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Impacts of Paid Maternity Leave Policy on Breastfeeding Practices and Bloody Diarrhea in Children under Age of Five: Longitudinal Evidence from Low-Income and Middle-Income Countries

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Impacts of Paid Maternity Leave Policy on Breastfeeding Practices and Bloody Diarrhea in Children under Age of Five: Longitudinal Evidence from Low-Income and Middle-Income Countries

A dissertation submitted in partial satisfaction of the requirements for the degree

Doctor of Philosophy in Epidemiology

by

Yan Chai

2019

ABSTRACT OF THE DISSERTATION

Impacts of Paid Maternity Leave Policy on Breastfeeding Practices and Bloody Diarrhea in Children under Age of Five: Longitudinal Evidence from Low-Income and Middle-Income Countries

by

Yan Chai

Doctor of Philosophy in Epidemiology

University of California, Los Angeles, 2019

Professor Sally J Heymann, Co-Chair

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Background: Diarrhea is the fourth-leading cause of death and second-leading infectious cause of death in children under five years of age. The global burden of morbidity and mortality due to severe diarrhea is concentrated primarily in South Asia and sub-Saharan Africa, where a significant percentage of the population resides in low-resource settings. This dissertation examines if more generous paid maternity leave policy is associated with improved breastfeeding practices and a lower risk of diarrhea in children under five years of age in low- and middle-income countries (LMICs).

Methods: We merged longitudinal data measuring national maternity leave policies with information on live births occurring between 1996 and 2014 in 40 LMICs that

participated at least twice in the Demographic and Health Surveys (DHS) between 2000 and 2015. In the first two studies (Chapter 2–3), we used a difference-in-differences approach to compare relative changes in the prevalence of early initiation and exclusive breastfeeding, the duration of breastfeeding, as well as the proportion of children with bloody diarrhea across countries that lengthened their paid maternity leave policy between 1995 and 2013 to the countries that did not. In the third study (Chapter 4), we performed a causal mediation analysis that examined the possible mediating role of breastfeeding duration underlying the association between paid maternity leave policy and childhood diarrhea incidence.

Results: We found that a one-month increase in the legislated duration of paid maternity leave was associated with a 7.4 percentage-point (95% CI 3.2–11.7) increase in the prevalence of early initiation of breastfeeding, a 5.9 percentage-point (95% CI 2.0–9.8) increase in the prevalence of exclusive breastfeeding, a 2.2-month (95% CI 1.1–3.4) increase in breastfeeding duration, and a 39% (RR 0.61, 95% CI 0.44–0.84) reduction in the risk of bloody diarrhea. Breastfeeding for at least six and 12 months were found to mediate the effect of paid maternity leave policy on bloody diarrhea by 14% and 17%, respectively.

Conclusion: In conclusion, the results support our hypotheses that more generous paid maternity leave is associated with improved breastfeeding practices and a lower diarrhea incidence in children under five years of age, suggesting a potential instrument for facilitating early-life interventions to improve young children's health outcomes in LMICs. From a policy planning perspective, further work is needed to examine the impact of paid maternity leave on other aspects of child health and whether there are shared effects across maternity leave and other policies. Further

studies may also seek to examine whether the increase in breastfeeding duration is longer than the increase in maternity leave duration because of threshold effects. Specifically, future studies could examine whether a certain minimum length of leave is needed to encourage breastfeeding initiation and whether it is easier to continue breastfeeding while working once an infant has reached a certain age. Such research could contribute to developing better early-life interventions to ensure positive health outcomes for mothers and infants in LMICs.

The dissertation of Yan Chai is approved.

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LIST OF ABBREVIATIONS

DHS	Demographic and Health Surveys
FTE	Full-time equivalence
GDP	Gross domestic product
ILO	International Labour Organization
LMICs	Low- and middle-income countries
MICS	Multiple Indicator Cluster Surveys
OECD	Organisation for Economic Co-operation and Development
PPP	Purchasing Power Parity
PROSPERED	Policy-Relevant Observational Studies for Population health Equity and Responsible Development
UN	United Nations
UNICEF	United Nations Children's Fund
WHO	World Health Organization

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ORAL PRESENTATION

1. **Chai, Y.**, Nandi, A., & Heymann, J. Assessing the impact of paid maternity leave policy on childhood diarrhea through breastfeeding duration: an application of mediation analysis in 40 low- and middle-income countries. *Society for Epidemiologic Research Annual Meeting: Global Health.* Minneapolis, MN, June 2019

2. **Chai, Y.**, Nandi, A., & Heymann, J. Extending the duration of legislated paid maternal leave increases early initiation of breastfeeding, exclusive breastfeeding and breastfeeding duration: evidence from 38 low- and middle-income countries. *Society for Epidemiologic Research Annual Meeting: Innovative Studies in Global Health.* Baltimore, MD, June 2018

Chapter 1. Introduction and background

1.1 Introduction

The Sustainable Development Goals adopted by the United Nations in 2015 aim to ensure healthy lives and to promote well-being for all children. Despite the remarkable improvement of children's survival between 1990 and 2015, there were still 5.6 million children who died before their fifth birthday in 2016 globally.[1] More than half of these deaths could be prevented or treated by simple and affordable interventions.[1] The leading causes of death in children younger than five years old are preterm birth complications, pneumonia, birth asphyxia, diarrhea, and malaria.[1]

1.1.1 Diarrhea

1.1.1.1 Global burden

Diarrhea remains the fourth-leading cause of death and second-leading infectious cause of death in children under five years of age. In 2015, diarrhea caused 0.526 million deaths in children aged 0–59 months, accounting for 8.9% of all deaths under five. Among neonates (e.g., 0–27 days) and children in the post-neonatal period (e.g., 1–59 months), diarrhea caused 0.017 million and 0.509 million deaths, respectively, accounting for 0.6% and 8.6% of all deaths that occurred between 0–27 days and 1–59 months of age.[2] Seventy-two percent of deaths associated with diarrhea happen in the first two years of life.[3]

Sub-Saharan Africa and Southern Asia, where a significant percentage of the population resides in low resource settings, had the highest numbers of deaths for

children under five in 2015.[2] Diarrhea ranked fourth and fifth, respectively, in sub-Saharan Africa and in Southern Asia, among the leading causes of death in children under five.[2]

1.1.1.2 Prevention

Diarrhea is preventable and treatable. Onset and severity of diarrhea can be largely reduced by implementing the "protect, prevent, and treat" framework.[4]

Exclusive breastfeeding for the first six months and continued breastfeeding up to two years of age or beyond with complementary foods have been proven to protect children from diarrhea.[5] Comparing with exclusively breastfed infants in the first six months of life, risks of death from diarrhea are shown to be 10.5 times greater among non-breastfed infants in the first six months.[6] A review of 18 studies from LMICs indicated that not breastfeeding was associated with a 165% and 32% increased risk of diarrhea incidence among infants 0–5 months of age and 6–11 months of age, respectively, compared to exclusive breastfeeding.[7]

Vaccine use has also been shown to be an effective preventative intervention against diarrhea in children. An existing review of six randomized trials and quasi-experimental studies from LMICs demonstrated that the use of rotavirus vaccines was associated with a 74% and a 61% reduction in very severe rotavirus infections and severe rotavirus infections, respectively.[8] A new review of 12 randomized trials and quasi-experimental studies from LMICs revealed that use of the oral cholera

vaccine was associated with a 52% reduction in the risk of cholera infection in children under five years of age.[9]

Other interventions, including improved sanitation and quality of water, have been shown to prevent children from diarrhea. A recent review estimated reductions in the risk of childhood diarrhea of 48%, 17%, and 36% attributable to hand washing with soap, improved water quality, and excreta disposal, respectively.[10] In addition, preventive zinc supplementation was shown to be associated with a 13% reduction in diarrhea incidence in young children [11].

1.1.2 Paid maternity leave policy

Paid maternity leave is defined as "leave that the country guarantees employed women in connection with the birth of a child".[12] The most-up-to-date convention of the International Labour Organization (ILO) mandates that all countries, regardless of income, guarantee women at least 14 weeks of paid maternity leave.[13] A review of laws in place as of April 2015 showed that only half of all LMICs provided paid maternity leave of at least 14 weeks[14] and 6% of low-income countries and 22% of middle-income countries provided paid maternity leave of at least 26 weeks.[14]

In addition, the wage replacement rate during maternity leave varies substantially, ranging from 25% to 100%.[15] The ILO mandates that all countries guarantee women at least two-thirds of their previous earnings during maternity leave to ensure a suitable standard of living.[13] Unpaid leave, which grants time off without wage replacement, may end up impoverishing many young families.[16] Take-up of

parental leave has generally been low where leave is unpaid or only provides low levels of wage replacement.[17] Globally, 81% of low-income countries provide a minimum wage replacement rate of at least two-thirds of the previous earnings, compared with 66% of middle-income countries.[15]

1.2 Gaps in the literature

The impacts of maternity leave policy on children's health have been studied in high-income countries.[18-27] Extending the duration of legislated paid maternity leave has been associated with lower infant mortality in a sample of 18 Organisation for Economic Co-operation and Development (OECD) countries.[24-27] A new parental leave benefit was introduced in Germany in 2007, which replaced a means-tested child-rearing benefit with a parental leave benefit providing 67–100% of pre-birth net income, increased the number of eligible parents, and reduced the maximum benefit period from two years to one year. According to a longitudinal study, Germany's 2007 parental leave reform increased breastfeeding at four months and at six months by 9.2 and 7.9 percentage points, respectively.[18] Another study showed a 10–20 percentage-point increase in breastfeeding for at least six months and a 3–5 percentage-point increase in exclusive breastfeeding for at least six months after California became the first state to offer paid family leave.[19]

Compared with studies conducted in high-income countries, evidence of paid maternity leave's effect on children's health in LMICs remains limited, in part due to limited comparative maternity leave policy data. Previous studies have found that more generous paid maternity leave policy was associated with lower infant

mortality and increased vaccination uptake in a sample of 20 LMICs.[28-30] However, the impacts of maternity leave policies on other aspects of children's health in LMICs have not been evaluated. In addition, in order to contribute more evidence for policy makers, more studies are needed to understand the mechanisms underlying the effects.

1.3 Overall objective and specific aims

The purpose of this dissertation is to assess the impact of paid maternity leave policy on children's health by examining whether more generous paid maternity leave policy affects the early initiation of breastfeeding, exclusive breastfeeding under six months, breastfeeding duration, and the risk of diarrhea for children under five years of age in LMICs.

We hypothesize that longer paid maternity leave policies have the potential to lower childhood diarrhea in LMICs through several possible mechanisms. First, paid maternity leave may improve the caregiving environment for newborns. Mothers who are able to take leave from work have more time and an enhanced ability to care for their children. This diminishes the potential for infection related to group care settings, such as daycare.[31-34] Second, paid maternity leave may facilitate preventive care. Mothers who can take leave from work are more likely to initiate and continue breastfeeding[35 36] and to have their children vaccinated on time,[29] both of which boost immunity and protect children from infection. Third, paid maternity leave may increase access to postnatal health services. Mothers who can take leave from work have the time and the financial ability to seek medical help

when a child is sick, which prevents early onset of infection and progression to more severe episodes.

The first aim (Chapter 2) is to examine whether extending the duration of paid maternity leave available to new mothers has an impact on early initiation of breastfeeding, exclusive breastfeeding under six months, and breastfeeding duration in LMICs. We hypothesize that more generous paid maternity leave policy leads to higher prevalence of early initiation of breastfeeding and exclusive breastfeeding under six months, and extended breastfeeding duration in LMICs.

The second aim (Chapter 3) is to examine whether extending the duration of legislated paid maternity leave has an impact on the risk of childhood diarrhea in LMICs. We hypothesize that longer paid maternity leave policy lowers the risk of childhood diarrhea in LMICs.

Building on the findings in the second aim, the third aim (Chapter 4) is to examine the possible mediating role of breastfeeding practices underlying the impact of paid maternity leave policy on the risk of childhood diarrhea. We hypothesize that breastfeeding at least six months and 12 months play a moderate role in the association between paid maternity leave policy and the risk of childhood diarrhea in LMICs.

Chapter 2. Does extending the duration of legislated paid maternity leave improve breastfeeding practices? Evidence from 38 low-income and middle-income countries

2.1 Abstract

Introduction

Among all barriers to breastfeeding, the need to work has been cited as one of the top reasons for not breastfeeding overall and for early weaning among mothers who seek to breastfeed. We aimed to examine whether extending the duration of paid maternity leave available to new mothers affected early initiation of breastfeeding, exclusive breastfeeding under six months, and breastfeeding duration in LMICs.

Methods

We merged longitudinal data measuring national maternity leave policies with information on breastfeeding related to 992,419 live births occurring between 1996 and 2014 in 38 LMICs that participated in the DHS. We used a difference-in-differences approach to compare changes in the prevalence of early initiation and exclusive breastfeeding, as well as the duration of breastfeeding, among treated countries that lengthened their paid maternity leave policy between 1995 and 2013 versus control countries that did not. Regression models included country and year fixed effects, as well as measured individual-, household-, and country-level covariates. All models incorporated robust standard errors and respondent-level sampling weights.

Results

A one-month increase in the legislated duration of paid maternity leave was associated with a 7.4 percentage-point (95% CI 3.2–11.7) increase in the prevalence of early initiation of breastfeeding, a 5.9 percentage-point (95% CI 2.0–9.8) increase in the prevalence of exclusive breastfeeding, and a 2.2-month (95% CI 1.1–3.4) increase in breastfeeding duration.

Conclusion

Extending the duration of legislated paid maternity leave appears to promote breastfeeding practices in LMICs. Our findings suggest a potential mechanism to reduce barriers to breastfeeding for working mothers.

2.2 Introduction

The benefits of breastfeeding on children's survival, health, and development are well-established in high-, middle-, and low-income countries.[37 38] Rates of diarrhea, respiratory tract infections, and other infections are lower among breastfed infants than non-breastfed infants, as well as among exclusively breastfed infants than partially breastfed infants during the first six months.[38-40] These benefits, provided through stronger immunity, lower exposure to pathogens, and better nutrition, make breastfeeding one of the most effective interventions for reducing child mortality. Early initiation of breastfeeding, specifically within one hour of birth, reduces risk of neonatal mortality by 50%.[41 42] A systematic review in 2017 showed that, compared to infants who initiated breastfeeding within one hour of birth, infants who initiated breastfeeding 2–23 hours after birth had a 33% greater risk of neonatal mortality, and infants who initiated breastfeeding 24 hours after birth had a 2-fold greater risk of neonatal mortality.[43] Data from 2015 suggest that an

estimated 823,000 annual deaths of children under two years of age could be prevented in 75 high-mortality LMICs if breastfeeding was scaled up to near-universal levels.[37] Breastfeeding also provides health benefits over the life course,[44] as it is associated with improved neurocognitive development[45-49] and reduced risk of adulthood obesity and diabetes.[50-52] In addition, breastfeeding benefits mothers. Women who breastfeed have a reduced risk of breast cancer before menopause, ovarian cancer, osteoporosis, coronary heart disease, and diabetes, as well as improved birth spacing.[53-60]

Given the benefits of breastfeeding, the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) recommend early initiation of breastfeeding within one hour of birth, exclusive breastfeeding for the first six months, and continued breastfeeding up to two years of age or beyond with complementary foods.[61] However, in LMICs, the prevalence of early initiation of breastfeeding remains low, ranging from 41% in South Asia to 45% in Sub-Saharan Africa,[62] and only 37% of children under six months (i.e. 0–6 months) are exclusively breastfed.[37] The prevalence of breastfeeding at 12 months varies across LMICs, ranging from 31% to 99%.[37] These numbers have been declining as work in the formal economy increases.[63]

When considering interventions to improve breastfeeding practices, many studies have reported that women who return to work after childbirth are less likely to initiate or maintain breastfeeding.[64-69] The most often-cited reasons for early weaning among mothers who seek to breastfeed are early return to work and the

conditions women experience after returning to work, instead of the quantity and quality of breast milk or interest in breastfeeding.[70-73] Given the increasing proportion of women in the workforce in the past several decades, the importance of social policies for promoting a healthy balance between work and family roles, in general, and for making exclusive and continued breastfeeding more feasible for new mothers, in particular, has been highlighted.[74] With respect to paid maternity leave policy, a review of laws in place as of April 2015 showed that only half of all LMICs provided paid maternity leave of at least 14 weeks[14] and 6% of low-income countries and 22% of middle-income countries provided paid maternity leave of at least 26 weeks.[14]

The impacts of maternity leave policy on breastfeeding practice have been studied in high-income countries.[18-23] A new parental leave benefit was introduced in Germany in 2007, which replaced a means-tested child-rearing benefit with a parental leave benefit providing 67–100% of pre-birth net income, increased the number of eligible parents, and reduced the maximum benefit period from two years to one year. According to a longitudinal study, Germany's 2007 parental leave reform increased breastfeeding at four months and at six months by 9.2 and 7.9 percentage points, respectively.[18] Another study showed a 10–20 percentage-point increase in breastfeeding for at least six months and a 3–5 percentage-point increase in exclusive breastfeeding for at least six months after California became the first state to offer paid family leave.[19] However, the impacts of maternity leave policies on breastfeeding practices in LMICs have not been evaluated, in part due to limited comparative maternity leave policy data. In this study, we provide the first

evaluation, to our knowledge, of whether paid maternity leave policy affects the early initiation of breastfeeding, exclusive breastfeeding under six months, and breastfeeding duration in LMICs

2.3 Methods

We linked quantitative data on national maternity leave policies developed by McGill University's Policy-Relevant Observational Studies for Population health Equity and Responsible Development (PROSPERED) project[75] and University of California Los Angeles' WORLD Policy Analysis Center to breastfeeding information collected through DHS conducted between 2000 and 2015 for 38 LMICs. We assessed the tenability of the parallel trends assumption and employed a difference-in-differences approach to examine the effects of extending the legislated duration of maternity leave on the prevalence of early initiation of breastfeeding and exclusive breastfeeding under six months, as well as the duration of breastfeeding in LMICs.

