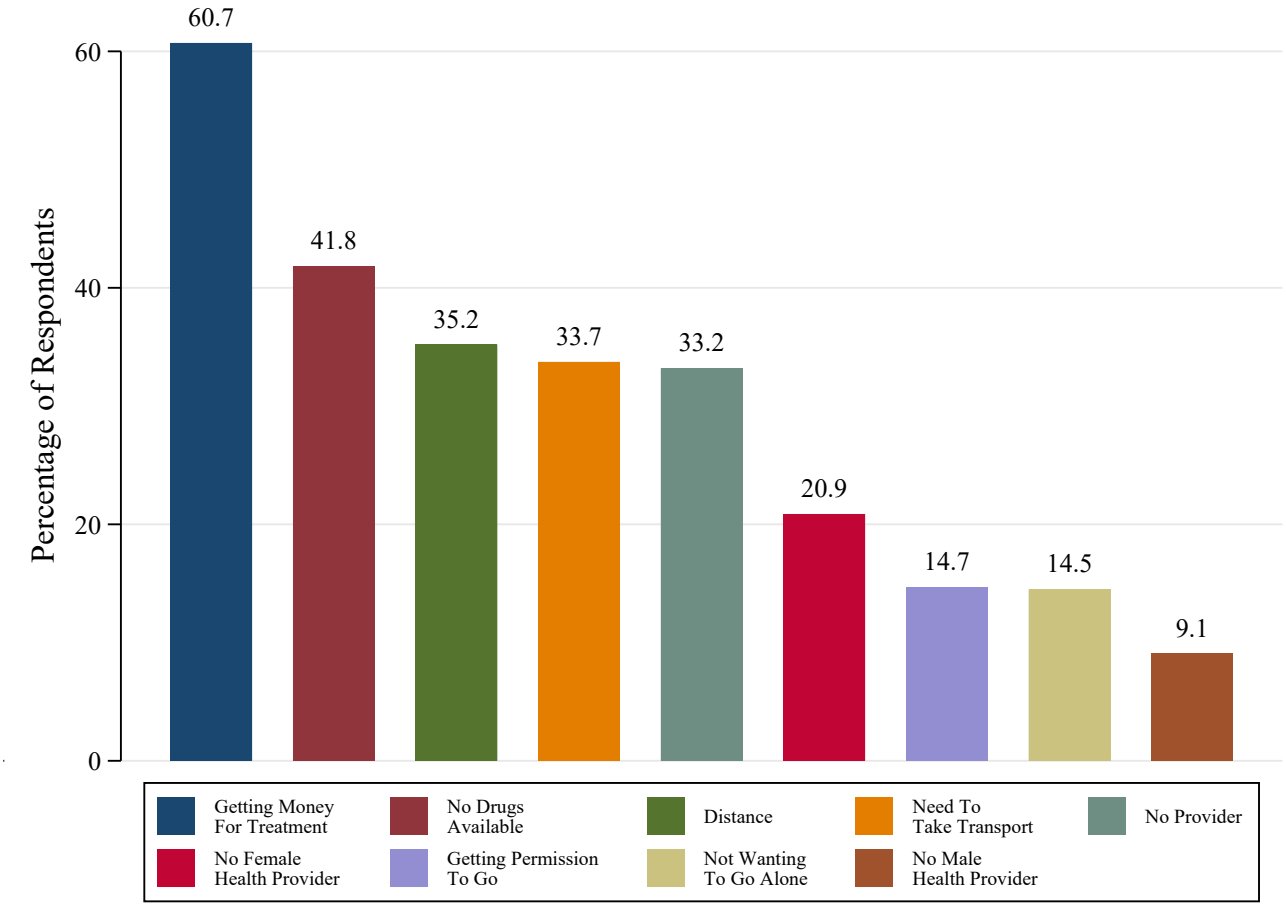
A Figures and Tables

Figure A1: Reasons for Not Delivering at a Health Facility



Note: Data from Demographic Health Survey 2008 and 2013 rounds. Pre-treatment data only. The reasons for not delivering at a health facility are not mutually exclusive. Survey weights are used to account for complex survey design.

Figure A2: Reasons for Not Seeking Healthcare When Sick



Note: Data from Demographic Health Survey 2008 round. Pre-treatment data for states where FMCHP is rolled out only. The reasons for not seeking healthcare when sick are not mutually exclusive. A reason is coded in affirmation if the respondent reports it as a big problem when she is sick and wants to get medical advice or treatment. Survey weights are used to account for complex survey design.

Figure A3: Timeline of FMCHP

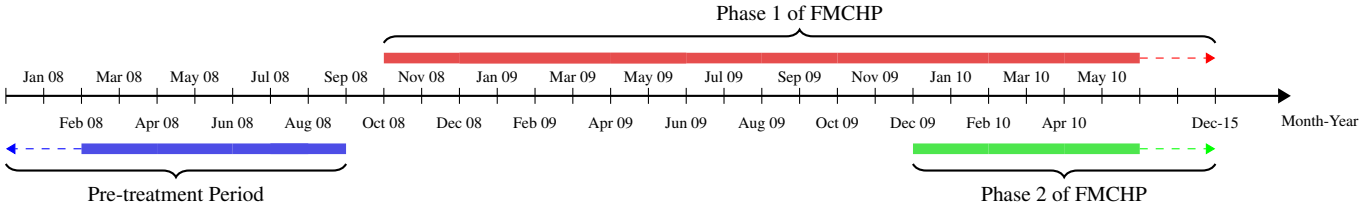
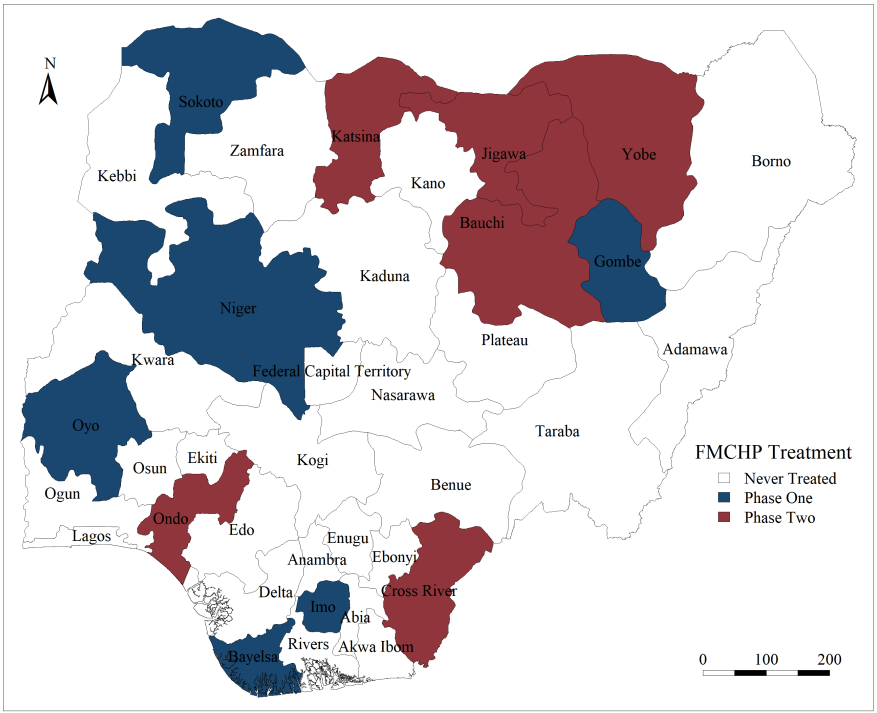
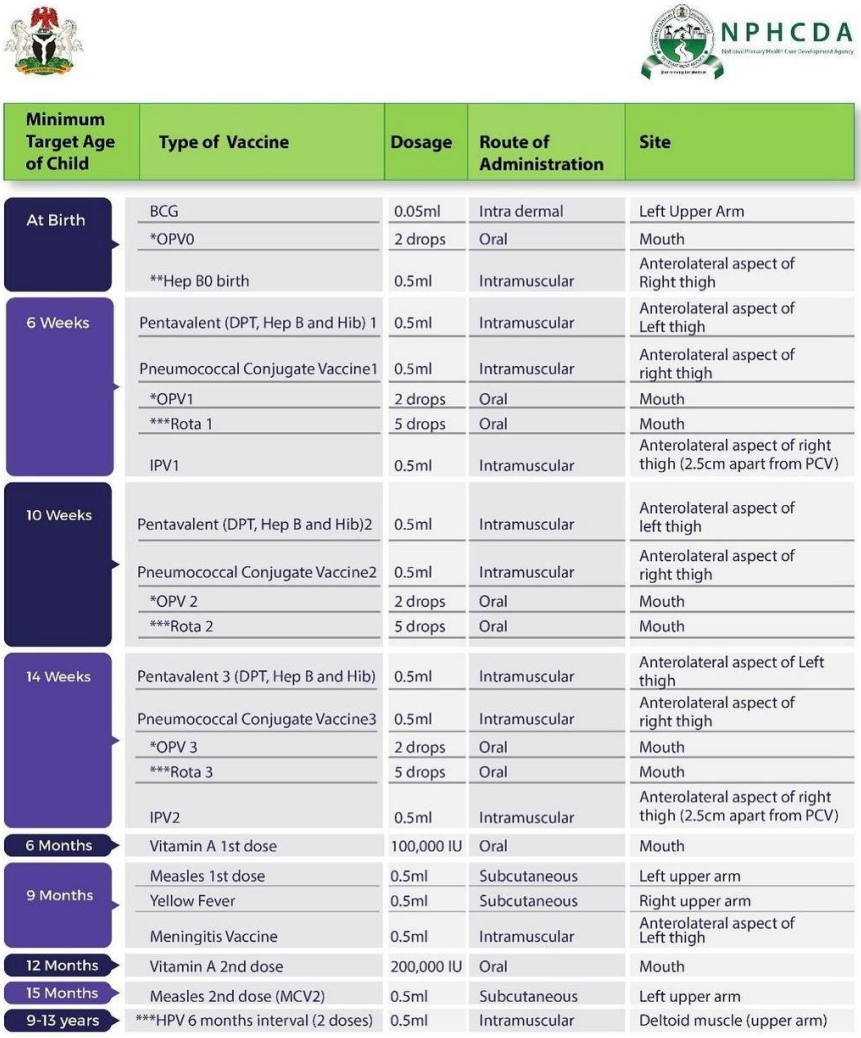


Figure A4: Spatial Variation in Free Maternal and Health Care Program (FMCHP) Roll Out



Note: Shapefiles data comes from Global Administrative Areas (GADM).