2.3.1 Data sources

Longitudinal data measuring current maternity leave policies for each selected country were made available by the University of California Los Angeles' WORLD Policy Analysis Center and then collected retrospectively to 1995 by McGill University's PROSPERED project. Further details regarding the collection and coding of global maternity leave policies are available elsewhere.[12]

Information on breastfeeding and other covariates were obtained from the DHS. These surveys use a two-stage cluster sampling design to obtain a range of detailed

health-related and demographic information, focusing on maternal and child health. Trained interviewers use structured questionnaires to interview eligible individuals from a nationally representative sample of households in LMICs. Standardized measurement techniques are used to ensure the comparability of surveys across countries and survey waves. Further details regarding the sampling and survey techniques are available elsewhere.[76 77]

2.3.2 Sample

Our sample comprised 1,000,753 children under five years of age at the time of interview from 111 DHS across 38 LMICs. These 38 countries were selected based on the availability of at least two DHS administered between 2000 and 2015, which allowed for the utilization of the difference-in-differences approach for comparing trends in breastfeeding outcomes within countries. Because paid maternity leave policy information was available from 1995 to 2013 (inclusive), a restriction on children's birth year was applied, leaving 992,419 children born between 1996 and 2014 (inclusive) in the sample (a one-year lag was used to respect temporality between exposure and outcome). After further excluding observations with missing and/or inconsistent breastfeeding information flagged by DHS, 401,067 children born in the last 24 months, 86,565 infants 0–5 months of age, and 750,118 children younger than five were included in the analyses of early initiation of breastfeeding, exclusive breastfeeding under six months, and breastfeeding duration, respectively (table 2.1).

2.3.3 Measures

2.3.3.1 Outcome variable

We used WHO's definitions for two of our outcome variables:[56] early initiation of breastfeeding, defined as the proportion of children born in the past 24 months who were put to the breast within an hour of birth, and exclusive breastfeeding under six months, defined as the proportion of infants 0–5 months of age who were fed exclusively with breast milk during the previous day. Our third outcome variable was breastfeeding duration in months. At the time of interview, mothers were asked to provide breastfeeding information for all living children she gave birth to in the last five years. If a child was ever breastfed after birth, the interviewer recorded the time the child was first put to the breast, any food the child was given to eat during the previous day, and the number of months the child was breastfed for. If the child was still being breastfed at the time of interview, the interval between the child's date of birth and the date of interview was used as the breastfeeding duration.

2.3.3.2 Exposure variables

The exposure of interest in our study was the legislated length of paid maternity leave, in weeks or full-time equivalence (FTE) weeks, for each sampled country between 1995 and 2013. We first recorded the legislated length of paid leave available to mothers only. We then calculated the FTE weeks of paid leave by multiplying the legislated length of leave by the wage replacement rate. To ensure temporality between exposure and outcome, as well as reduce exposure misclassification, each observation was assigned the legislated length of paid

maternity leave one year prior to the birth year. We did not distinguish between leave that could be taken before or after birth.

2.3.3.3 Control variables

Based on literature review,[78-81] we identified potential confounders and other determinants of breastfeeding practices in LMICs. Individual-level characteristics included the mother's socio-demographic characteristics (e.g., age at childbirth, number of living children, education level, working status in the last 12 months, marital status) and birth order and sex of the child. Household-level characteristics included the number of listed household members, household wealth index, and place of residence (e.g., urban or rural). We obtained information on these variables from the DHS. In addition, potential country-level confounders, which may influence paid maternity leave policy reforms and be associated with breastfeeding practices, were extracted from the World Bank's World Development Indicators and Global Development Finance databases.[82] These variables included gross domestic product (GDP) per capita based on purchasing power parity, female labor force participation among women aged 15 to 64, unemployment as a percent of the female labor force, and government health expenditures per capita based on purchasing power parity. Information on workplace support for breastfeeding, specifically the age of the infant (months) until which the mother is guaranteed breastfeeding breaks at work, was obtained from McGill University's PROSPERED project and the University of California Los Angeles' WORLD Policy Analysis Center.

2.3.4 Statistical analysis

2.3.4.1 Examination of parallel trends assumption

We examined the parallel trends assumption by comparing the prevalence of early initiation of breastfeeding, the prevalence of exclusive breastfeeding under six months, and the average duration of breastfeeding among treated and control groups before 2000—the first year any of the treated countries adopted a policy change. First, we plotted each breastfeeding outcome for all treated countries against all control countries among children born between 1996 and 2001. Second, we used a linear regression model with an interaction between treatment status and birth year to assess potential departures from additivity (non-parallel trends on the additive scale) for breastfeeding outcomes among treated and control groups between 1996 and 2001.

2.3.4.2 Effect of paid maternity leave

Our difference-in-differences approach used the following fixed effects regression models to estimate the effect of a one-month increase in paid maternity leave policy on the average breastfeeding duration in months, and the probabilities of early initiation of breastfeeding and exclusive breastfeeding:

$$g\left(E[Y_{ijt}|M_{jt-1}]\right) = \beta_0 + \beta_1 * M_{jt-1} + \lambda_j + \delta_t + \varepsilon_{ijt} \qquad [1]$$

$$g\left(E[Y_{ijt}|M_{jt-1}]\right) = \beta_0 + \beta_1 * M_{jt-1} + \sum \beta_n * Z_{ijt} + \lambda_j + \delta_t + \varepsilon_{ijt} \qquad [2]$$

$$g\left(E[Y_{ijt}|M_{jt-1}]\right) = \beta_0 + \beta_1 * M_{jt-1} + \sum \beta_n * Z_{ijt} + \sum \beta_k * C_{jt-1} + \lambda_j + \delta_t + \varepsilon_{ijt} \qquad [3]$$

Linear regression was used to model breastfeeding duration and logistic regression was used for the early initiation of breastfeeding and exclusive breastfeeding outcomes. Marginal effects at the means were calculated from logistic regression models to present estimates on the additive scale as prevalence differences.

In all three models, Y_{ijt} represents the breastfeeding outcome for child *i* born in country *j* and in year *t* and M_{jt-1} is the calculated months of paid maternity leave in country *j* one year before the child's birth (t – 1). In the first model, we included fixed effects for country (λ_j) and year (δ_t) to control for, respectively, unobserved time-invariant confounders that vary across countries and any temporal trends in breastfeeding outcomes shared across countries. In the second model, we adjusted for individual- and household-level characteristics, represented by the vector Z_{ijt}. In the third model, we additionally controlled for time-varying country-level confounders measured one year before birth (t – 1), represented by the vector C_{jt-1}.

All models incorporated robust standard errors to account for clustering at the country level and respondent-level sampling weights to account for individual survey sampling designs. Per DHS guidelines, we applied the de-normalization of the standard weight approach described in the DHS Sampling and Household Listing Manual using information on the number of women aged 15 to 49 in each survey year from the Population Division of the United Nations.[83 84] Statistical analyses were performed using SAS software version 9.4 (SAS Institute Inc., Cary, NC) and Stata software version 15 (Stata Corp, College Station, TX).

2.3.5 Sensitivity analyses

For each breastfeeding outcome, sensitivity analyses using exposures with different lead times were conducted to examine the robustness of our main estimates. The examination of lead effects, specifically the length of paid maternity leave in weeks or in FTE weeks during the birth year (t), and one, two, and three years after birth ($t + 1$, $t + 2$, $t + 3$), was used to test whether policy effects could be detected before the actual year of implementation, which would be inconsistent with the inference that paid maternity leave had a causal effect on the breastfeeding outcome.

2.4 Results

2.4.1 Descriptive statistics

Between 1995 and 2013, the average weeks and FTE weeks of paid maternity leave in the control group were 12.8 and 12.2, respectively (Figure 2.1). Among the seven countries (i.e., Bangladesh, Kenya, Lesotho, Malawi, Uganda, Zambia, and Zimbabwe) that changed the duration of leave available, paid maternity leave increased, on average, from 7.1 weeks in 1995 to 13.1 weeks in 2013 (Figure 2.2). These seven countries were included in the treated group for the analysis of paid maternity leave in weeks.

Eight (i.e., Bangladesh, Ghana, Kenya, Lesotho, Malawi, Uganda, Zambia, and Zimbabwe) countries increased paid maternity leave in terms of FTE weeks (Figure 2.3). Ghana did not increase the length of paid maternity leave but raised the wage

replacement rate from 50% to 100% in 2004, thereby doubling FTE weeks of paid maternity leave from 6 to 12. Zimbabwe raised the wage replacement rate from 75% to 100% in 2003 and increased the length of paid maternity leave from 12.9 weeks to 14 weeks in 2006, leading to increases in FTE weeks of paid maternity leave in 2003 and 2006. These eight countries were included in the treated group for the analysis of paid maternity leave in FTE weeks.

In the period before 2000, the first year that the treated countries adopted a policy change, the weighted prevalence of early initiation of breastfeeding and exclusive breastfeeding under six months were 54.51% (SD = 0.11) and 69.50% (SD = 0.09) in treated countries compared with 48.35% (SD = 0.03) and 86.62% (SD = 0.04) in control countries. The weighted average duration of breastfeeding was 18.67 months (SD = 1.20) in treated countries and 16.83 months (SD = 0.76) in control countries.

2.4.2 Examination of parallel trends assumption

Prior to paid maternity leave reforms beginning in 2000, the trends in the prevalence of early initiation of breastfeeding, the prevalence of exclusive breastfeeding under six months, and the duration of breastfeeding among treated and control countries were similar (Figures 2.4–2.6). *P-values* for the interaction terms of treatment status and birth year between 1996 and 2001 ranged from 0.1 to 0.9 for each breastfeeding outcome. Overall, we did not find evidence supporting different trends in breastfeeding outcomes between treated and control countries before the period when these policies began to change.

2.4.3 Effect of weeks of paid maternity leave

Table 2.2 shows the effect of a one-month increase in the length of paid maternity leave on the prevalence of early initiation of breastfeeding among children born in the last 24 months. In the fully adjusted model (model 3), a one-month increase in paid maternity leave policy was associated with a 7.40 percentage-point (95% CI 3.15–11.65) increase in the prevalence of early initiation of breastfeeding.

Table 2.3 shows the effect of one-month increase in the length of paid maternity leave on the prevalence of exclusive breastfeeding under six months among infants 0–5 months of age. In the fully adjusted model (model 3), a one-month increase in paid maternity leave policy was associated with a 5.86 percentage-point (95% CI 1.95–9.77) increase in the prevalence of exclusive breastfeeding under six months.

Table 2.4 shows the effect of a one-month increase in the length of paid maternity leave on the average duration of breastfeeding among children under five years of age. In the fully adjusted model (model 3), a one-month increase in paid maternity leave policy was associated with a 2.21-month (95% CI 1.05–3.38) increase in average breastfeeding duration.

2.4.4 Effect of FTE weeks of paid maternity leave

Table 2.8, 2.9, and 2.10 show the effect of a one-month increase in the length of paid maternity leave, in FTE units, on early initiation of breastfeeding among children born in the last 24 months, exclusive breastfeeding under six months

among infants 0–5 months, and breastfeeding duration among children under five years of age, respectively. A one-month increase in paid maternity leave policy, in FTE units, was associated with a 6.85 percentage-point (95% CI 2.93–10.76) increase in the prevalence of early initiation of breastfeeding, a 5.32 percentage-point (95% CI 1.65–9.00) increase in the prevalence of exclusive breastfeeding under six months, and a 2-month (95% CI: 0.78–3.17) increase in average breastfeeding duration.

2.4.5 Sensitivity analysis

As expected, the results of analyses using a one-year lead, a two-year lead and a three-year lead in paid maternity leave policy, both in weeks and in FTE weeks, did not provide evidence of an association with breastfeeding outcomes (Table 2.5, 2.6, and 2.7). Overall, the results of these sensitivity analyses support the temporality between changes in paid maternity leave policy and each breastfeeding outcome and the robustness of our main estimates.

2.5 Discussion

By linking longitudinal data on paid maternity leave duration between 1995 and 2013 to individual-level data on 992,419 children from DHS conducted in 38 LMICs, we evaluated the effect of extending legislated paid maternity leave on breastfeeding practices in these countries. Our difference-in-difference analyses indicated that each additional month of paid maternity leave corresponded to a 7 percentage-point increase in the prevalence of early initiation of breastfeeding, a roughly 6 percentage-point increase in the prevalence of exclusive breastfeeding

under six months, and a 2-month increase in breastfeeding duration. Sensitivity analyses supported the robustness of our main estimates. As the first analysis to examine this relation in LMICs, our analyses build on previously published studies from higher-income contexts using quasi-experimental methods.

With increasing numbers of women in the workforce, paid maternity leave has become increasingly important. Globally, 185 countries had a maternity leave policy in place in 2015 but only 57% (n=105 countries) met the 14 week standard[85] set by the International Labour Organization in convention C183. Among the 80 countries not meeting the standard, 84% (n=67 countries) were LMICs.[14] In addition, the wage replacement rate during maternity leave varies substantially, ranging from 25% to 100%.[86] Unpaid leave, which grants time off without wage replacement, may end up impoverishing many young families.[16] Take-up of parental leave has generally been low where leave is unpaid or only provides low levels of wage replacement.[17] Our study showed that extending the duration of paid maternity leave in weeks and FTE weeks promote breastfeeding practices in LMICs, as the right to take leave and having financial support during that leave are both important.

Prior work has found that providing more generous paid maternity leave policy lowers infant mortality in LMICs.[28] As breastfeeding is one of the most effective interventions for reducing child mortality[37], our findings implicate breastfeeding as one of the mechanisms for this reduced mortality. To protect and promote newborns' health and survival, many determinants of breastfeeding practice,

including a wide range of cultural, socioeconomic, and workplace factors, are amenable to interventions. Meta-analyses of the effects of interventions in health systems and services, family and community, and workplace and employment showed that interventions delivered in health systems and communities strongly promote breastfeeding practices and the largest effects of interventions can be achieved by delivering combinations of interventions.[87] Interventions in health systems, such as baby-friendly support and counselling or education, have been found to increase exclusive breastfeeding under six months by 49% and 66%, respectively, and continued breastfeeding for 12–23 months by 26% and 15%, respectively.[87] Combined health systems and community interventions were found to have a major effect on exclusive breastfeeding under six months (RR 2.52 [1.39–4.59]) and continued breastfeeding for 12–23 months (RR 10.2 [7.66–13.74]).[87] The few results available on interventions in the workplace suggest that maternity leave policy increases the chance of exclusive breastfeeding under six months (RR 1.52 [1.03–2.23]).[87] Our results were consistent with the majority of studies that reported positive associations between existing interventions and breastfeeding practices.

Several limitations of this study should be noted. First, the parallel trends assumption is difficult to examine visually in the difference-in-differences approach with several policy changes and multiple treated and control countries. We lacked longitudinal measurements on each breastfeeding outcome from the DHS for all of our sampled countries in the pre-intervention period prior to reforms occurring in treated countries. However, the observations of similar trends in each breastfeeding

outcome in the pre-intervention period gave some assurance that this assumption may not be violated (Figures 2.5–2.6). Second, although we included individual-, household-, and country-level characteristics as covariates, as well as year and country as fixed effects, uncontrolled time-varying confounding is still possible. For example, social and cultural attitudes toward breastfeeding, which are not measured in the DHS, may be uncontrolled confounders if they are associated with paid leave policy reforms and also influence breastfeeding practices. Third, we did not account for the implementation of other interventions, such as breastfeeding promotion programs, that could coincide with changes in paid maternity leave. Fourth, information related to our outcome variables and several covariates was collected based on maternal recall. Measurements are more prone to recall bias in mothers with older children; however, there is likely less recall bias for breastfeeding than less significant aspects of parenting history. Fifth, although we did not distinguish between paid maternity leave that can be taken before and after birth, or account for other leave (e.g., parental leave) that might be available to mothers, exposure misclassification is expected to be minor because the majority of paid maternity leave is taken subsequent to birth in LMICs and paid parental leave is short (e.g., less than four weeks) among the sampled countries. Sixth, the results might be prone to survivor bias since breastfeeding information is only available for children who were alive at the time of interview. This could weaken a true positive association between increases in paid maternity leave policy and early initiation and continuation of breastfeeding if the causes of death prevented by paid maternity leave policy also influence the initiation and continuation of breastfeeding, although no evidence for such selection has been established.

Seventh, due to the lack of information on policy compliance or enforcement, the intent-to-treat estimate obtained in our study may be downwardly biased. Furthermore, women in informal work sectors are not always protected by paid maternity leave. As a result, an average population effect may underestimate the true effect of paid maternity leave when provided to all women. Finally, the generalization of our results to all LMICs is limited as the sampling weights only allowed us to draw inference to the target population of the 38 sampled countries.

In conclusion, our study suggested a positive effect of extended paid maternity leave on early initiation of breastfeeding, exclusive breastfeeding under six months, and breastfeeding duration. From a policy planning perspective, further studies are needed to deepen our understanding of the impact of maternity leave policy on breastfeeding practices. This might include within-country studies with additional information on policy implementation and enforcement. Further studies may also seek to examine whether the increase in breastfeeding duration is longer than the increase in maternity leave duration because of threshold effects. Specifically, future studies could examine whether a certain minimum length of leave is needed to encourage breastfeeding initiation and whether it is easier to continue breastfeeding while working once an infant has reached a certain age. Studies should also explore the impact of other related policies, such as paid parental leave, on breastfeeding practices.[74 88] This research could help to develop effective early-life interventions to ensure positive health outcomes for mothers and infants in LMICs.

2.6 Tables and figures

Table 2.1. Sample description by breastfeeding outcome

Early initiation of breastfeeding (within first hour of birth) among children born in the last 24 months (N = 401,067)

Country	DHS survey years	Birth Years available (Min, Max)	Sample Size	Average proportion of children born in the last 24 months who were put to the breast within one hour of birth [d]
Bangladesh	2004, 2007, 2011, 2014	2002, 2014	11,316	42.59%
Kenya	2003, 2008, 2014	2001, 2014	8,540	59.27%
Lesotho	2004, 2009, 2014	2002, 2014	4,361	61.10%
Malawi	2000, 2004, 2010	1998, 2010	17,153	77.92%
Uganda	2000, 2006, 2011	1998, 2011	9,004	40.96%
Zambia	2001, 2007, 2013	1999, 2014	10,290	59.46%
Zimbabwe	2005, 2010, 2015	2003, 2015	6,795	67.54%
All Treated Countries [a]			67,459	60.54% (SD = 0.07)
Armenia	2000, 2005, 2010	1998, 2010	1,776	30.69%
Benin	2001, 2006, 2011	1999, 2012	13,490	54.61%
Bolivia	2003, 2008	2001, 2008	7,170	64.27%
Burkina Faso	2003, 2010	2001, 2010	9,892	38.24%
Cameroon	2004, 2011	2002, 2011	7,741	35.56%
Chad	2004, 2014	2002, 2015	8,362	28.35%
Colombia	2000, 2005, 2010	1998, 2010	14,402	61.88%
Congo	2005, 2011	2003, 2012	5,698	30.48%
Democratic Republic of Congo	2007, 2013	2005, 2014	10,576	51.56%
Dominican Republic	2002, 2007, 2013	2000, 2013	9,616	60.38%
Egypt	2000, 2005, 2008, 2014	1998, 2014	20,509	45.30%
Ethiopia	2000, 2005, 2011	1998, 2011	11,770	57.14%
Gabon	2000, 2012	1998, 2012	4,080	53.14%
Ghana [c]	2003, 2008, 2014	2001, 2014	5,091	52.32%
Guinea	2005, 2012	2003, 2012	5,326	27.99%
Haiti	2000, 2005, 2012	1998, 2012	7,790	46.97%
Honduras	2005, 2011	2003, 2012	8,607	72.52%

Indonesia	2002, 2007, 2012	2000, 2012	20,471	41.58%
Jordan	2002, 2007, 2012	2000, 2012	9,754	32.06%
Liberia	2007, 2013	2004, 2013	5,093	59.86%
Madagascar	2003, 2008	2001, 2009	6,891	64.69%
Mali	2001, 2006, 2012	1999, 2013	14,404	47.60%
Mozambique	2003, 2011	2001, 2011	8,511	74.81%
Nepal	2001, 2006, 2011	1999, 2012	6,698	35.39%
Niger	2006, 2012	2004, 2012	8,475	50.60%
Nigeria	2003, 2008, 2013	2001, 2013	25,078	34.81%
Peru	2000, 2004, 2007, 2009, 2010, 2011, 2012	1998, 2012	34,044	50.19%
Philippines	2003, 2008, 2013	2001, 2013	7,551	53.12%
Senegal	2005, 2010, 2012, 2014, 2015	2003, 2015	17,504	35.05%
Sierra Leone	2008, 2013	2006, 2013	6,592	54.12%
Tanzania	2004, 2010, 2015	2002, 2016	10,646	48.08%
All Control Countries [b]			333,608	48.32% (SD = 0.02)

Exclusive breastfeeding up to 6 months among infants 0–5 months of age (N = 86,565)

Country	DHS survey years	Birth Years available (Min, Max)	Sample Size	Average proportion of infants 0–5 months of age who are fed exclusively with breast milk during the previous day [d]
Bangladesh	2004, 2007, 2011, 2014	2003, 2014	2,618	82.21%
Kenya	2003, 2008, 2014	2002, 2014	2,035	67.01%
Lesotho	2004, 2009, 2014	2004, 2014	1,156	89.72%
Malawi	2000, 2004, 2010	2000, 2010	3,995	78.88%
Uganda	2000, 2006, 2011	2000, 2011	2,199	81.74%
Zambia	2001, 2007, 2013	2001, 2014	2,442	73.43%
Zimbabwe	2005, 2010, 2015	2005, 2015	1,705	66.38%
All Treated Countries [a]			16,150	76.65% (SD = 0.029)
Armenia	2000, 2010	2000, 2010	306	83.73%
Benin	2001, 2006, 2011	2001, 2012	3,190	83.47%
Bolivia	2003, 2008	2003, 2008	1,607	90.03%

Burkina Faso	2003, 2010	2003, 2010	2,537	88.75%
Cameroon	2004, 2011	2003, 2011	1,902	69.66%
Chad [e]	-	-	-	-
Colombia	2000, 2010	1999, 2010	1,944	81.29%
Congo [e]	-	-	-	-
Democratic Republic of Congo	2007, 2013	2006, 2014	2,788	72.03%
Dominican Republic	2002, 2007, 2013	2002, 2013	2,216	74.81%
Egypt	2000, 2008, 2014	1999, 2014	3,816	76.47%
Ethiopia	2000, 2011	2000, 2011	2,151	86.03%
Gabon [e]	-	-	-	-
Ghana [c]	2003, 2008, 2014	2003, 2014	1,259	81.43%
Guinea	2005, 2012	2004, 2012	1,427	80.43%
Haiti	2000, 2005, 2012	1999, 2012	1,889	55.48%
Honduras [e]	-	-	-	-
Indonesia	2002, 2007, 2012	2002, 2012	4,768	59.05%
Jordan	2002, 2007, 2012	2002, 2012	2,463	77.89%
Liberia	2007, 2013	2006, 2013	1,210	88.10%
Madagascar	2003, 2008	2003, 2009	1,704	94.65%
Mali	2001, 2006, 2012	2000, 2013	3,671	89.51%
Mozambique	2003, 2011	2003, 2011	2,055	72.75%
Nepal	2001, 2006, 2011	2001, 2012	1,604	92.64%
Niger	2006, 2012	2005, 2012	2,227	83.07%
Nigeria	2003, 2008, 2013	2002, 2013	6,225	66.91%
Peru	2000, 2004, 2007, 2009, 2010, 2011, 2012	2000, 2012	7,485	94.74%
Philippines	2003, 2008	2003, 2008	1,197	82.56%
Senegal	2005, 2010, 2012, 2014, 2015	2004, 2015	4,516	86.17%
Sierra Leone	2008, 2013	2007, 2013	1,674	62.41%
Tanzania	2004, 2010, 2015	2004, 2016	2,584	80.12%
All Control Countries [b]			70,415	81.34% (SD = 0.025)

Breastfeeding duration among children under five years of age (N = 750,118)

Country	DHS survey years	Birth Years available (Min, Max)	Sample Size	Average breastfeeding duration (months) among children younger than five [d]

Bangladesh	2004, 2007, 2011, 2014	1999, 2014	23,499	20.35
Kenya	2003, 2008, 2014	1998, 2014	20,281	15.23
Lesotho	2004, 2009, 2014	1999, 2014	7,651	18.33
Malawi	2000, 2004, 2010	1996, 2010	37,405	17.55
Uganda	2000, 2006, 2009, 2011	1996, 2011	19,749	14.68
Zambia	2001, 2007, 2013	1996, 2014	23,886	15.88
Zimbabwe	2005, 2010, 2015	2000, 2014	7,544	18.63
All Treated Countries [a]			140,015	16.68 (SD = 0.75)
Armenia	2000, 2005, 2010	1996, 2010	3,157	12.45
Benin	2001, 2006, 2011	1996, 2012	22,975	20.16
Bolivia	2003, 2008	1998, 2008	17,683	13.65
Burkina Faso	2003, 2010	1998, 2010	15,180	25.11
Cameroon	2004, 2011	1999, 2011	17,175	13.25
Chad	2004, 2014	1999, 2014	10,418	22.61
Colombia	2000, 2005, 2010	1996, 2010	31,918	11.68
Congo	2005, 2011	2000, 2012	7,047	18.20
Democratic Republic of Congo	2007, 2013	2002, 2014	14,403	19.75
Dominican Republic	2002, 2007, 2013	1997, 2013	23,345	8.43
Egypt	2000, 2005, 2008, 2014	1996, 2014	36,875	18.34
Ethiopia	2000, 2005, 2011	1996, 2011	22,360	22.28
Gabon	2000, 2012	1996, 2012	5,077	18.28
Ghana [c]	2003, 2008, 2014	1998, 2014	8,319	19.72
Guinea	2005, 2012	2000, 2012	8,166	23.68
Haiti	2000, 2005, 2012	1996, 2012	12,951	17.27
Honduras	2005, 2011	2000, 2012	13,836	18.49
Indonesia	2002, 2007, 2012	1997, 2012	37,970	19.20
Jordan	2002, 2007, 2012	1997, 2012	17,263	15.73
Liberia	2007, 2013	2002, 2013	7,517	20.22
Madagascar	2003, 2008	1998, 2009	16,514	15.21
Mali	2001, 2006, 2012	1996, 2013	26,099	19.20
Mozambique	2003, 2011	1998, 2011	12,722	21.37
Nepal	2001, 2006, 2011	1996, 2012	14,727	21.32
Niger	2006, 2012	2001, 2012	12,326	21.46
Nigeria	2003, 2008, 2013	1998, 2013	38,792	17.16
Peru	2000, 2004, 2007, 2009, 2010, 2011, 2012	1996, 2012	82,897	14.51

Philippines	2003, 2008, 2013	1998, 2013	13,808	15.89
Senegal	2005, 2010, 2012, 2014, 2015	2000, 2014	21,030	18.38
Sierra Leone	2008, 2013	2003, 2013	8,286	19.24
Tanzania	2004, 2007, 2010, 2011, 2015	1999, 2014	29,267	16.63
All Control Countries [b]			610,103	14.37 (SD = 0.43)

[a] treated countries are countries that experienced a change in the duration of paid maternity leave between 1995 and 2013

[b] control countries are countries that did not experience a change in the duration of paid maternity leave between 1995 and 2013

[c] Ghana was added to the 'treated' group in the analysis on FTE weeks of paid maternity leave

[d] average weighted by Demographic and Health Survey weight

[e] these countries were excluded from the analyses of exclusive breastfeeding outcome due to having only one survey

Table 2.2. Effect of a 1-month increase in length of paid maternity leave policy on the prevalence of early initiation of breastfeeding among children born in the last 24 months

	Model 1 (n = 397,406)	Model 2 (n = 387,288)	Model 3 (n = 387,288)
Exposure			
1-month increase in length of paid maternity leave policy	8.87 (4.94, 12.80)	8.09 (4.49, 11.68)	7.40 (3.15, 11.65)
Household- and individual-level covariates			
Number of listed household members		-0.05 (-0.27, 0.17)	-0.06 (-0.27, 0.16)
Household wealth			
poorest		Ref	Ref
poorer		0.40 (-0.79, 1.59)	0.42 (-0.78, 1.62)
middle		0.49 (-1.36, 2.34)	0.50 (-1.35, 2.35)
richer		1.52 (-0.87, 3.92)	1.52 (-0.87, 3.90)
richest		1.85 (-0.84, 4.54)	1.81 (-0.86, 4.48)
Place of residence			
urban		Ref	Ref
rural		0.29 (-1.11, 1.69)	0.26 (-1.21, 1.73)
Mother's age at childbirth (years)		-0.08 (-0.26, 0.10)	-0.08 (-0.26, 0.10)
Mother's number of living children		2.79 (2.05, 3.53)	2.74 (1.99, 3.50)
Maternal education			
no education		Ref	Ref
incomplete primary		1.21 (-1.30, 3.73)	1.15 (-1.33, 3.63)
complete primary		3.99 (0.91, 7.06)	4.04 (1.04, 7.04)
incomplete secondary		1.59 (-1.47, 4.64)	1.65 (-1.32, 4.62)
complete secondary		-1.49 (-5.59, 2.62)	-1.38 (-5.36, 2.59)
higher		-5.79 (-11.19, -0.39)	-5.58 (-10.86, -0.30)
Mother's current marital status			
never in union		Ref	Ref
married		2.39 (0.67, 4.10)	2.49 (0.74, 4.23)
living with partner		3.01 (1.33, 4.68)	3.01 (1.33, 4.68)
separated/divorced/widowed		1.84 (0.38, 3.30)	1.96 (0.50, 3.42)
Mother worked in the last 12 months			
did not work		Ref	Ref
worked in the past year		-3.99 (-6.37, -1.61)	-4.30 (-6.47, -2.13)
currently working		-2.36 (-4.02, -0.70)	-2.38 (-3.99, -0.77)
have a job, but on leave last 7 days		-9.08 (-11.88, -6.28)	-10.35 (-14.13, -6.56)
Child's birth order		-1.47 (-2.02, -0.91)	-1.42 (-1.95, -0.89)
Child's sex			

Male	Ref	Ref
Female	1.23 (0.69, 1.76)	1.23 (0.69, 1.77)
Country-level covariates		
GDP per capita		1.88 (-0.63, 4.39)
Health expenditure per capita		-0.62 (-1.48, 0.23)
% Females aged 15–64 participating in the labor force		0.00 (0.00, 0.00)
Unemployment female (% of female labor force)		0.43 (-0.23, 1.08)

Reported estimates are marginal effects at the means, which were multiplied by 100 in order to be interpreted as the percentage point difference in prevalence
95% confidence intervals are in parentheses
Model 1 includes country and year fixed effects
Model 2 additionally controlled for measured individual and household characteristics
Model 3 additionally controlled for country-level characteristics

Table 2.3. Effect of a 1-month increase in length of paid maternity leave policy on the prevalence of exclusive breastfeeding under six months among infants 0–5 months of age

	Model 1 (n = 84,593)	Model 2 (n = 82,081)	Model 3 (n = 82,081)
Exposure			
1-month increase in length of paid maternity leave policy	5.87 (1.94, 9.80)	6.20 (2.07, 10.33)	5.86 (1.95, 9.77)
Household- and individual-level covariates			
Number of listed household members		0.14 (0.02, 0.25)	0.14 (0.02, 0.26)
Household wealth			
poorest		Ref	Ref
poorer		-0.33 (-1.12, 0.45)	-0.35 (-1.14, 0.43)
middle		-0.13 (-1.42, 1.17)	-0.13 (-1.43, 1.17)
richer		-0.97 (-2.55, 0.61)	-0.98 (-2.57, 0.60)
richest		-1.95 (-3.83, -0.08)	-1.94 (-3.77, -0.10)
Place of residence			
urban		Ref	Ref
rural		-0.07 (-1.54, 1.40)	-0.07 (-1.55, 1.42)
Mother's age at childbirth (years)		0.04 (-0.06, 0.14)	0.04 (-0.06, 0.13)
Mother's number of living children		0.21 (-0.58, 1.01)	0.24 (-0.53, 1.00)
Maternal education			
no education		Ref	Ref
incomplete primary		-1.25 (-3.08, 0.59)	-1.21 (-3.03, 0.61)
complete primary		-0.42 (-2.25, 1.41)	-0.46 (-2.28, 1.37)
incomplete secondary		-0.79 (-2.66, 1.07)	-0.83 (-2.70, 1.05)
complete secondary		1.97 (-0.87, 4.81)	1.93 (-0.88, 4.74)
higher		3.92 (0.40, 7.43)	3.87 (0.41, 7.32)
Mother's current marital status			
never in union		Ref	Ref
married		2.33 (-0.13, 4.79)	2.26 (-0.24, 4.75)
living with partner		3.06 (1.33, 4.79)	3.10 (1.33, 4.88)
separated/divorced/widowed		-0.27 (-2.63, 2.10)	-0.32 (-2.67, 2.04)
Mother worked in the last 12 months			
did not work		Ref	Ref
worked in the past year		0.49 (-1.06, 2.03)	0.62 (-0.91, 2.15)
currently working		-2.56 (-3.62, -1.51)	-2.50 (-3.57, -1.44)
have a job, but on leave last 7 days		5.17 (3.54, 6.80)	5.57 (3.74, 7.39)
Child's birth order		-0.38 (-1.09, 0.32)	-0.41 (-1.08, 0.27)
Child's sex			