Figure A5: Nigeria Immunization Schedule

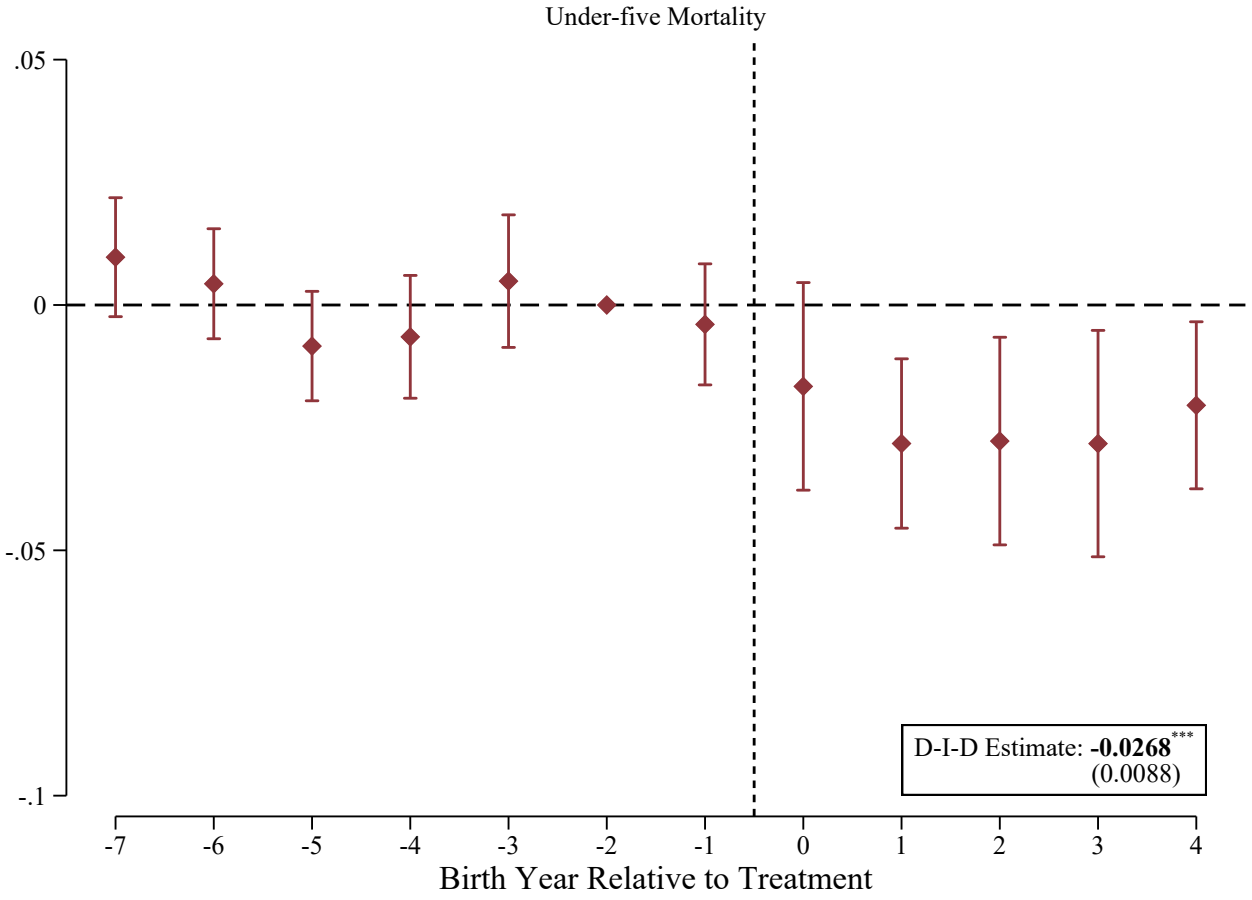


NPHCDA

Minimum Target Age of Child	Type of Vaccine	Dosage	Route of Administration	Site
At Birth	BCG	0.05ml	Intra dermal	Left Upper Arm
	*OPV0	2 drops	Oral	Mouth
	**Hep B0 birth	0.5ml	Intramuscular	Anterolateral aspect of Right thigh
6 Weeks	Pentavalent (DPT, Hep B and Hib) 1	0.5ml	Intramuscular	Anterolateral aspect of Left thigh
	Pneumococcal Conjugate Vaccine1	0.5ml	Intramuscular	Anterolateral aspect of right thigh
	*OPV1	2 drops	Oral	Mouth
	***Rota 1	5 drops	Oral	Mouth
	IPV1	0.5ml	Intramuscular	Anterolateral aspect of right thigh (2.5cm apart from PCV)
10 Weeks	Pentavalent (DPT, Hep B and Hib)2	0.5ml	Intramuscular	Anterolateral aspect of left thigh
	Pneumococcal Conjugate Vaccine2	0.5ml	Intramuscular	Anterolateral aspect of right thigh
	*OPV 2	2 drops	Oral	Mouth
	***Rota 2	5 drops	Oral	Mouth
14 Weeks	Pentavalent 3 (DPT, Hep B and Hib)	0.5ml	Intramuscular	Anterolateral aspect of Left thigh
	Pneumococcal Conjugate Vaccine3	0.5ml	Intramuscular	Anterolateral aspect of right thigh
	*OPV 3	2 drops	Oral	Mouth
	***Rota 3	5 drops	Oral	Mouth
	IPV2	0.5ml	Intramuscular	Anterolateral aspect of right thigh (2.5cm apart from PCV)
6 Months	Vitamin A 1st dose	100,000 IU	Oral	Mouth
9 Months	Measles 1st dose	0.5ml	Subcutaneous	Left upper arm
	Yellow Fever	0.5ml	Subcutaneous	Right upper arm
	Meningitis Vaccine	0.5ml	Intramuscular	Anterolateral aspect of Left thigh
12 Months	Vitamin A 2nd dose	200,000 IU	Oral	Mouth
15 Months	Measles 2nd dose (MCV2)	0.5ml	Subcutaneous	Left upper arm
9-13 years	***HPV 6 months interval (2 doses)	0.5ml	Intramuscular	Deltoid muscle (upper arm)

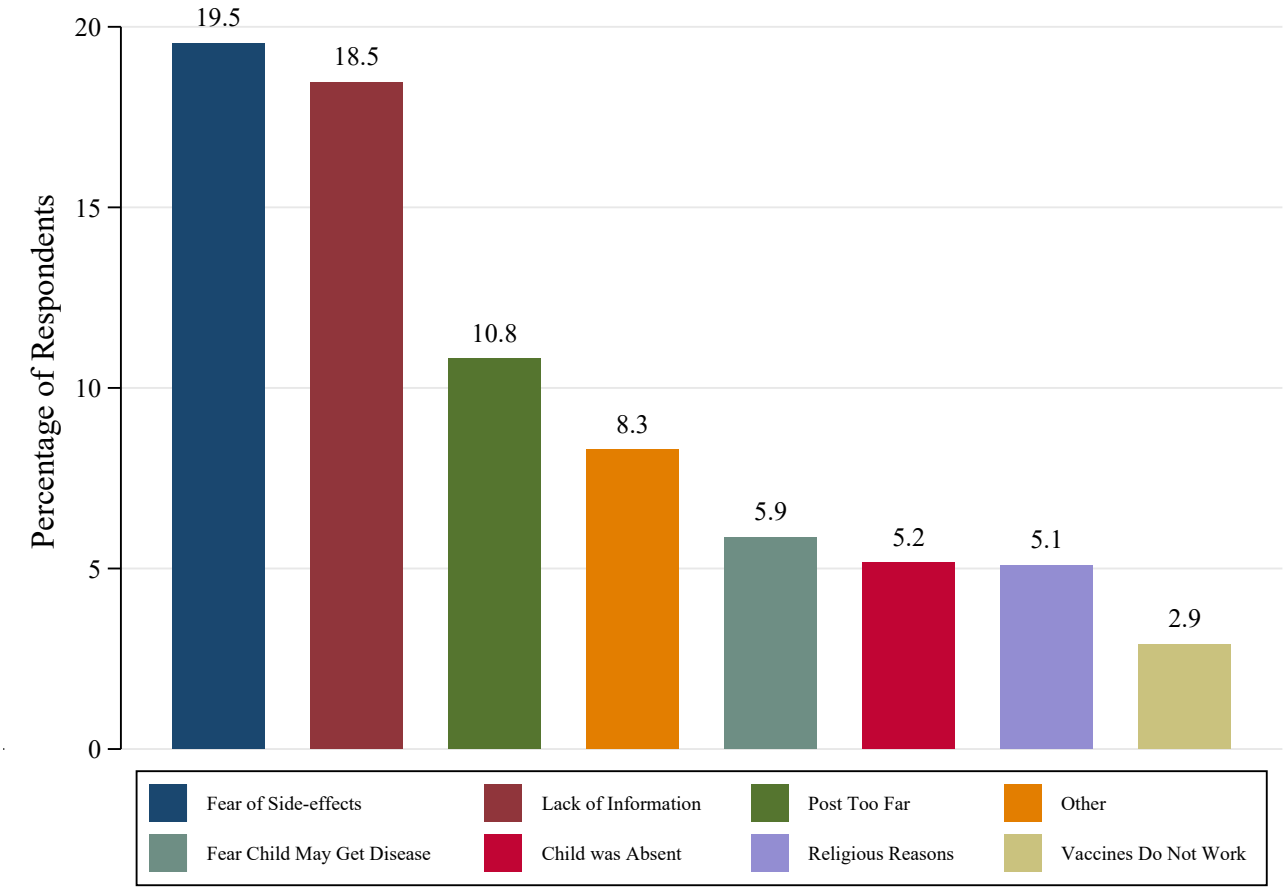
Note: The figure presents Nigeria's Immunization Schedule. The schedule was downloaded in June 2025 using the following UNICEF web page https://www.unicef.org/nigeria/documents/nigeria-immunization-schedule.

Figure A6: Event-study Estimates: Mother Fixed-Effects



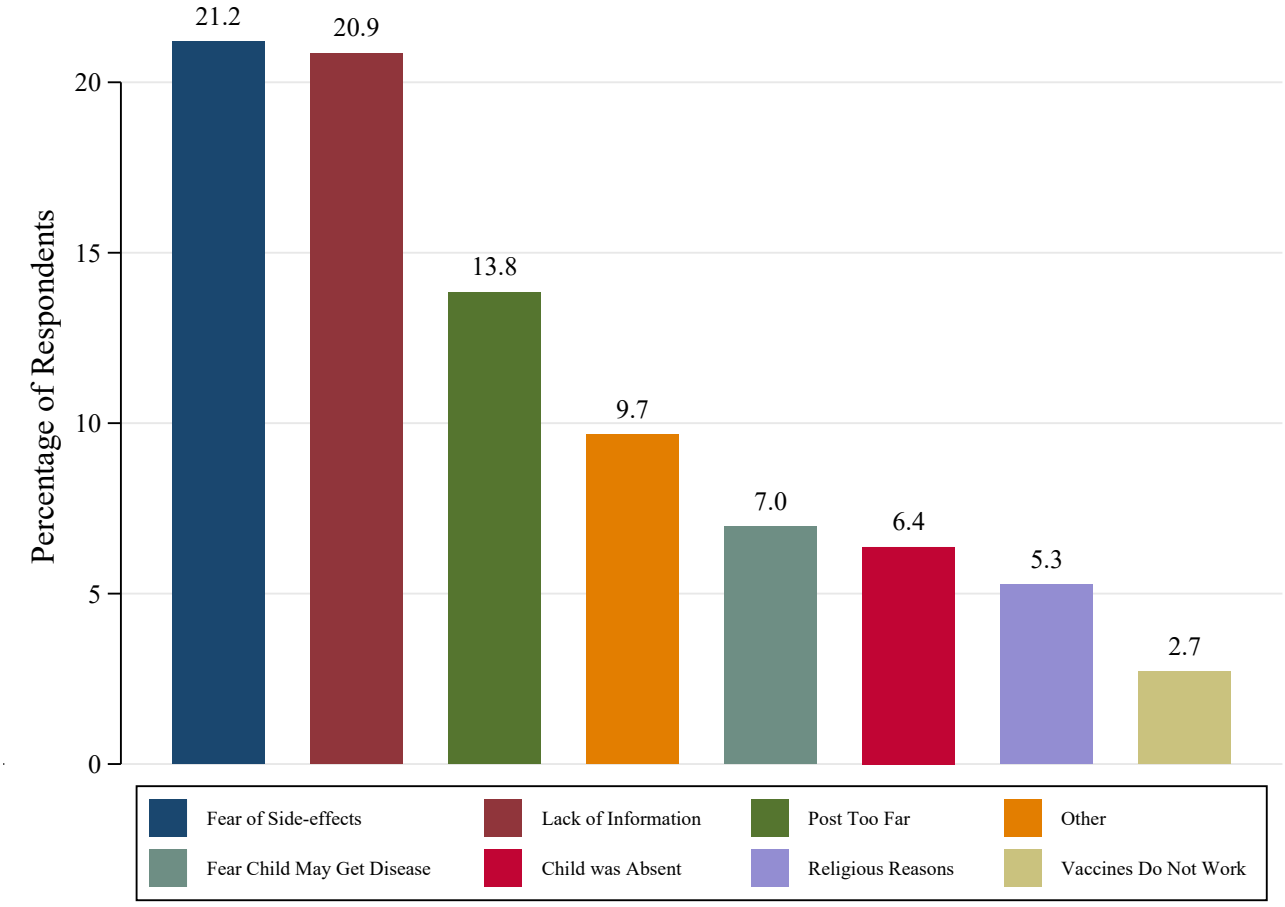
Note: The figure presents event-study estimates and 90% confidence intervals from a specification with mother and year-month-of-birth fixed-effects. This specification is presented in Equation 2. This specification also includes an indicator for multiple births, birth order, and an indicator for the sex of the child. All estimates are relative to two periods immediately before the first year of treatment. Estimates are from interaction weighted (IW) estimator in Sun and Abraham (2021). The estimates are for indicator variables that take a value of one if the difference between the year-of-birth and the first year of treatment is as indicated. The first year of treatment is denoted by zero. All births after 2015 are dropped from the analytical sample. Confidence intervals are constructed using heteroskedasticity robust standard errors clustered by the local government area. Exposure to the Free Maternal and Child Health Program (FMCHP) is determined based on the date-of-birth of the child. These data come from the Demographic and Health Survey (DHS). Waves three to five of DHS are used. The respondents in these waves were interviewed between 2003 and 2018.

Figure A7: Reasons for Not Vaccinating the Child



Note: Data from Demographic Health Survey 2008 round. Pre-treatment data for states where FMCHP is rolled out only. The reasons for not vaccinating the child are not mutually exclusive. Survey weights are used to account for complex survey design.

Figure A8: Reasons for Not Vaccinating the Child Against Polio



Note: Data from Demographic Health Survey 2008 round. Pre-treatment data for states where FMCHP is rolled out only. The reasons for not vaccinating the child are not mutually exclusive. Survey weights are used to account for complex survey design.