	Male	Ref	Ref
	Female	0.40 (-0.15, 0.95)	0.40 (-0.15, 0.96)
Country-level covariates			
GDP per capita			-0.35 (-1.79, 1.09)
Health expenditure per capita			-0.05 (-1.03, 0.93)
% Females aged 15–64 participating in the labor force			0.00 (0.00, 0.00)
Unemployment female (% of female labor force)			-0.42 (-1.21, 0.37)

Reported estimates are marginal effects at the means, which were multiplied by 100 in order to be interpreted as the percentage point difference in prevalence
95% confidence intervals are in parentheses
Model 1 includes country and year fixed effects
Model 2 additionally controlled for measured individual and household characteristics
Model 3 additionally controlled for country-level characteristics

Table 2.4: Effect of a 1-month increase in length of paid maternity leave policy on breastfeeding duration (months) among children under five years of age

	Model 1 (n = 750,107)	Model 2 (n = 728,541)	Model 3 (n = 727,236)
Exposure			
1-month increase in length of paid maternity leave policy	1.58 (0.33, 2.82)	1.64 (0.48, 2.81)	2.21 (1.05, 3.38)
Household- and individual-level covariates			
Number of listed household members		-0.10 (-0.15, -0.05)	-0.10 (-0.15, -0.05)
Household wealth			
poorest		0.00 (ref)	0.00 (ref)
poorer		-0.02 (-0.21, 0.18)	-0.01 (-0.20, 0.18)
middle		-0.16 (-0.41, 0.09)	-0.16 (-0.41, 0.09)
richer		-0.38 (-0.69, -0.07)	-0.37 (-0.68, -0.06)
richest		-0.96 (-1.44, -0.48)	-0.93 (-1.41, -0.45)
Place of residence			
urban		0.00 (ref)	0.00 (ref)
rural		0.23 (0.03, 0.43)	0.24 (0.05, 0.44)
Mother's age at childbirth (years)		0.02 (0.00, 0.05)	0.02 (0.00, 0.05)
Mother's number of living children		0.30 (0.12, 0.48)	0.27 (0.07, 0.47)
Maternal education			
no education		0.00 (ref)	0.00 (ref)
incomplete primary		-0.22 (-0.52, 0.08)	-0.18 (-0.48, 0.12)
complete primary		-0.29 (-0.70, 0.12)	-0.26 (-0.67, 0.15)
incomplete secondary		-0.59 (-1.03, -0.15)	-0.56 (-1.01, -0.12)
complete secondary		-0.89 (-1.40, -0.37)	-0.91 (-1.41, -0.40)
higher		-1.82 (-2.33, -1.31)	-1.86 (-2.34, -1.38)
Mother's current marital status			
never in union		0.00 (ref)	0.00 (ref)
married		0.43 (0.15, 0.70)	0.41 (0.11, 0.70)
living with partner		0.41 (0.14, 0.69)	0.35 (0.07, 0.63)
widowed		2.09 (1.63, 2.55)	2.04 (1.57, 2.50)
divorced		1.45 (0.87, 2.03)	1.39 (0.81, 1.98)
no longer living together/separated		0.92 (0.59, 1.25)	0.86 (0.52, 1.21)
Mother worked in the last 12 months			
did not work		0.00 (ref)	0.00 (ref)
worked in the past year		0.21 (-0.22, 0.63)	0.27 (-0.22, 0.75)
currently working		1.13 (0.87, 1.39)	1.12 (0.86, 1.39)
have a job, but on leave last 7 days		-1.42 (-2.05, -0.78)	-1.30 (-2.26, -0.34)

Child's birth order	-0.08 (-0.20, 0.05)	-0.06 (-0.19, 0.08)
Child's sex		
Male	0.00 (ref)	0.00 (ref)
Female	0.02 (-0.10, 0.14)	0.02 (-0.10, 0.14)
Country-level covariates		
GDP per capita		-0.68 (-1.13, -0.23)
Health expenditure per capita		-0.05 (-0.31, 0.21)
% Females aged 15–64 participating in the labor force		0.00 (0.00, 0.00)
Unemployment female (% of female labor force)		-0.01 (-0.20, 0.17)
Age of infant (months) until which mother is guaranteed breastfeeding breaks at work		0.21 (0.07, 0.34)

95% confidence intervals are in parentheses
Model 1 includes country and year fixed effects
Model 2 additionally controlled for measured individual and household characteristics
Model 3 additionally controlled for country-level characteristics

Table 2.5: Sensitivity analyses of effects of a 1-month increase in length of paid maternity leave policy on the prevalence of early initiation of breastfeeding among children born in the last 24 months

	Estimate	95% LCL	95% UCL
1-month increase in legislated length of paid maternity leave			
Lagged one year, t-1	**7.40**	**3.15**	**11.65**
Concurrent, t	5.38	0.76	9.99
Lead, t+1	2.60	-2.64	7.84
Lead two years, t+2	1.62	-3.96	7.20
Lead three years, t+3	0.90	-4.51	6.30
1-month increase in FTE length of paid maternity leave			
Lagged one year, t-1	**6.85**	**2.93**	**10.76**
Concurrent, t	5.10	0.79	9.40
Lead, t+1	2.44	-2.52	7.40
Lead two years, t+2	1.56	-3.92	7.04
Lead three years, t+3	0.90	-4.51	6.30

Reported estimates are marginal effects at the means, which were multiplied by 100 in order to be interpreted as the percentage point difference in prevalence

Models includes country and year fixed effects and additionally controlled for country-level characteristics

Table 2.6: Sensitivity analyses of effects of a 1-month increase in length of paid maternity leave policy on the prevalence of exclusive breastfeeding among infants 0–5 months of age

	Estimate	95% LCL	95% UCL
1-month increase in legislated length of paid maternity leave			
Lagged one year, t-1	**5.86**	**1.95**	**9.77**
Concurrent, t	-0.12	-5.92	5.67
Lead, t+1	-1.63	-7.92	4.67
Lead two years, t+2	0.57	-5.52	6.67
Lead three years, t+3	-1.44	-7.10	4.22
1-month increase in FTE length of paid maternity leave			
Lagged one year, t-1	**5.32**	**1.65**	**9.00**
Concurrent, t	-0.16	-5.82	5.50
Lead, t+1	-1.63	-7.92	4.67
Lead two years, t+2	0.57	-5.52	6.67
Lead three years, t+3	-1.44	-7.10	4.22

Reported estimates are marginal effects at the means, which were multiplied by 100 in order to be interpreted as the percentage point difference in prevalence
Models includes country and year fixed effects and additionally controlled for country-level characteristics

Table 2.7: Sensitivity analyses of effects of a 1-month increase in length of paid maternity leave policy on breastfeeding duration (months) among children under five years of age

	Estimate	95% LCL	95% UCL
1-month increase in length of paid maternity leave policy			
Lagged one year, t-1	**2.21**	**1.05**	**3.38**
Concurrent, t	0.93	-0.28	2.13
Lead, t+1	0.13	-1.12	1.38
Lead two years, t+2	0.42	-0.86	1.70
Lead three years, t+3	0.29	-1.56	2.14
1-month increase in FTE length of paid maternity leave policy			
Lagged one year, t-1	**2.00**	**0.78**	**3.17**
Concurrent, t	0.84	-0.29	1.97
Lead, t+1	-0.12	-1.31	1.07
Lead two years, t+2	0.10	-1.23	1.44
Lead three years, t+3	0.00	-1.85	1.85

Models includes country and year fixed effects and additionally controlled for country-level characteristics

Table 2.8: Effect of a 1-month increase in FTE length of paid maternity leave policy on the prevalence of early initiation of breastfeeding among children born in the last 24 months

	Model 1 (n = 397,406)	Model 2 (n = 387,288)	Model 3 (n = 387,288)
Exposure			
1-month increase in FTE length of paid maternity leave policy	8.49 (4.77, 12.21)	7.77 (4.33, 11.21)	6.85 (2.93, 10.76)
Household- and individual-level covariates			
Number of listed household members		-0.05 (-0.27, 0.17)	-0.06 (-0.27, 0.16)
Household wealth			
poorest		Ref	Ref
poorer		0.39 (-0.80, 1.58)	0.42 (-0.78, 1.62)
middle		0.48 (-1.36, 2.33)	0.49 (-1.35, 2.34)
richer		1.51 (-0.88, 3.91)	1.51 (-0.88, 3.90)
richest		1.85 (-0.84, 4.54)	1.81 (-0.86, 4.48)
Place of residence			
urban		Ref	Ref
rural		0.29 (-1.11, 1.69)	0.26 (-1.21, 1.73)
Mother's age at childbirth (years)		-0.08 (-0.26, 0.10)	-0.08 (-0.26, 0.10)
Mother's number of living children		2.79 (2.05, 3.54)	2.75 (1.99, 3.50)
Maternal education			
no education		Ref	Ref
incomplete primary		1.20 (-1.32, 3.72)	1.14 (-1.34, 3.63)
complete primary		3.98 (0.90, 7.06)	4.03 (1.02, 7.03)
incomplete secondary		1.58 (-1.48, 4.64)	1.65 (-1.33, 4.62)
complete secondary		-1.49 (-5.59, 2.61)	-1.39 (-5.37, 2.59)
higher		-5.80 (-11.19, -0.40)	-5.59 (-10.87, -0.31)
Mother's current marital status			
never in union		Ref	Ref
married		2.43 (0.70, 4.16)	2.52 (0.76, 4.28)
living with partner		3.00 (1.33, 4.67)	3.00 (1.33, 4.68)
separated/divorced/widowed		1.88 (0.42, 3.35)	1.99 (0.53, 3.46)
Mother worked in the last 12 months			
did not work		Ref	Ref
worked in the past year		-3.98 (-6.36, -1.59)	-4.29 (-6.46, -2.12)
currently working		-2.36 (-4.02, -0.70)	-2.38 (-3.99, -0.77)
have a job, but on leave last 7 days		-9.29 (-12.16, -6.42)	-10.53 (-14.41, -6.64)
Child's birth order		-1.47 (-2.02, -0.92)	-1.43 (-1.96, -0.89)
Child's sex			

	Male	Ref	Ref
	Female	1.23 (0.69, 1.76)	1.23 (0.69, 1.77)
Country-level covariates			
GDP per capita			1.87 (-0.70, 4.44)
Health expenditure per capita			-0.58 (-1.44, 0.28)
% Females aged 15-64 participating in the labor force			0.00 (0.00, 0.00)
Unemployment female (% of female labor force)			0.41 (-0.26, 1.08)

Reported estimates are marginal effects at the means, which were multiplied by 100 in order to be interpreted as the percentage point difference in prevalence
95% confidence intervals are in parentheses
Model 1 includes country and year fixed effects
Model 2 additionally controlled for measured individual and household characteristics
Model 3 additionally controlled for country-level characteristics

Table 2.9: Effect of a 1-month increase in FTE length of paid maternity leave policy on the prevalence of exclusive breastfeeding under six months among infants 0–5 months of age

	Model 1 (n = 84,593)	Model 2 (n = 82,081)	Model 3 (n = 82,081)
Exposure			
1-month increase in FTE length of paid maternity leave policy	5.63 (1.83, 9.44)	5.58 (1.71, 9.45)	5.32 (1.65, 9.00)
Household- and individual-level covariates			
Number of listed household members		0.14 (0.02, 0.25)	0.14 (0.02, 0.26)
Household wealth			
poorest		Ref	Ref
poorer		-0.32 (-1.11, 0.46)	-0.35 (-1.13, 0.44)
middle		-0.12 (-1.42, 1.18)	-0.12 (-1.43, 1.18)
richer		-0.97 (-2.56, 0.61)	-0.99 (-2.58, 0.60)
richest		-1.96 (-3.84, -0.07)	-1.95 (-3.79, -0.11)
Place of residence			
urban		Ref	Ref
rural		-0.06 (-1.54, 1.41)	-0.07 (-1.55, 1.42)
Mother's age at childbirth (years)		0.04 (-0.06, 0.13)	0.04 (-0.06, 0.13)
Mother's number of living children		0.22 (-0.58, 1.01)	0.24 (-0.53, 1.01)
Maternal education			
no education		Ref	Ref
incomplete primary		-1.25 (-3.09, 0.59)	-1.22 (-3.05, 0.61)
complete primary		-0.41 (-2.24, 1.42)	-0.46 (-2.29, 1.37)
incomplete secondary		-0.78 (-2.65, 1.08)	-0.83 (-2.70, 1.05)
complete secondary		1.97 (-0.88, 4.82)	1.93 (-0.89, 4.75)
higher		3.92 (0.40, 7.45)	3.87 (0.41, 7.33)
Mother's current marital status			
never in union		Ref	Ref
married		2.39 (-0.07, 4.86)	2.31 (-0.19, 4.81)
living with partner		3.06 (1.34, 4.77)	3.1 (1.35, 4.86)
separated/divorced/widowed		-0.23 (-2.59, 2.13)	-0.28 (-2.63, 2.07)
Mother worked in the last 12 months			
did not work		Ref	Ref
worked in the past year		0.49 (-1.06, 2.03)	0.63 (-0.90, 2.16)
currently working		-2.57 (-3.62, -1.51)	-2.50 (-3.56, -1.44)
have a job, but on leave last 7 days		5.00 (3.27, 6.73)	5.44 (3.59, 7.28)
Child's birth order		-0.39 (-1.10, 0.32)	-0.41 (-1.09, 0.27)
Child's sex			

	Male	Ref	Ref
	Female	0.39 (-0.16, 0.94)	0.4 (-0.15, 0.95)
Country-level covariates			
GDP per capita			-0.38 (-1.78, 1.02)
Health expenditure per capita			-0.01 (-1.01, 1.00)
% Females aged 15-64 participating in the labor force			0.00 (0.00, 0.00)
Unemployment female (% of female labor force)			-0.44 (-1.23, 0.36)

Reported estimates are marginal effects at the means, which were multiplied by 100 in order to be interpreted as the percentage point difference in prevalence
95% confidence intervals are in parentheses
Model 1 includes country and year fixed effects
Model 2 additionally controlled for measured individual and household characteristics
Model 3 additionally controlled for country-level characteristics

Table 2.10: Effect of a 1-month increase in FTE length of paid maternity leave policy on breastfeeding duration (months) among children under five years of age

	Model 1 (n = 750,107)	Model 2 (n = 728,541)	Model 3 (n = 727,236)
Exposure			
1-month increase in FTE length of paid maternity leave policy	1.45 (0.23, 2.67)	1.51 (0.36, 2.66)	2.00 (0.78, 3.17)
Household- and individual-level covariates			
Number of listed household members		-0.10 (-0.15, -0.05)	-0.10 (-0.15, -0.05)
Household wealth			
poorest		0.00 (ref)	0.00 (ref)
poorer		-0.02 (-0.21, 0.18)	-0.01 (-0.20, 0.18)
middle		-0.16 (-0.41, 0.09)	-0.16 (-0.41, 0.09)
richer		-0.38 (-0.69, -0.07)	-0.37 (-0.68, -0.06)
richest		-0.96 (-1.44, -0.48)	-0.93 (-1.41, -0.45)
Place of residence			
urban		0.00 (ref)	0.00 (ref)
rural		0.23 (0.03, 0.43)	0.24 (0.05, 0.44)
Mother's age at childbirth (years)		0.02 (0.00, 0.05)	0.02 (0.00, 0.05)
Mother's number of living children		0.30 (0.12, 0.49)	0.28 (0.08, 0.48)
Maternal education			
no education		0.00 (ref)	0.00 (ref)
incomplete primary		-0.22 (-0.52, 0.08)	-0.18 (-0.48, 0.12)
complete primary		-0.29 (-0.70, 0.12)	-0.26 (-0.67, 0.15)
incomplete secondary		-0.59 (-1.03, -0.15)	-0.56 (-1.00, -0.12)
complete secondary		-0.89 (-1.40, -0.37)	-0.91 (-1.41, -0.40)
higher		-1.81 (-2.32, -1.30)	-1.86 (-2.33, -1.38)
Mother's current marital status			
never in union		0.00 (ref)	0.00 (ref)
married		0.44 (0.16, 0.71)	0.41 (0.12, 0.71)
living with partner		0.42 (0.15, 0.69)	0.36 (0.08, 0.64)
widowed		2.11 (1.64, 2.57)	2.05 (1.58, 2.52)
divorced		1.47 (0.89, 2.05)	1.42 (0.83, 2.01)
no longer living together/separated		0.93 (0.60, 1.26)	0.88 (0.53, 1.22)
Mother worked in the last 12 months			
did not work		0.00 (ref)	0.00 (ref)
worked in the past year		0.21 (-0.22, 0.64)	0.28 (-0.22, 0.77)
currently working		1.13 (0.87, 1.39)	1.13 (0.86, 1.39)
have a job, but on leave last 7 days		-1.46 (-2.13, -0.80)	-1.34 (-2.33, -0.35)