Table A1: Balance of Covariates: Child Health Outcomes

	Pre-Treatment		Post-Treatment		T-Test (Pre-Treatment)
	Control	Treatment	Control	Treatment	Treatment - Control
Under-five Mortality	0.153	0.193	0.098	0.119	0.040
	(0.360)	(0.395)	(0.298)	(0.323)	(0.001)
Infant Mortality	0.086	0.092	0.061	0.068	0.006
	(0.281)	(0.290)	(0.239)	(0.251)	(0.001)
Underweight	0.208	0.330	0.224	0.313	0.122
	(0.406)	(0.470)	(0.417)	(0.464)	(0.005)
Birth Weight	3.529	3.917	3.476	3.848	0.388
	(1.366)	(2.164)	(1.202)	(1.917)	(0.046)
Low Birth Weight	0.076	0.082	0.067	0.070	0.006
	(0.265)	(0.274)	(0.250)	(0.255)	(0.008)
Very Low Birth Weight	0.005	0.008	0.006	0.004	0.003
	(0.074)	(0.090)	(0.076)	(0.062)	(0.002)
Stunted	0.375	0.468	0.313	0.429	0.092
	(0.484)	(0.499)	(0.464)	(0.495)	(0.006)
Wasted	0.107	0.166	0.150	0.167	0.059
	(0.309)	(0.372)	(0.357)	(0.373)	(0.004)
N	126,463	74,993	13,617	8,438	

Notes: This table presents the descriptive statistics and balance of covariates in the pre-treatment and post-treatment period of the Free Maternal and Child Health Program (FMCHP). The mean of the variables and standard deviations are presented. Standard deviations are in parenthesis. The variable is displayed in the left column. Under-five mortality refers to the event of the child dying before their fifth birthday and infant mortality refers to the event of a child dying before their first birthday. Birth weight information is not available for all children who are born in the five years preceding the survey date. A child is classified as being underweight if their weight-for-age z-score is below two standard deviations of World Health Organization (WHO) child growth standards. A child is classified as stunted and wasted if their height-for-age and weight-for-height z-scores are below two standard deviations of WHO child growth standards, respectively. We note that wasting results due to acute inadequate undernutrition while stunting is a consequence of chronic undernutrition (Caulfield, Richard, Rivera, Musgrove and Black, 2006; Hoddinott, Alderman, Behrman, Haddad and Horton, 2013). Being underweight, on the other hand, encompasses both stunting and wasting. All births after 2015 are dropped from the analytical sample. Exposure to the FMCHP is determined based on the date-of-birth of the child. The treatment group consists of all the births that happened in the states where FMCHP is rolled out. All births in states where FMCHP is not rolled out constitute the control group. The pre-treatment period is all the years before the rollout of the FMCHP program, while the post-treatment period is all the years after the rollout of the FMCHP program. The T-test column provides test statistics for the two-group mean-comparison test in the pre-treatment period between the treatment and control group. The data come from the Demographic and Health Survey (DHS). Waves three to five of DHS are used. The respondents in these waves were interviewed between 2003 and 2018.

Table A2: Composition of Mothers

	Mother Illiterate	Mother No Education	Household Top Two Wealth Quintiles	Mother Married	Spouse No Education	Covered by Health Insurance	Urban Residence
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\mathbb{1}\left\{Treat_{s(b)}\right\} \times$	0.01951	0.01369	0.01098	-0.00872	0.00113	-0.00353	-0.04929
$\mathbb{1}\left\{Post_{MoB(b),YoB(b)}\right\}$	(0.01666)	(0.01610)	(0.01795)	(0.00843)	(0.01876)	(0.00429)	(0.03026)
$\frac{\text{Coefficient}}{\text{Pre-treatment Mean in Treatment Group}} \times 100$	2.822	2.299	4.136	-0.974	0.217	-28.600	-20.231
Adj. R^2	0.350	0.461	0.298	0.126	0.360	0.050	0.208
N	50,831	51,065	51,065	51,064	49,547	50,868	51,065

Notes: Heteroskedasticity robust standard errors clustered by the local government area in parentheses. (* p<.10 ** p<.05 *** p<.01). The treated group comprises all states where the Free Maternal and Child Health Program (FMCHP) is rolled out. Each specification includes indicators for the mother's year-of-birth, indicators for religion, number of household members, mother's residence state fixed-effects, child's month- and year-of-birth fixed-effects. The dependent variable is displayed in the column header. Refer to Section 4 for the definition of each dependent variable. The Independent variable in each column is the interaction of an indicator variable for mothers' residence state ever having FMCHP rollout and an indicator for the birth to be after FMCHP is rolled out. The interaction is displayed in the left column. All births after 2015 are dropped from the analytical sample. Exposure to the Free Maternal and Child Health Program (FMCHP) is determined based on the child's month- and year-of-birth. The data comes from the Demographic and Health Survey (DHS). Waves three to five of DHS are used. The respondents in these waves were interviewed between 2003 and 2018.

Table A3: Heterogeneity: Socioeconomic Characteristics

	Education		Age		Health Insurance		Multigenerational Household		Previous Pregnancy Complication		Mass Media Consumption		Urban Residence	
	No Education	Primary or Higher	Below 30	Above 30	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
$\mathbb{1}\{Treat_{s(b)}\} \times$	-0.0090	-0.0178*	-0.0182*	-0.0298**	-0.0181	-0.0262***	-0.0442	-0.0262***	-0.0232	-0.0273***	-0.0215**	-0.0277**	-0.0235*	-0.0217**
$\mathbb{1}\{Post_{MoB(b),YoB(b)}\}$	(0.0094)	(0.0097)	(0.0101)	(0.0131)	(0.0355)	(0.0087)	(0.0325)	(0.0092)	(0.0168)	(0.0099)	(0.0091)	(0.0113)	(0.0117)	(0.0106)
	p-value $(H_0:$ Equal Coeff.$) = 0.366$		p-value $(H_0:$ Equal Coeff.$) = 0.384$		p-value $(H_0:$ Equal Coeff.$) = 0.811$		p-value $(H_0:$ Equal Coeff.$) = 0.590$		p-value $(H_0:$ Equal Coeff.$) = 0.841$		p-value $(H_0:$ Equal Coeff.$) = 0.636$		p-value $(H_0:$ Equal Coeff.$) = 0.906$	
$\frac{\text{Coefficient}}{\text{Pre-treatment Mean in Treatment Group}} \times 100$	-6.818	-7.977	-9.306	-16.030	-13.475	-13.659	-21.645	-13.721	-10.488	-14.583	-12.658	-13.245	-16.831	-10.561
Adj. R^2	0.082	0.141	0.144	0.135	0.031	0.126	0.141	0.125	0.121	0.127	0.114	0.132	0.088	0.133
N	104,866	119,328	171,037	53,157	3,357	219,918	11,229	212,809	32,509	191,404	102,158	121,791	65,360	158,834

Notes: Heteroskedasticity robust standard errors clustered by the local government area in parentheses. (* p<.10 ** p<.05 *** p<.01). Each cell in all columns is a separate estimation of Equation (1). Each specification includes an indicator for multiple births, birth order, an indicator for sex of the child, mother fixed-effects, and child's month- and year-of-birth fixed-effects. The dependent variable in all columns is under-five mortality. Refer to Section 3.1 for the definition of the dependent variable. The subpopulation that constitute the estimation sample is denoted in the column header. All subpopulations are constructed using the reported data in the DHS. Households are designated to be residing in the urban area if their place of residence is reported to be urban. Women are designated to have had pregnancy complication if they report ever having a pregnancy that miscarried, was aborted, or ended in a stillbirth. Women are designated to consume mass media if they report any mass media (newspaper, magazine, radio, or TV) use at least once a week. The Independent variable in each cell is the interaction of an indicator variable for mothers' residence state ever having Free Maternal and Child Health Program (FMCHP) rollout and an indicator for the birth to be after FMCHP is rolled out. All births after 2015 are dropped from the analytical sample. Exposure to the FMCHP is determined based on the child's month- and year-of-birth. The data comes from the Demographic and Health Survey (DHS). Waves three to five of DHS are used. The respondents in these waves were interviewed between 2003 and 2018.

Table A4: Mechanisms: Acute Care

	Diarrhea Last Two Weeks	Fever Last Two Weeks	Cough Last Two Weeks	Diarrhea Any Treament	Fever/Cough Any Treatment	Diarrhea Treatment at a Health Institution	Fever/Cough Treatment at a Health Institution	Either Treatment at a Health Institution	Any Drug Taken For Diarrhea	Any Drug Taken For Fever/Cough	Oral Rehydration For Diarrhea
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
$\mathbb{1}\{Treat_{s(b)}\} \times$	0.02394*	0.01189	0.01482	-0.01245	-0.00574	-0.03018	0.01979	0.01513	-0.01095	0.02607	0.03311
$\mathbb{1}\{Post_{MoB(b),YoB(b)}\}$	(0.01431)	(0.01130)	(0.01100)	(0.05301)	(0.02791)	(0.04490)	(0.02990)	(0.02574)	(0.06850)	(0.02158)	(0.02098)
$\frac{\text{Coefficient}}{\text{Pre-treatment Mean in Treatment Group}} \times 100$	17.485	6.718	12.881	-1.999	-0.773	-7.913	4.178	3.295	-2.402	3.136	12.656
Adj. R^2	0.289	0.378	0.433	0.882	0.828	0.896	0.851	0.789	0.839	0.783	0.851
N	53,338	53,286	53,211	5,570	9,302	5,570	9,302	12,366	5,551	9,234	5,545

Notes: Heteroskedasticity robust standard errors clustered by the local government area in parentheses. (* p<.10 ** p<.05 *** p<.01). Each cell in all columns is a separate estimation of Equation (1). Each specification includes an indicator for multiple births, birth order, and indicator for sex of the child, mother fixed-effects, and child's month- and year-of-birth fixed-effects. The dependent variable is displayed in the column header. In the first three columns, the child is designated to have the ailment if they have that ailment in the two weeks preceding the survey date. The child is designated to have received treatment for diarrhea and fever or cough in the last two weeks if they sought advice or treatment for the illness from any source. The child is designated to have received treatment for diarrhea and fever or cough in the last two weeks at a health institution if they receive treatment at a government hospital, government health center, government health post, private hospital or clinic, private pharmacy, or private doctor. In column (8), the indicator variable takes a value of one if the indicator variable in either column (6) or column (7) takes a value of one. In column (9) and column (10), the indicator variables take a value of one if the respondent reports that the youngest child born in the last five years took any drug as part of treatment for diarrhea and fever or cough in the last two weeks, respectively. This variable is only defined for those children who had the illness in the last two weeks. In the last column, the child is designated to have received oral rehydration as part of diarrhea treatment if they report receiving it for diarrhea in the last two weeks from the survey date. This variable is defined only for those children who have had diarrhea in the last two weeks from the survey date. The Independent variable in each cell is the interaction of an indicator variable for mothers' residence state ever having Free Maternal and Child Health Program (FMCHP) rollout and an indicator for the birth to be after FMCHP is rolled out. All births after 2015 are dropped from the analytical sample. Exposure to the FMCHP is determined based on the child's month- and year-of-birth. The data comes from the Demographic and Health Survey (DHS). Waves three to five of DHS are used. The respondents in these waves were interviewed between 2003 and 2018.

Table A5: Mechanisms: Pre-delivery Interaction with Medical Providers

	Received Some Antenatal Care	Institutional Antenatal Care	Antenatal Care by a Health Personnel	Blood Pressure Measured During Pregnancy	Urine Sample Given During Pregnancy	Blood Sample Given During Pregnancy	Tetanus Injection Received During Pregnancy	Iron Supplement Received During Pregnancy	Pre-delivery Interaction Index
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\mathbb{1}\{Treat_{s(b)}\} \times$	0.05527**	0.03934***	0.08459***	0.03608*	0.03255*	0.03430	0.05331**	0.06431***	0.15461***
$\mathbb{1}\{Post_{MoB(b),YoB(b)}\}$	(0.02642)	(0.01137)	(0.02253)	(0.01969)	(0.01656)	(0.02118)	(0.02121)	(0.02272)	(0.04970)
$\frac{\text{Coefficient}}{\text{Pre-treatment Mean in Treatment Group}} \times 100$	11.192	4.360	19.936	4.390	4.770	5.012	12.844	14.528	53.009
Adj. R^2	0.288	0.076	0.269	0.060	0.087	0.077	0.281	0.229	0.289
N	38,052	23,995	37,880	24,303	24,283	24,280	37,877	37,649	37,998

Notes: Heteroskedasticity robust standard errors clustered by the local government area in parentheses. (* p<.10 ** p<.05 *** p<.01). Each specification includes indicators for the mother's year-of-birth, birth order, an indicator for multiple births, indicators for religion, number of household members, an indicator for the sex of child, the mother's residence state fixed-effects, and the child's month- and year-of-birth fixed-effects. The dependent variable is displayed in the column header. The dependent variable in column (2) and column (3) is defined only for those respondents who report receiving some antenatal care. Respondent is designated as having blood pressure checked during pregnancy if she reports blood pressure being measured at least once during her antenatal care visit. Respondent is designated as having her urine sample drawn during pregnancy if she reports giving a urine sample at least once during her antenatal care visit. Respondent is designated as having her blood sample drawn if she reports giving a blood sample at least once during her antenatal care visit. The variables in column (5) to column (7) are defined only for those respondents who received any antenatal care. Respondent is designated as having received a tetanus injection during the pregnancy if she reports having received a tetanus injection during pregnancy. Respondent is designated as having received an iron supplement if she reports buying or receiving an iron tablet or syrup during pregnancy. The dependent variable in the last column is a standardized weighted index of multiple indicator variables using a GLS weighting procedure as described in Anderson (2008). The indicator variables used for the construction of this index are reported in the first five columns. The Independent variable in each cell is the interaction of an indicator variable for mothers' residence state ever having Free Maternal and Child Health Program (FMCHP) rollout and an indicator for the birth to be after FMCHP is rolled out. All births after 2015 are dropped from the analytical sample. Exposure to the FMCHP is determined based on the child's month- and year-of-birth. The data comes from the Demographic and Health Survey (DHS). Waves three to five of DHS are used. The respondents in these waves were interviewed between 2003 and 2018.