Child's birth order	-0.08 (-0.21, 0.05)	-0.06 (-0.20, 0.08)
Child's sex		
Male	0.00 (ref)	0.00 (ref)
Female	0.02 (-0.10, 0.14)	0.02 (-0.10, 0.14)
Country-level covariates		
GDP per capita		-0.67 (-1.14, -0.21)
Health expenditure per capita		-0.04 (-0.30, 0.21)
% Females aged 15-64 participating in the labor force		0.00 (0.00, 0.00)
Unemployment female (% of female labor force)		-0.02 (-0.21, 0.17)
Age of infant (months) until which mother is guaranteed breastfeeding breaks at work		0.18 (0.04, 0.33)

95% confidence intervals are in parentheses
Model 1 includes country and year fixed effects
Model 2 additionally controlled for measured individual and household characteristics
Model 3 additionally controlled for country-level characteristics

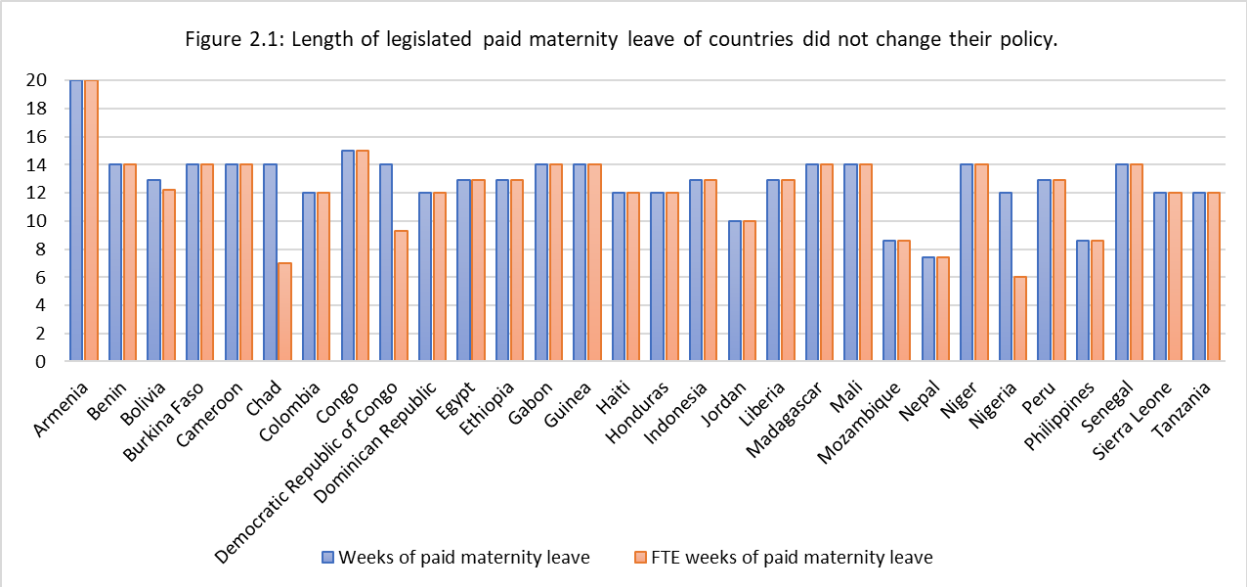

Figure 2.1. Length of legislated paid maternity leave of countries did not change their policy.

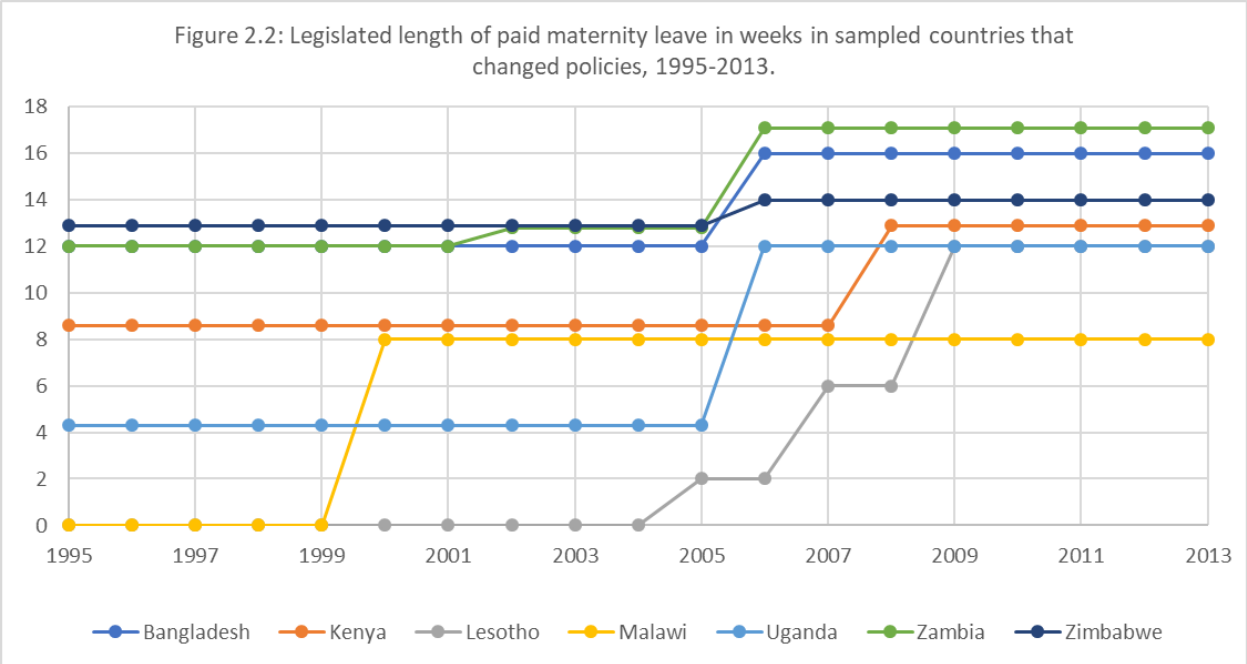

Figure 2.2. Legislated length of paid maternity leave in weeks in sampled countries that changed policies, 1995-2013

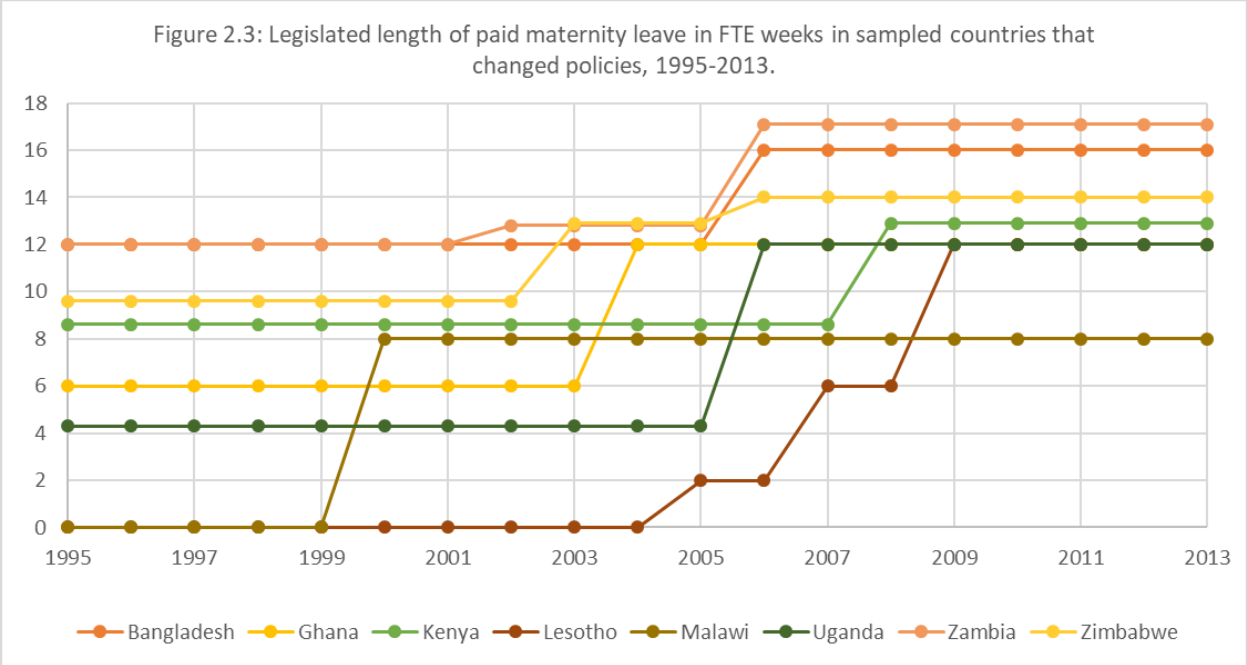

Figure 2.3. Legislated length of paid maternity leave in FTE weeks in sampled countries that changed policies, 1995-2013

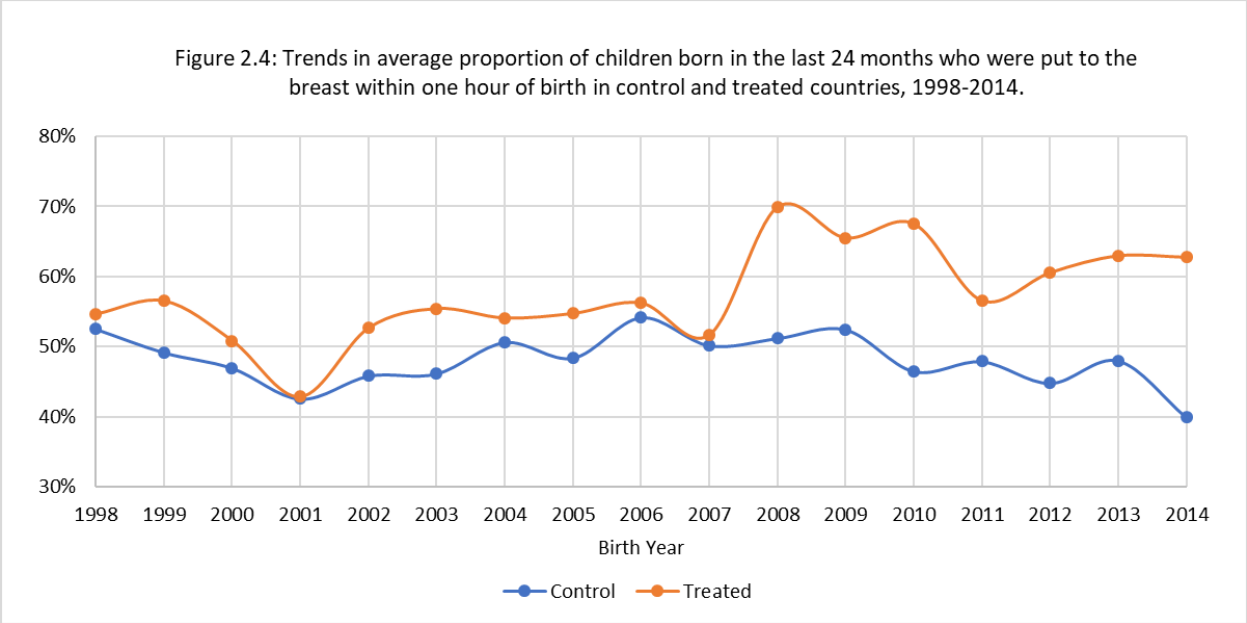

Figure 2.4. Trends in average proportion of children born in the last 24 months who were put to the breast within one hour of birth in control and treated countries, 1998-2014.

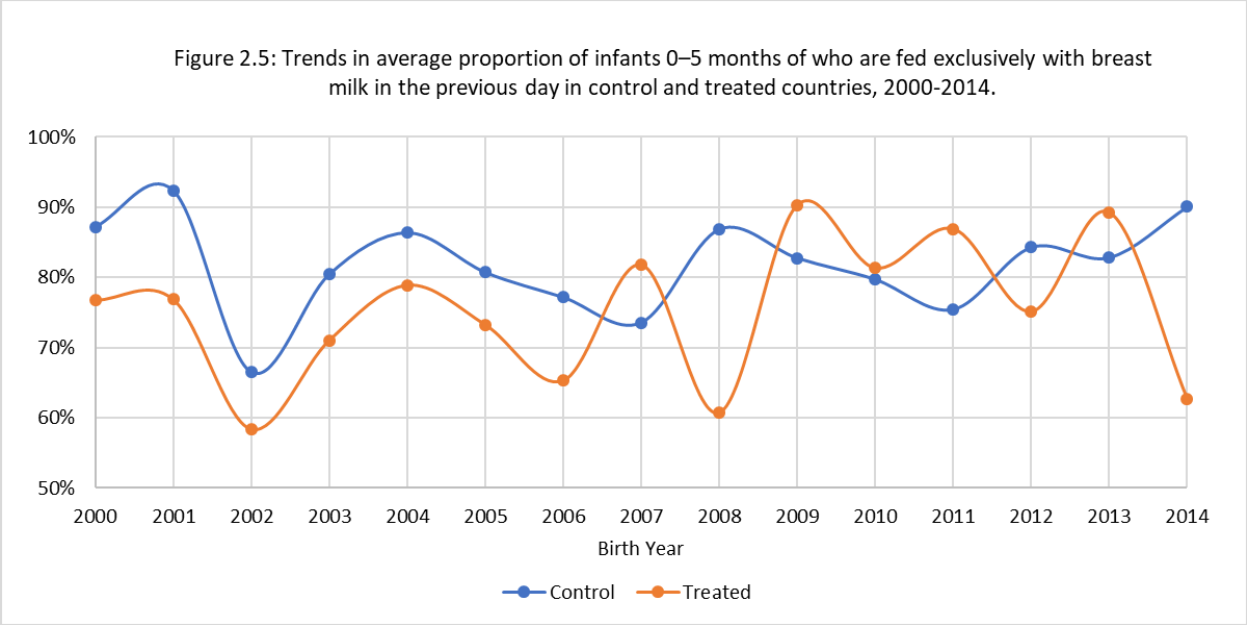

Figure 2.5. Trends in average proportion of infants 0–5 months of who are fed exclusively with breast milk in the previous day in control and treated countries, 2000-2014

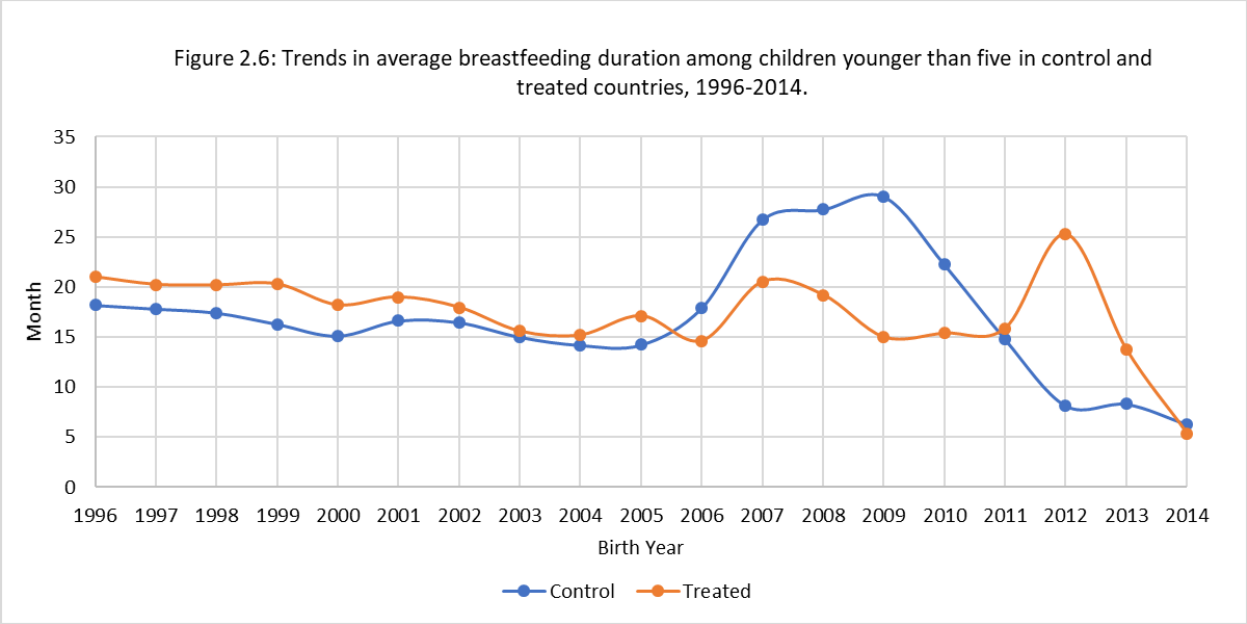

Figure 2.6. Trends in average breastfeeding duration among children younger than five in control and treated countries, 1996-2014

Chapter 3. Association of increased duration of legislated paid maternity leave with childhood diarrhea incidence in low-income and middle-income countries: a difference-in-differences analysis

3.1 Abstract

Introduction

Diarrhea is the second-leading infectious cause of death in children younger than age five. The global burden of severe diarrheal disease is concentrated in Africa and Southeast Asia, where a significant percentage of the population resides in low-resource settings. We aimed to quantitatively examine whether extending the duration of legislated paid maternity leave affected the incidence of childhood diarrhea in LMICs.

Methods

We merged longitudinal data measuring national maternity leave policies with information on the incidence of bloody diarrhea related to 936,127 live births occurring between 1996 and 2014 in 40 LMICs that participated at least twice in the DHS between 2000 and 2015. We used a difference-in-differences approach to compare relative changes in the proportion of children with bloody diarrhea across eight countries that lengthened their paid maternity leave policy between 1995 and 2013 to the 32 countries that did not.

Results

The average weighted proportion of children under five with bloody diarrhea in the past two weeks was 1.60% (SD = 0.004) in countries that changed their policies and 1.34% (SD = 0.001) in countries that did not. A one-month increase in the

legislated duration of paid maternity leave was associated with a 35% (RR 0.65, 95% CI 0.50–0.86) reduction in the risk of bloody diarrhea.

Conclusion

Extending the duration of paid maternity leave policy appears to lower diarrhea incidence in children under five years of age in LMICs. Our findings may suggest a potential instrument for facilitating early-life interventions to reduce children's risk of bloody diarrhea.

3.2 Introduction

Globally, diarrhea is the fourth-leading cause of death and second-leading infectious cause of death in children under five years of age.[3 89] In 2015, an estimated 957.5 million episodes of diarrhea occurred in children younger than age five, of which 499,000 episodes led to death.[89] The burden of diarrheal disease is concentrated primarily in younger children. Diarrhea incidence peaks before one year of age and then decreases with age.[90] A high proportion (72%) of deaths from diarrhea occur in children younger than two years of age.[3] From 1990 to 2010, the incidence of diarrhea in children under five has decreased by 10.4%, with the fastest decrease in western and eastern sub-Saharan Africa.[89] Nevertheless, in LMICs, acute diarrheal infection remains one of the most frequent childhood illnesses, and severe diarrhea is among the most common reasons for hospital admission in children.[3]

Diarrhea is both preventable and treatable. There are proven interventions that can go a long way toward reducing diarrhea incidence and mortality.[91-98] A recent review estimated reductions in the risk of childhood diarrhea of 48%, 17%, and

36%, attributable to hand washing with soap, improved water quality, and excreta disposal, respectively.[10] A review of 18 studies from LMICs indicated that not breastfeeding was associated with a 165% and 32% increase risk of diarrhea incidence among infants 0–5 months of age and 6–11 months of age, respectively, compared to exclusive breastfeeding.[7] Furthermore, preventive zinc supplementation was associated with a 13% reduction in diarrhea incidence in children.[11] Vaccine coverage might reduce diarrhea incidence by lowering the risk of viral infection. A review of six randomized trials and quasi-experimental studies from LMICs demonstrated that the use of rotavirus vaccines was associated with a 74% and a 61% reduction in very severe rotavirus infection and severe rotavirus infection, respectively.[8] Similarly, a review of 12 randomized trials and quasi-experimental studies from LMICs showed that use of the oral cholera vaccine was associated with a 52% reduction in the risk of cholera infection in children under five years of age.[9] Despite extensive research on preventive and therapeutic interventions, the evidence for informing specific national policy strategies to lower childhood diarrhea incidence through these mechanisms remains limited.[11 91 99]

Extending the duration of legislated paid maternity leave has been associated with lower infant mortality in a sample of 18 Organisation for Economic Co-operation and Development (OECD) countries[24-27] and a sample of 20 LMICs.[28] In addition, more generous paid maternity leave policies were associated with increased breastfeeding practices[18 19 21-23 36] and vaccination uptake.[29 30] To date, the impacts of maternity leave policies on childhood diarrhea have not been evaluated. In this study, using a novel database on nationally legislated maternity leave policies, we

provide the first evaluation, to the best of our knowledge, of whether paid maternity leave policy affects childhood diarrhea incidence in LMICs.

3.3 Methods

3.3.1 Data sources

Longitudinal data measuring national maternity leave policies for each UN member state were made available by the University of California Los Angeles' WORLD Policy Analysis Center and then collected retrospectively to 1995 by McGill University's Policy-Relevant Observational Studies for Population health Equity and Responsible Development (PROSPERED) project.[75] Further details regarding the collection and coding of global maternity leave policies are available elsewhere.[12]

DHS were used to measure childhood diarrhea and other individual-level covariates for children under five years of age. Many LMICs have conducted multiple DHS, often at a five-year interval. These nationally representative household surveys provide a wide range of detailed health-related and demographic information focusing on maternal and child health. Standard DHS utilize a two-stage cluster sampling design, with the first stage selecting sample points (e.g., clusters) and the second stage selecting households. Trained interviewers and structured questionnaires are used to interview selected married women and married men aged 15 to 49. In addition to collecting demographic information, the surveys also collected information on household assets and features of the dwelling units. Information on children younger than age five in the household was also recorded. Standardized measurement techniques were used to ensure the comparability of

surveys across countries and survey waves. Further details regarding the sampling and survey techniques are available elsewhere.[76 77]

3.3.2 Sample

For the analysis, we linked the national maternity leave policies between 1995 and 2013 (inclusive) to information from 1,073,751 children under five years of age at the time of the interviews in 40 LMICs. These 40 countries were identified based on the availability of at least two DHS between 2000 and 2015 (inclusive), allowing for analyses of policy change occurring within countries over time. A one-year lag was used to respect temporality between policy year and the children's birth year, leaving 1,064,906 children born between 1996 and 2014 (inclusive) in the sample. After excluding observations with missing diarrhea information, our final sample included 936,127 children from 115 DHS in 40 LMICs (Table 3.1). In further analyses using FTE weeks of paid maternity leave, Namibia was excluded because we lacked information on FTE weeks of paid maternity leave between 1995 and 2003. Thus, these analyses included 924,423 children born between 1996 and 2014 from 112 DHS across 39 LMICs (Table 3.1).

3.3.3 Measures

3.3.3.1 Outcome variable

Our primary outcome variable was whether the child had blood in their stools in the past two weeks at the time of the interview. This measure was used as an indicator of severe diarrhea and because the frequency of loose stools in breastfed infants can be difficult to distinguish from pathologic diarrhea due to an infection based on

survey data. Information on bloody diarrhea (clearly pathologic) was extracted from at least two DHS for each sampled country. Briefly, mothers surveyed in the DHS were asked to provide information on the occurrence of diarrhea for all children under the age of five in the household. If a child had diarrhea in the past two weeks, mothers were additionally asked whether there was blood in the stools.

3.3.3.2 Exposure variables

The exposure of interest in our study was the legislated length of paid maternity leave, in weeks or FTE weeks, for each sampled country between 1995 and 2013 (inclusive). We first recorded the legislated length of paid leave available to mothers only. We then calculated the FTE weeks of paid leave by multiplying the legislated length of leave by the wage replacement rate. To ensure temporality between exposure and outcome, as well as reduce exposure misclassification, each observation was assigned the legislated length of paid maternity leave one year prior to the birth year. We did not distinguish between leave that could be taken before or after birth. Further details regarding calculation of FTE weeks of paid maternity leave are available elsewhere.[12] Treated and control countries were distinguished based on whether or not they experienced a change in national paid maternity leave policy.

3.3.3.3 Control variables

Research on the epidemiology of diarrhea in children[3 7 91] was used to identify potential confounders and other determinants at the household, maternal, and child level of childhood diarrhea in LMICs. Covariates at the household level included

number of listed household members, number of children under five years of age living in the household, place of residence (e.g., urban or rural), and an indicator for drinking water source (unimproved or improved), which was created by using the new scale for household drinking water used by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF).[100] We also included the asset-based DHS household wealth index, which was created by and used as a standard by the DHS and UNICEF Multiple Indicator Cluster Surveys (MICS) to capture the within-country relative wealth standing of each household. At the maternal and child level, covariates included mother's education received in years, mother's age at delivery, mother's number of living children, child's sex, child's age at interview, and child's birth order.

In addition, to minimize confounding on the country level, we measured country-level characteristics that may be associated with changes to paid maternity leave policies and with childhood diarrhea incidence from the World Bank's World Development Indicators and Global Development Finance databases.[101] These variables included GDP per capita (constant 2011 international dollar) based on purchasing power parity (PPP), female labor force participation rate (percentage of female population ages 15 to 64), percentage of unemployed female labor force, government health expenditures per capita based on PPP (constant 2011 international dollar), and total health expenditure (percentage of GDP).

3.3.4 Statistical analysis

3.3.4.1 Examination of parallel trends assumption

One of the primary assumptions in the difference-in-differences approach is the parallel trends assumption.[102] That is, in the absence of treatment, trends in outcomes between treated and control groups remain the same over time. In our study, we examined the tenability of the assumption on the multiplicative scale by first plotting the natural logarithm of the average weighted proportion of children under five with bloody diarrhea for all treated countries against all control countries for each survey year in the pre-intervention period before 2000, after which we observed reforms to paid maternity leave policies in our treated countries. Then, we used a log-binomial regression model with an interaction between treatment status and survey year to assess whether trends in the incidence of bloody diarrhea were similar for treated and control countries between 1996 and 2001.

3.3.4.2 Effect of paid maternity leave

We estimated the effect of a one-month increase in paid maternity leave policy on the incidence of bloody diarrhea on the risk ratio scale using the following log-binomial regression models:

$$log\ Pr(Y_{ijt} = 1) = \beta_0 + \beta_1 * M_{jt-1} + \lambda_j + \delta_t + \varepsilon_{ijt} \quad [1]$$

$$log\ Pr(Y_{ijt} = 1) = \beta_0 + \beta_1 * M_{jt-1} + \sum \beta_n * Z_{ijt} + \lambda_j + \delta_t + \varepsilon_{ijt} \quad [2]$$

$$log\ Pr(Y_{ijt} = 1) = \beta_0 + \beta_1 * M_{jt-1} + \sum \beta_n * Z_{ijt} + \sum \beta_k * C_{jt-1} + \lambda_j + \delta_t + \varepsilon_{ijt} \quad [3]$$

In all three models, Y_{ijt} represents the outcome (i.e., whether the child had blood in the stools in the past two weeks at the time of the interview) for child *i* born in country *j* in year *t*, and M_{jt-1} is the calculated months of paid maternity leave in country *j* one year before the child's birth (t – 1). In the first model, we included fixed effects for country (λ_j) and survey year (δ_t) to account for, respectively, unobserved time-invariant confounders that vary across countries and temporal trends in the outcome shared across countries. In the second model, we additionally adjusted for individual- and household-level characteristics, represented by the vector Z_{ijt}. In the third model, we further controlled for time-varying, country-level confounders measured one year before birth (t – 1), represented by the vector C_{jt-1}.

All models incorporated robust standard errors to account for clustering at the country-level and respondent-level sampling weights to account for individual survey sampling designs. Per DHS guidelines, we applied the de-normalization of the standard weight approach described in the DHS Sampling and Household Listing Manual using information on the number of women aged 15 to 49 in each survey year from the Population Division of the United Nations.[83 84] Statistical analyses were performed using Stata software version 15 (Stata Corp, College Station, TX).

3.3.5 Sensitivity analyses

To examine the robustness of the main estimates, sensitivity analyses testing for lead effects using exposures at different times were performed. Specifically, the length of paid maternity leave in weeks or in FTE weeks during the birth year (t),

and one, two, and three years after birth (t + 1, t + 2, t + 3), was used to test whether policy effects could be detected before the actual year of implementation, which would be inconsistent with the inference that paid maternity leave has a causal effect on the diarrhea outcome.

3.4 Results

3.4.1 Descriptive statistics

In the pre-intervention period prior to reforms occurring in any of the treated countries, the average weighted proportion of children under five with bloody diarrhea in the past two weeks at the time of interview was 1.60% (SD = 0.004) in countries that had changed their policy compared with 1.34% (SD = 0.001) in countries that had not.

On average, each household had seven listed members and two children under five years of age. Over 65% of households in the sampled countries had improved drinking water sources, and 64% were located in rural areas. The mean age of mothers in the sample was 27 years, with three living children on average (Table 3.2).

Between 1995 and 2013, the average weeks and FTE weeks of paid maternity leave among the 33 countries that did not change the duration of leave available were 12.8 and 12.2, respectively (Figure 3.1). Among the seven countries (i.e., Bangladesh, Kenya, Lesotho, Malawi, Uganda, Zambia, and Zimbabwe) that changed the duration of leave available, paid maternity leave increased on average

from 7.1 weeks in 1995 to 13.1 weeks in 2013 (Figure 2.2). Eight countries (i.e., Bangladesh, Ghana, Kenya, Lesotho, Malawi, Uganda, Zambia, and Zimbabwe) were included in the treated group for the analysis of paid maternity leave in FTE weeks (Figure 2.3). Ghana did not increase the length of paid maternity leave but raised the wage replacement rate from 50% to 100% in 2004, thereby doubling FTE weeks of paid maternity leave from 6 to 12 in 2004. Zimbabwe raised the wage replacement rate from 75% to 100% in 2003 and increased the length of paid maternity leave from 12.9 weeks to 14 weeks in 2006, leading to increases in FTE weeks of paid maternity leave in 2003 and 2006.

3.4.2 Examination of parallel trends assumption

In the pre-intervention period (i.e., before 2000), trends in the natural logarithm of the proportion of children with bloody diarrhea among treated and control countries were approximately parallel (Figure 3.2). *P*-values for the interaction terms of treatment status and birth year between 1996 and 2001 ranged from 0.14 to 0.81. Overall, we did not find evidence supporting different pre-intervention trends on the multiplicative scale in the proportions of children with bloody diarrhea between the treated and control groups.

3.4.3 Effect of weeks of paid maternity leave

Table 3.3 shows the effect of a one-month increase in the length of paid maternity leave on the risk of bloody diarrhea in the past two weeks for children under five. The fully adjusted model (Model 3) estimated that a one-month increase in paid

maternity leave policy was associated with a 35% (RR 0.65, 95% CI 0.50 to 0.86) reduction in the risk of bloody diarrhea for children under five.

3.4.4 Effect of FTE week of paid maternity leave

Paid maternity leave in FTE weeks showed similar effects on the risk of childhood diarrhea (Table 3.4). In the fully adjusted model (Model 3), a one-month increase in legislated paid maternity leave in FTE unit was associated with a 36% (RR 0.64, 95% CI 0.48 to 0.84) reduction in the risk of bloody diarrhea for children under five.

3.4.5 Sensitivity analyses

As expected, the results of analyses using a policy that changed one-year, two-years, or three-years after birth did not provide evidence of an association between paid maternity leave and our outcome (Table 3.5). Extended duration of paid maternity leave was associated with lower incidence of bloody diarrhea when the policy was measured in the same year as the child's birth year (Table 3.5). Overall, the results of these sensitivity analyses support temporal association between changes in paid maternity leave policy and our outcome, and the robustness of our main estimates.

3.5 Discussion

This quasi-experimental study offers new evidence on how public polices such as paid maternity leave could contribute to reducing childhood diarrhea in LMICs. By merging longitudinal data on the legislated duration of paid maternity leave

between 1995 and 2013 to a multilevel panel of 936,127 children included in the DHS in 40 LMICs, we found that a one-month increase in the legislated duration of paid maternity leave was associated with a 35% (RR 0.65, 95% CI 0.50 to 0.86) reduction in the risk of bloody diarrhea for children under five in LMICs. Given an estimated global burden of 34.6 million severe diarrhea episodes, primarily concentrated among children under five years in Africa and Southeast Asia, this relative reduction could have a substantial public health impact.