Table A6: Mechanisms: Demand for Institutional Care

	Health Institution Delivery	Home Delivery	Public Health Institution Delivery	Private Health Institution Delivery	C-section	Health Personnel Assisted Delivery
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbb{1}\left\{Treat_{s(b)}\right\} \times$	0.01628**	-0.01604**	0.01169	0.00458	0.00011	0.01499*
$\mathbb{1}\left\{Post_{MoB(b),YoB(b)}\right\}$	(0.00783)	(0.00763)	(0.00843)	(0.00487)	(0.00294)	(0.00828)
$\frac{\text{Coefficient}}{\text{Pre-treatment Mean in Treatment Group}} \times 100$	7.998	-2.028	7.997	7.999	1.162	6.476
Adj. R^2	0.788	0.793	0.712	0.804	0.565	0.810
N	59,534	59,534	59,534	59,534	59,784	59,292

Notes: Heteroskedasticity robust standard errors clustered by the local government area in parentheses. (* p<.10 ** p<.05 *** p<.01). Each cell in all columns is a separate estimation of Equation (1). Each specification includes an indicator for multiple births, birth order, and indicator for sex of the child, mother fixed-effects, and child's month- and year-of-birth fixed-effects. The dependent variable is displayed in the column header. A delivery is designated to have occurred at a health institution if it didn't occur either at the respondents' or other persons' home in addition to the reported place of delivery not being . A delivery is designated to have occurred at home if it occurred either at respondents' or other persons' home. A public health institution is either a government hospital, a government health center, a government health post, or other public health institutions. A private health institution is either a private hospital, private clinic, or other private medical institution. Health personnel consists of a doctor, nurse, midwife, and auxiliary midwife. The Independent variable in each cell is the interaction of an indicator variable for mothers' residence state ever having Free Maternal and Child Health Program (FMCHP) rollout and an indicator for the birth to be after FMCHP is rolled out. All births after 2015 are dropped from the analytical sample. Exposure to the FMCHP is determined based on the child's month- and year-of-birth. The data comes from the Demographic and Health Survey (DHS). Waves three to five of DHS are used. The respondents in these waves were interviewed between 2003 and 2018.

Table A7: Money as the Reason for Not Seeking Healthcare When Sick

	All Women	Currently Pregnant Women
	(1)	(2)
$\mathbb{1}\left\{Treat_{s(b)}\right\} \times$	-0.06916***	-0.06540***
$\mathbb{1}\left\{Post_{MoB(b),YoB(b)}\right\}$	(0.01631)	(0.02331)
$\frac{\text{Coefficient}}{\text{Pre-treatment Mean in Treatment Group}} \times 100$	-12.409	-11.442
Adj. R^2	0.076	0.061
N	50,861	6,420

Notes: Heteroskedasticity robust standard errors clustered by the local government area in parentheses. (* p<.10 ** p<.05 *** p<.01). Each cell in all columns is a separate estimation of a specification with mothers' residence state and year-month-of-birth fixed-effects. This specification also includes indicator variables for religion and controls for family size. "All Women" estimate is for all surveyed women. The "Currently Pregnant Women" estimate drops all women who were not pregnant at the time of the survey from the analytical sample. The dependent variable in each column is an indicator variable for whether the respondent reports getting money needed for treatment as a big problem when she is sick and wants to get medical advice or treatment. The Independent variable in each cell is the interaction of an indicator variable for mothers' residence state ever having Free Maternal and Child Health Program (FMCHP) rollout and an indicator for the birth to be after FMCHP is rolled out. All births after 2015 are dropped from the analytical sample. Exposure to the FMCHP is determined based on the child's month- and year-of-birth for the estimation sample labeled "All Women". Exposure to the FMCHP is determined based on the survey year and month for the estimation sample labeled "Currently Pregnant Women". The data comes from the Demographic and Health Survey (DHS). Waves three to five of DHS are used. The respondents in these waves were interviewed between 2003 and 2018.

B State Fixed-effects Specifications

In this section, we report the estimates for the main outcome variable, under-five mortality, from the specification that leverages variation within states across birth cohorts in exposure to the Free Maternal and Child Health Program (FMCHP). The empirical specification is the following.

$$y_b = \alpha_{s(b)} + \alpha_{MoB(b),YoB(b)} + \beta \left[\mathbb{1}\left\{ Treat_{s(b)} \right\} \times \mathbb{1}\left\{ Post_{MoB(b),YoB(b)} \right\} \right] + \mathbf{X}_b\gamma + \zeta_b \tag{B1}$$

In Equation B1, all parameters are the same as those in specification in Equation 1, except that mother fixed-effects $\alpha_{m(b)}$ in Equation 1 is replaced with mother's state of residence fixed-effects $\alpha_{s(b)}$. We also report event-study estimates from the following specification.

(B2)

$$y_b = \alpha_{s(b)} + \alpha_{MoB(b),YoB(b)} + \sum_{i=-7, i\neq -2}^{4} \beta_i \left[\mathbb{1}\left\{ Treat_{s(b)} \right\} \times \mathbb{1}\left\{ YoB(b) - TreatYear_{s(b)} = i \right\} \right] + \mathbf{X}_b\gamma + \eta_b$$

All parameters in Equation B2 are the same as that in Equation 2, except once again that mother fixed-effects $\alpha_{m(b)}$ in Equation 2 is replaced with mother's state of residence fixed-effects $\alpha_{s(b)}$. We restrict the analytical sample while estimating specifications in this section to first births only.

Compared to the specifications in Section 4, specifications in this section allow for the inclusion of mothers who had births entirely before or after the roll out of FMCHP in their residence state. If mothers who take up the FMCHP benefits are more likely to benefit from the program then we expect the estimates from specifications in this section to be higher in magnitude than those reported in the main text.