Several limitations of this study should be noted. First, the parallel trends assumption is difficult to check visually in the generalized fixed-effects difference-in-differences design, with multiple countries with policy changes at multiple time points.[102] We lacked longitudinal measurements on our outcome for all sampled countries, as some countries had only one DHS available before policy reform. However, the observations of similar aggregated trends in the incidence of diarrhea for treated and control countries in the pre-intervention period provided some evidence that the assumption was not violated. Second, having specified a comprehensive set of covariates at the child-, household-, and country-level may not rule out the possibility of residual confounding. Factors that influence childhood diarrhea – for example, social attitudes toward breastfeeding practices or hygiene practices, or interventions promoting preventive care – may represent uncontrolled confounders if they change coincidently with reforms to paid maternity leave policies. Third, we did not account for population-level changes to other public policies that may coincide with changes in paid maternity leave. For instance, reforms to policies legislating breastfeeding breaks at work, which may have

affected breastfeeding practices, or reforms to healthcare policy, which may have affected access to preventive interventions, could also affect childhood diarrhea incidence. Fourth, information related to our outcome variable (e.g., whether there was blood in the stools of children who had diarrhea in the past two weeks) was collected based on maternal recall. However, recall bias is less of a concern because mothers were recalling a significant event that had happened in the past two weeks. Fifth, while we did not account for other types of leave (e.g., parental leave) that might be available to mothers or distinguish whether paid maternity leave can be taken before and after birth, misclassification of exposure is unlikely because the majority of paid maternity leave is taken subsequent to birth in LMICs, and paid parental leave is relatively short (e.g., less than four weeks) among the sampled countries. Sixth, the diarrhea information was only collected on children who were alive at the time of the interview, and therefore the possibility of survivor bias may not be ruled out if diarrhea-related mortality is also prevented by paid maternity leave policy. Seventh, due to the lack of information on policy compliance and implementation, the intent-to-treat estimate obtained in our study may be downwardly biased. Furthermore, ILO reported that 92% of employed women in low-income countries and 85% of employed women in lower-middle countries were in informal employment by 2016.[103] Women in informal economy who are the most vulnerable with the poorest health outcomes may not be protected by paid maternity leave, depending on the structure of the social policy. As a result, an average population effect may underestimate the true effect of paid maternity leave. Finally, the generalization of our results may be limited to countries with similar socio-demographic profiles to the 40 sampled countries.

Previous work has found that longer paid maternity leave policy lowers infant mortality in LMICs.[28] Since diarrhea is the fourth-leading cause of death and second-leading infectious cause of death in children under five years of age, our findings suggest a possible instrument for reducing mortality. From a policy planning perspective, further studies are needed to examine the impact of paid maternity leave on other aspects of child health to develop a comprehensive early life-policy framework that ensures the maximum health benefits for children in LMIC.

3.6 Tables and figures

Table 3.1. Study sample description

Country	DHS survey years	Birth Years available (Min, Max)	Sample Size	Average percentage of children with bloody diarrhea in the past two weeks [e]
Bangladesh	2004, 2007, 2011, 2014	1999, 2014	26,944	0.39%
Kenya	2003, 2008, 2014	1998, 2014	29,856	1.36%
Lesotho	2004, 2009, 2014	1999, 2014	9,062	1.08%
Malawi	2000, 2004, 2010	1996, 2010	33,682	0.87%
Uganda	2000, 2006, 2011	1996, 2011	19,210	3.27%
Zambia	2001, 2007, 2013	1996, 2014	22,788	1.28%
Zimbabwe	2005, 2010, 2015	2000, 2014	13,811	1.15%
All Treated Countries [a]			155,353	1.60% (SD = 0.004)
Armenia	2000, 2005, 2010	1996, 2010	4,090	0.19%
Benin	2001, 2006, 2011	1996, 2012	29,584	0.48%
Bolivia	2003, 2008	1998, 2008	15,565	2.37%
Burkina Faso	2003, 2010	1998, 2010	20,823	0.83%
Cameroon	2004, 2011	1999, 2011	16,074	1.92%
Chad	2004, 2014	1999, 2014	19,633	2.42%
Colombia	2000, 2005, 2010	1996, 2010	32,371	1.00%
Congo	2005, 2011	2000, 2012	12,277	0.99%
Democratic Republic of Congo	2007, 2013	2002, 2014	23,482	1.18%
Dominican Republic	2002, 2007, 2013	1997, 2013	23,200	0.89%
Egypt	2000, 2005, 2008, 2014	1996, 2014	45,632	0.34%
Ethiopia	2000, 2005, 2011	1996, 2011	24,633	1.21%
Gabon	2000, 2012	1996, 2012	9,089	1.31%
Ghana [d]	2003, 2008, 2014	1998, 2014	11,168	1.45%
Guinea	2005, 2012	2000, 2012	10,951	1.37%
Haiti	2000, 2005, 2012	1996, 2012	15,771	2.17%
Honduras	2005, 2011	2000, 2012	20,876	1.00%
Indonesia	2002, 2007, 2012	1997, 2012	44,299	0.04%
Jordan	2002, 2007, 2012	1997, 2012	25,324	0.50%
Liberia	2007, 2013	2002, 2013	11,716	4.07%
Madagascar	2003, 2008	1998, 2009	16,013	0.38%

Mali	2001, 2006, 2012	1996, 2013	28,853	0.57%
Mozambique	2003, 2011	1998, 2011	17,856	0.70%
Namibia [c]	2000, 2006, 2013	1996, 2013	11,704	1.30%
Nepal	2001, 2006, 2011	1996, 2012	15,530	1.29%
Niger	2006, 2012	2001, 2012	17,716	1.45%
Nigeria	2003, 2008, 2013	1998, 2013	57,047	1.17%
Peru	2000, 2004, 2007, 2009, 2010, 2011, 2012	1996, 2012	79,881	1.01%
Philippines	2003, 2008, 2013	1998, 2013	19,334	0.34%
Rwanda	2000, 2005, 2010, 2014	1996, 2014	27,517	0.92%
Senegal	2005, 2010, 2012, 2014, 2015	2000, 2014	37,237	1.27%
Sierra Leone	2008, 2013	2003, 2013	15,036	2.61%
Tanzania	2004, 2010, 2015	1999, 2014	20,492	0.62%
All Control Countries [b]			780,774	1.34% (SD = 0.001)

[a] treated countries are countries that experienced a change in the duration of paid maternity leave between 1995 and 2013

[b] control countries are countries that did not experience a change in the duration of paid maternity leave between 1995 and 2013

[c] Namibia was excluded in the analysis on FTE weeks of paid maternity leave

[d] Ghana was added to the 'treated' group in the analysis on FTE weeks of paid maternity leave

[e] average weighted by Demographic and Health Survey weight

Table 3.2. Demographics and characteristics of the independent variables in the study sample, 1996–2014, N = 936,127. Values are numbers (percentages) unless stated otherwise

		Missing data (%)
Household- and individual-level covariates		
Mean (SD) number of listed household members	6.84 (0.004)	0
Mean (SD) number of children under 5 years of age living in household	1.98 (0.001)	0
Household wealth		
poorest	240,758 (25.72)	0
poorer	206,302 (22.04)	0
middle	186,423 (19.91)	0
richer	163,451 (17.46)	0
richest	139,193 (14.87)	0
Drinking-water source		
improved source	576,943 (61.63)	4.13
Place of residence		
Rural	603,331 (64.45)	0
Mean (SD) mother's education, years	5.26 (0.005)	0.04
Mean (SD) mother's age at childbirth, years	26.89 (0.007)	0
Mean (SD) mother's number of living children	3.31 (0.002)	0
Child's sex		
Female	463,324 (49.49)	0
Mean (SD) child's age at interview, years	1.97 (0.001)	0
Mean (SD) child's birth order	3.36 (0.002)	0
Country-level covariates		
Mean (SD) GDP per capita, PPP (constant 2011 international $)	3918.96 (3.330)	0.10
Mean (SD) health expenditure, total (% of GDP)	10.30 (0.008)	0
Mean (SD) health expenditure per capita (constant 2011 international $)	41.41 (0.020)	0
Mean (SD) labor force participation rate, female (% of female population ages 15+)	57.30 (0.019)	0
Mean (SD) unemployment female (% of female labor force)	9.17 (0.008)	0

Table 3.3. Effect of a 1-month increase in legislated length of paid maternity leave on the risks of bloody diarrhea for children under five

	Model 1 (n = 936,116) Risk Ratio (95% CI)	Model 2 (n = 897,067) Risk Ratio (95% CI)	Model 3 (n = 896,127) Risk Ratio (95% CI)
Exposure			
1-month increase in legislated length of paid maternity leave policy	0.67 (0.51, 0.87)	0.70 (0.53, 0.93)	0.65 (0.50, 0.86)
Household- and individual-level covariates			
Number of listed household members		1.02 (1.01, 1.03)	1.02 (1.01, 1.03)
Number of children under 5 years of age living in household		0.97 (0.95, 1.00)	0.97 (0.94, 1.00)
Household wealth			
poorest		Ref	Ref
poorer		0.86 (0.78, 0.94)	0.86 (0.78, 0.94)
middle		0.77 (0.69, 0.85)	0.77 (0.69, 0.85)
richer		0.70 (0.60, 0.80)	0.70 (0.60, 0.80)
richest		0.55 (0.46, 0.67)	0.55 (0.46, 0.67)
Drinking-water source			
unimproved source		Ref	Ref
improved source		0.93 (0.88, 0.99)	0.93 (0.88, 0.99)
Place of residence			
urban		Ref	Ref
rural		1.03 (0.92, 1.15)	1.03 (0.92, 1.15)
Mother's education (years)		0.96 (0.95, 0.97)	0.96 (0.95, 0.97)
Mother's age at childbirth (years)		0.98 (0.97, 0.99)	0.98 (0.97, 0.99)
Mother's number of living children		0.89 (0.85, 0.94)	0.89 (0.85, 0.94)
Child's sex			
Male		Ref	Ref
Female		0.93 (0.89, 0.98)	0.93 (0.89, 0.98)
Child's age at interview (years)		0.98 (0.94, 1.03)	0.99 (0.95, 1.03)
Child's birth order		1.16 (1.11, 1.21)	1.16 (1.11, 1.21)
Country-level covariates			
GDP per capita, PPP (constant 2011 international $)			1.00 (1.00, 1.00)
Health expenditure, total (% of GDP)			0.98 (0.93, 1.03)
Health expenditure per capita (constant 2011 international $)			0.89 (0.79, 1.01)
Female labor force participation rate (% of female population 15+)			0.98 (0.89, 1.09)
Unemployment female (% of female labor force)			0.97 (0.89, 1.05)

95% confidence intervals are in parentheses

Model 1 includes country and year fixed effects
Model 2 additionally controlled for measured individual and household characteristics
Model 3 additionally controlled for country-level characteristics

Table 3.4. Effect of a 1-month increase in FTE length of paid maternity leave policy on the risks of bloody diarrhea for children under five

	Model 1 (n = 924,412) Risk Ratio (95% CI)	Model 2 (n = 885,811) Risk Ratio (95% CI)	Model 3 (n = 884,871) Risk Ratio (95% CI)
Exposure			
1-month increase in FTE length of paid maternity leave policy	0.65 (0.49, 0.86)	0.68 (0.51, 0.92)	0.64 (0.48, 0.84)
Household- and individual-level covariates			
Number of listed household members		1.02 (1.01, 1.03)	1.02 (1.01, 1.03)
Number of children under 5 years of age living in household		0.97 (0.94, 1.00)	0.97 (0.94, 1.00)
Household wealth			
poorest		Ref	Ref
poorer		0.85 (0.78, 0.94)	0.86 (0.78, 0.94)
middle		0.77 (0.69, 0.85)	0.77 (0.69, 0.85)
richer		0.70 (0.60, 0.80)	0.70 (0.60, 0.80)
richest		0.55 (0.46, 0.67)	0.55 (0.46, 0.67)
Drinking-water source			
unimproved source		Ref	Ref
improved source		0.94 (0.89, 0.99)	0.93 (0.88, 0.99)
Place of residence			
urban		Ref	Ref
rural		1.03 (0.92, 1.16)	1.03 (0.92, 1.16)
Mother's education (years)		0.96 (0.95, 0.97)	0.96 (0.95, 0.97)
Mother's age at childbirth (years)		0.98 (0.97, 0.99)	0.98 (0.97, 0.99)
Mother's number of living children		0.90 (0.85, 0.94)	0.90 (0.85, 0.94)
Child's sex			
Male		Ref	Ref
Female		0.93 (0.88, 0.98)	0.93 (0.89, 0.98)
Child's age at interview (years)		0.98 (0.94, 1.03)	0.99 (0.95, 1.03)
Child's birth order		1.16 (1.11, 1.21)	1.16 (1.11, 1.21)
Country-level covariates			
GDP per capita, PPP (constant 2011 international $)			1.00 (1.00, 1.00)
Health expenditure, total (% of GDP)			0.98 (0.92, 1.05)
Health expenditure per capita (constant 2011 international $)			0.89 (0.79, 1.00)
Female labor force participation rate (% of female population 15+)			0.98 (0.89, 1.09)
Unemployment female (% of female labor force)			0.96 (0.88, 1.05)

95% confidence intervals are in parentheses

Model 1 includes country and year fixed effects
Model 2 additionally controlled for measured individual and household characteristics
Model 3 additionally controlled for country-level characteristics

Table 3.5. Sensitivity analyses of the effect of a 1-month increase in length of paid maternity leave policy on bloody diarrhea for children under five years of age

	Risk Ratios	95% LCL	95% UCL
1-month increase in legislated length of paid maternity leave			
Lagged one year, t-1	**0.65**	**0.50**	**0.86**
Concurrent, t	0.57	0.40	0.80
Lead one year, t+1	0.71	0.43	1.17
Lead two years, t+2	0.79	0.46	1.35
Lead three years, t+3	1.15	0.49	2.71
1-month increase in FTE length of paid maternity leave			
Lagged one year, t-1	**0.64**	**0.48**	**0.84**
Concurrent, t	0.56	0.40	0.79
Lead one year, t+1	0.70	0.42	1.16
Lead two years, t+2	0.77	0.45	1.30
Lead three years, t+3	1.08	0.49	2.41

Models includes country and year fixed effects and additionally controlled for country-level characteristics

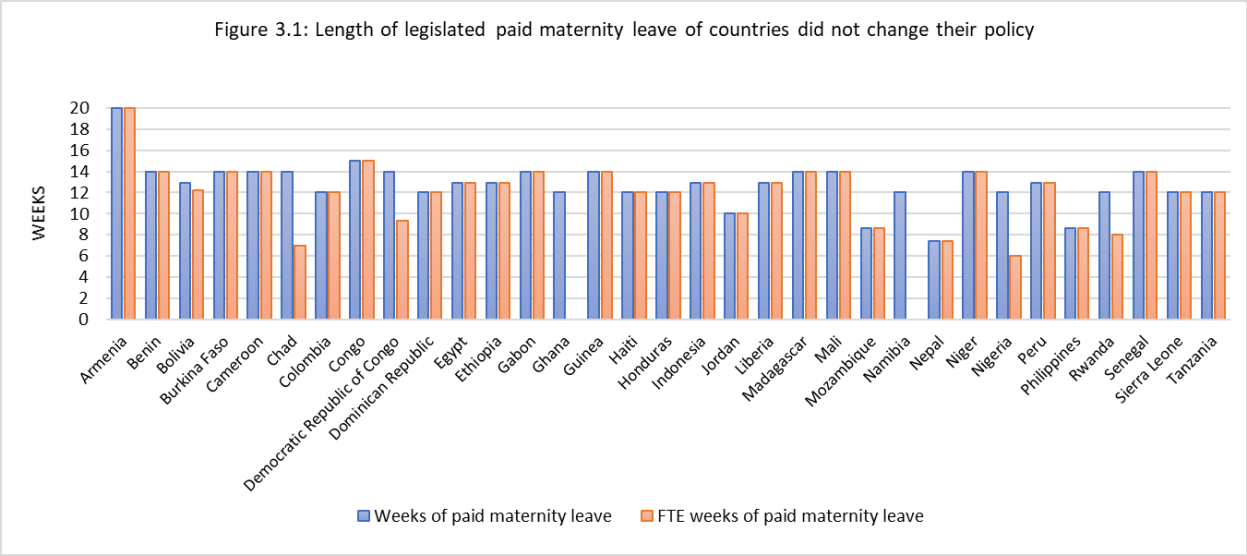

Figure 3.1. Length of legislated paid maternity leave of countries did not change their policy.