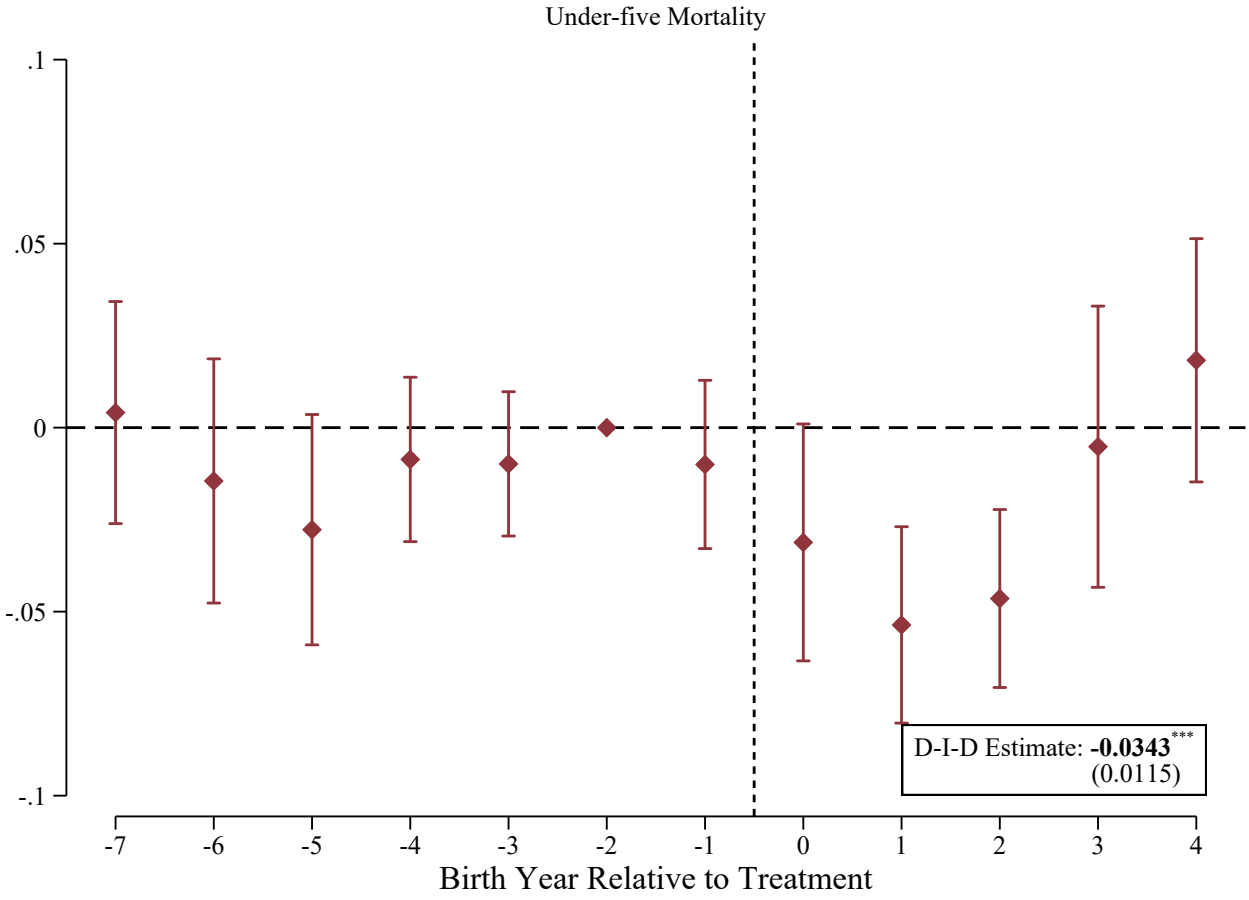
The estimates from the specification in Equation B2 are reported in Figure B1. The estimates in Figure B1 show dynamics in under-five mortality that are similar to those reported in Figure A6. The likelihood of the child dying declines immediately post the FMCHP roll out and this decline persists for all post-treatment periods except the last period when the FMCHP had started to experience funding issues. We are not able to reject the null hypothesis that all of the pre-treatment parameter estimates are zero. p-value from a Wald test of the null hypothesis that all pre-treatment estimates are zero for under-five mortality is 0.82.

Table B1 report estimates from Equation B1. The point estimates show that the births that benefit from free healthcare through FMCHP are 3.4 percentage points less likely to have the child die before their fifth birthday relative to those deaths that are not exposed to FMCHP. Relative to the pre-treatment mean in the treated group, the under-five mortality improvement is substantial at approximately 18%. Furthermore, we can reject the null hypothesis that the estimates from two different specifications are

the same (p-value: 0.08) when we expand the analytical sample to include all births and not only those that are first-order.

Overall, the estimates in this section show that the exposed mothers may be endogenously taking up FMCHP benefits. The empirical specifications in the main text account for this endogenous selection into FMCHP benefits by controlling for time-invariant mother-level characteristics that drive this endogenous takeup.

Figure B1: Event-study Estimates: Canonical Difference-in-Differences



Note: The figure presents event-study estimates and 99% confidence intervals from a specification with the mother's residence state and year-month-of-birth fixed-effects. This specification is presented in Equation B2. This specification also includes an indicator for multiple births and an indicator for the sex of the child. All estimates are relative to two periods immediately before the first year of treatment. Estimates are from interaction weighted (IW) estimator in Sun and Abraham (2021). The estimates are for indicator variables that take a value of one if the difference between the year-of-birth and the first year of treatment is as indicated. The first year of treatment is denoted by zero. All births after 2015 or not first-order are dropped from the analytical sample. Confidence intervals are constructed using heteroskedasticity robust standard errors clustered by the local government area. Exposure to the Free Maternal and Child Health Program (FMCHP) is determined based on the date-of-birth of the child. These data come from the Demographic and Health Survey (DHS). Waves three to five of DHS are used. The respondents in these waves were interviewed between 2003 and 2018.

Table B1: Main Effects: Under-five Mortality and State Fixed-Effects Specifications

	(1)	(2)
$\mathbb{1}\left\{Treat_{s(b)}\right\} \times$	-0.03430***	-0.03433***
$\mathbb{1}\left\{Post_{MoB(b),YoB(b)}\right\}$	(0.01119)	(0.01146)
$\frac{\text{Coefficient}}{\text{Pre-treatment Mean in Treatment Group}} \times 100$	-18.4	-18.4
Adj. R^2	0.042	0.047
N	51,202	51,202
State FEs	Yes	Yes
Year × Month FEs	Yes	Yes
Controls	No	Yes

Notes: Heteroskedasticity robust standard errors clustered by the local government area in parentheses. (* p<.10 ** p<.05 *** p<.01). The treated group comprises all states where the Free Maternal and Child Health Program (FMCHP) is rolled out. Each column is a separate estimation of Equation (B1). Each specification includes state fixed-effects and child's month- and year-of-birth fixed-effects. To the specification in column (1), column (2) adds an indicator for multiple births, birth order, and an indicator for sex of the child. The dependent variable in each column is under-five mortality. Refer to Section 3.1 for the definition of each dependent variable. The Independent variable in each cell is the interaction of an indicator variable for mothers' residence state ever having FMCHP rollout and an indicator for the birth to be after FMCHP is rolled out. All births after 2015 or not first order are dropped from the analytical sample. Exposure to the Free Maternal and Child Health Program (FMCHP) is determined based on the child's month- and year-of-birth. The data comes from the Demographic and Health Survey (DHS). Waves three to five of DHS are used. The respondents in these waves were interviewed between 2003 and 2018.