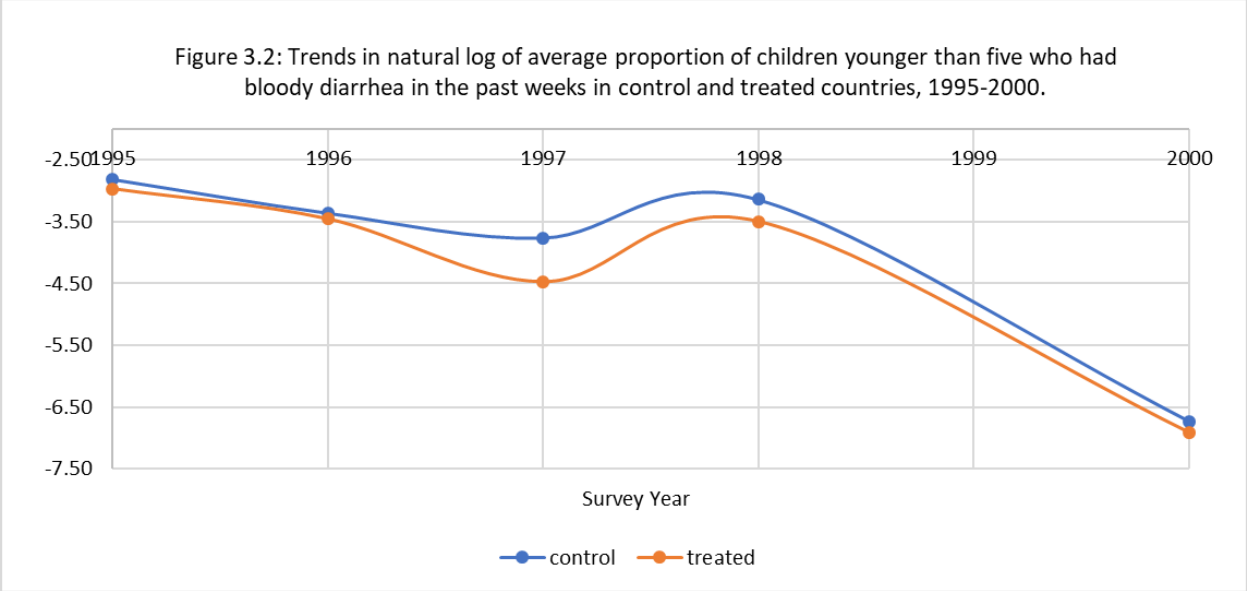

Figure 3.2. Trends in natural log of average proportion of children younger than five who had bloody diarrhea in the past weeks in control and treated countries, 1995-2000

Chapter 4. Is the impact of paid maternity leave policy on the incidence of childhood diarrhea mediated by breastfeeding duration? Quasi-experimental evidence from 40 low- and middle-income countries

4.1 Abstract

Introduction

Diarrhea is a leading cause of morbidity and mortality among children under five years of age in low- and middle-income countries (LMICs). Quasi-experimental evidence suggests that extending the duration of legislated paid maternity leave is associated with lower incidence of childhood diarrhea in LMICs. This study examines whether this effect is mediated by changes in breastfeeding duration.

Methods

We merged longitudinal data on national maternity leave policies with information on childhood diarrhea related to 1,073,751 live births between 1996 and 2014 in 40 LMICs that participated in the Demographic and Health Surveys (DHS) at least twice between 2000 and 2015. We used a difference-in-differences approach to estimate the total effect of a one-month increase in paid maternity leave on the incidence of bloody diarrhea. We then ran a series of models including the duration of breastfeeding to estimate the controlled direct effect of increasing the duration of paid maternity leave on the incidence of diarrhea through other pathways, as well as the proportion of the total effect eliminated by controlling for breastfeeding duration. All effects were estimated on the risk ratio scale from log-binomial regression models that included country and year fixed effects. All models incorporated robust standard errors and respondent-level sampling weights.

Results

The average weighted proportion of children under five with bloody diarrhea in the previous two weeks was 1.58% (SD = 0.4) in countries that had changed their policies and 1.17% (SD = 0.1) in countries that had not. A one-month increase in the legislated duration of paid maternity leave was associated with a 39% (RR 0.61, 95% CI 0.44–0.84) reduction in the risk of bloody diarrhea. Breastfeeding for at least six months and 12 months mediated 14% and 17% of this effect, respectively.

Conclusion

Extending the duration of paid maternity leave appears to lower diarrhea incidence in children under five years of age in LMICs. This effect is slightly mediated by changes in breastfeeding duration. Further research is required to explore additional and more complex causal pathways.

4.2 Introduction

4.2.1 Background

Globally, diarrhea is responsible for the unnecessary loss of 0.5 million young lives each year and is a threat to sustainable development for the poorest nations.[104] Diarrhea ranks the fourth-leading cause of death and second-leading infectious cause of death in children under five years of age.[3 89] Diarrhea mortality is disproportionately concentrated in low-resource settings. Low-income and lower-middle-income countries have 62% of the world's under-five population, but account for more than 90% of the global diarrhea deaths.[104]

There are proven interventions that can go a long way toward reducing diarrhea incidence and mortality.[91-96 98 105] Childhood diarrhea can be effectively prevented by exclusive breastfeeding for the first six months of life,[37] continued breastfeeding,[37 93] vitamin A supplementation,[106] immunization,[107 108] safe drinking water, sanitation and hygiene.[10 109 110] However, due to the lack of policy data on a sufficiently large number of nations to allow comparative analyses, the evidence for informing specific national policy strategies to lower childhood diarrhea morbidity and mortality remains limited.[11 91 99]

There is growing interest in supporting evidence-based policy-making by estimating the impact of public policies on population health, with increasing experimental and quasi-experimental evidence; however, the mediating pathways linking policies to population health outcomes are rarely examined. Understanding the causal mechanisms through which policy reforms impact population health outcomes not only supports the plausibility of the association but may also facilitate theory building and inform the choice of alternative or complementary interventions. Causal mechanisms can be identified by specifying mediators on the causal pathway between policy and outcomes.[111] One approach involves the application of causal mediation analysis, which has been employed to test pathways within the evaluation of health interventions.[112 113]

There is a growing body of evidence evaluating the impact of paid maternity leave in LMICs. Paid maternity leave, defined as the “leave that the country guarantees employed women in connection with the birth of a child,”[12] enables women to take

time off from work following childbirth while maintaining a partial income. In 2015, 185 out of 193 United Nations (UN) member states had a national maternity leave policy in place, but only 57% (n=105 countries) met the 14-week minimum standard[85] set by the International Labour Organization (ILO) in convention C183. The empirical evidence shows that increasing the generosity of paid maternity leave policies is associated with lower infant mortality,[28] improved breastfeeding practices,[36] and increased vaccination uptake in LMICs.[29] A recent study showed a 35% (RR 0.65, 95% CI 0.50–0.86) reduction in the risk of severe childhood diarrhea for each month increase in the legislated duration of paid maternity leave in LMICs. However, existing studies have not explored the pathways through which paid maternity leave might affect child health. In this study we build on the existing literature by applying causal mediation methods to examine the pathways linking increases in the duration of paid maternity leave to decreases in childhood diarrhea incidence.

4.2.2 Conceptual framework

We hypothesize that longer paid maternity leave policies have the potential to lower the incidence of childhood diarrhea in LMICs through several possible mechanisms (Fig. 1). First, paid maternity leave may affect the caregiving environment for newborns and infants. Mothers with access to paid maternity leave may be able to dedicate more time to the care of their children in the first few weeks of their lives, which might protect children from early infection in group care settings, such as daycare,[31-34] or at workplaces, in contexts where daycare facilities are lacking. Second, access to paid maternity leave may facilitate preventive care. Mothers who

can take leave from work are more likely to initiate and continue breastfeeding[35 36] and to have their children vaccinated on time,[29] both of which boost immunity and protect children from infection. Third, access to paid maternity leave may facilitate access to postnatal health services, which could prevent infection and progression to more severe disease.

A systematic review in 2013 showed consistent inverse associations between breastfeeding intensity and diarrhea outcomes in children.[114] Fifteen studies that provided 18 estimates on the effect of breastfeeding on diarrhea incidence among children younger than five yielded a pooled relative risk of 0.69 (95% CI 0.58–0.82) comparing more intense breastfeeding practices to less intense breastfeeding. Among infants younger than six months, 49 estimates from 23 studies provided a pooled relative risk of 0.37 (95% CI 0.27–0.50). From the 11 studies that evaluated children aged 6–59 months, more intense breastfeeding practices were associated with a pooled relative risk of diarrhea incidence of 0.46 (95% CI 0.28–0.78).

For the assessment of the short-term consequences of breastfeeding, the comparison between ever-breastfed subjects and those never breastfed would tend to underestimate any association because there is usually a cumulative effect of breastfeeding, rather than a critical-window effect.[114] In this study, we estimated whether the protective effect of increasing the duration of paid maternity leave on childhood diarrhea was mediated by the duration of breastfeeding (part of red path in Figure 4.1). First, we exploited legislated increases in the duration of paid

maternity leave in LMICs to estimate impacts on the incidence of childhood diarrhea using a difference-in-differences design. Second, we applied causal mediation methods to estimate the extent to which breastfeeding duration explained this total effect.

4.3 Methods

4.3.1 Data sources

Longitudinal data on national maternity leave policies for each UN member state were made available by the University of California Los Angeles' WORLD Policy Analysis Center and collected retroactively to 1995 by McGill University's Policy-Relevant Observational Studies for Population health Equity and Responsible Development (PROSPERED) project.[75] Further details on the collection and coding of global maternity leave policies are available elsewhere.[12]

Demographic and Health Surveys (DHS) were used to obtain individual-level information on childhood diarrhea, breastfeeding duration, and other covariates for children under five years of age. DHS is conducted approximately every five years in many LMICs, using a nationally representative two-stage cluster sampling design, with the first stage selecting clusters and the second selecting households. In each household, trained interviewers and structured questionnaires were used to obtain socioeconomic, demographic, and health information from women aged 15 to 49 and anthropometric information for children younger than five. Standardized measurement techniques were used to ensure the comparability of surveys across

countries and survey waves. Further details regarding the sampling and survey techniques are available elsewhere.[76 77]

4.3.2 Sample

For the analysis, we linked the national maternity leave policies between 1995 and 2013 (inclusive) to information on 1,073,751 children from 40 LMICs who were under five years of age at the time of interview. The seven treated countries (i) experienced at least one change in the duration of paid maternity leave policy between 1995 and 2013 and (ii) had at least one survey before and after the policy change. We also included 33 control countries with data available from at least two DHS between 2000 and 2015 (inclusive). These inclusion criteria allowed us to compare changes in the duration of breastfeeding and the incidence of diarrhea over time for treated and control countries that did or did not reform their paid maternity leave policies, respectively. Our sample included two countries in East Asia, two in South Asia, one in Central Asia, two in the Middle East, six in Latin America, and 27 in sub-Saharan Africa.

A one-year lag was used to respect the temporality between policy year and children's birth year, leaving 1,064,906 children born between 1996 and 2014 (inclusive) in the sample. After further excluding observations with missing outcome data and missing and/or inconsistent breastfeeding data flagged by DHS, our final sample included 696,343 children from 115 DHS in 40 LMICs (Table 4.1).

4.3.3 Measures

4.3.3.1 Exposure

The exposure of interest in our study was the legislated length of paid maternity leave for each sampled country between 1995 and 2013 (inclusive). We recorded the legislated length of paid leave available to mothers only. To ensure temporality between exposure and outcome, and to reduce exposure misclassification, each observation was assigned the legislated length of paid maternity leave one year prior to the birth year. We did not distinguish between leave that could be taken before or after birth.

4.3.3.2 Outcome

Our primary outcome variable was whether the child had bloody stools in the two weeks prior to the interview. This measure was used as an indicator of severe diarrhea because the frequency of loose stools in breastfed infants can be difficult to distinguish from pathologic diarrhea based on survey data. Information on bloody diarrhea (clearly pathologic) was extracted from at least two DHS for each sampled country. Briefly, mothers surveyed in the DHS were asked to provide information on the incidence of diarrhea for all children in the household under the age of five. If a child had diarrhea in the previous two weeks, the presence of blood in the stools was also recorded.

4.3.3.3 Mediators

Our two mediators were whether the child was breastfed for at least six months or at least 12 months after birth. At the time of interview, mothers provided

breastfeeding information for all children in the household under the age of five. If a child was ever breastfed after birth, the interviewer recorded the number of months of breastfeeding. If the child was still being breastfed at the time of interview, the interval between the child's date of birth and date of interview was used as the breastfeeding duration.

4.3.3.4 Covariates

Based on several empirical studies on diarrhea in children,[3 7 78 91 115 116] we identified potential confounders and other household, maternal, and child-level determinants of childhood diarrhea and breastfeeding duration in LMICs. Covariates at the household level included the number of listed household members, number of children under five years of age living in the household, place of residence (e.g., urban or rural), and an indicator for drinking water source (unimproved or improved), based on the new scale for household drinking water used by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF).[100] We also included the DHS household wealth index, which was created and used as a standard by the DHS and UNICEF Multiple Indicator Cluster Surveys (MICS) to capture the within-country relative wealth standing of each household. At the maternal and child levels, covariates included mother's education in years, mother's age at delivery, mother's number of living children, child's sex, child's age at interview, and child's birth order. Information on all variables was obtained from the DHS.

In addition, we included country-level indicators from the World Bank's World Development Indicators and Global Development Finance databases that may be associated with paid maternity leave policy reforms and also affect breastfeeding duration or childhood diarrhea incidence.[101] These variables included the gross domestic product (GDP) per capita (constant 2011 international dollar) based on purchasing power parity (PPP), female labor force participation rate (percentage of female population ages 15–64), percentage of unemployed female labor force, government health expenditures per capita based on PPP (constant 2011 international dollar), and total health expenditure (percentage of GDP).

4.3.4 Statistical analysis

Our inferential goal was to estimate the controlled direct effect (CDE) of increasing the duration of paid maternity leave on the risk of childhood diarrhea had we intervened to fix the duration of breastfeeding in treated and control countries. Identification of the CDE assumes no unmeasured confounding of (1) the total effect of paid maternity leave on the risk of diarrhea and (2) the relation between the mediator, breastfeeding duration, and the risk of diarrhea.[112 113]

4.3.4.1 Difference-in-differences and examination of parallel trends

We used the difference-in-difference[117] approach to address potential confounding of the exposure-outcome and mediator-outcome effects by time-fixed characteristics that vary across treated and control countries and shared temporal trends in breastfeeding duration and the risk of diarrhea. Unbiased estimation of the average treatment effect on the treated (ATT) using the difference-in-differences approach requires the "parallel trends" assumption. In our case, the

assumption would hold if the change in average the breastfeeding duration and average proportion of children under five with bloody diarrhea in control countries that did not change their maternity leave policy during the study period was equivalent to the change in the treated countries that did, had they increased their maternity leave policy. Although this assumption cannot be verified empirically, it is more tenable if pre-treatment trends are parallel. Accordingly, we examined pre-treatment trends on the multiplicative scale by plotting the natural logarithm of the average weighted proportion of children under five with bloody diarrhea and the natural logarithm of the average weighted proportion of children being breastfed for at least six months or 12 months for all treated countries against all control countries for each survey year before 2000, the first year that a treated country experienced a change in the legislated duration of paid leave in our study period.

4.3.4.2 Mediation analysis

We examined the mediating role of breastfeeding duration using a three-step process.

Step 1: Estimate the total effect of paid maternity leave on bloody diarrhea

First, we estimated the total effect of a one-month increase in paid maternity leave policy on the incidence of bloody diarrhea on the risk ratio scale using the following log-binomial regression model:

$$log\ Pr(Y_{ict} = 1) = \alpha_0 + \alpha_1 A_{ct-1} + \sum \alpha_n Z_{ict} + \sum \alpha_k C_{ct-1} + \lambda_c + \delta_t + \varepsilon_{ict}$$

where Y_{ict} represents the outcome (i.e., whether the child had bloody stool in the previous two weeks) for child *i* born in country *c* in year *t*, and A_{ct-1} is the calculated months of paid maternity leave in country *c* one year before the child's

birth (t – 1). Vector Z_{ict} represents individual- and household-level characteristics, while vector C_{ct-1} represents time-varying, country-level confounders measured one year before birth (t – 1). We also included fixed effects for country (λ_c) and year (δ_t) to account for, respectively, unobserved time-invariant confounders that vary across countries and temporal trends in the outcome shared across countries.

In this model, α_1 estimates the effect of a one-month increase in the duration of paid maternity leave on the incidence of bloody diarrhea.

Step 2: Estimate the CDE of paid maternity leave on diarrhea when breastfeeding duration is fixed

Second, we ran two separate log-binomial regression models with different breastfeeding durations as mediators:

$$log\ Pr(Y_{ict} = 1) = \beta_0 + \beta_1 A_{ct-1} + \beta_2 M_{ict} + \beta_3 A_{ct-1} M_{ict} + \sum \beta_n Z_{ict} + \sum \beta_k C_{ct-1} + \lambda_c + \delta_t + \varepsilon_{ict}$$

where M_{ict} represents the mediator (i.e., being breastfed for at least six months or at least 12 months) for child *i* born in country *c* in year *t*, and $A_{ct-1} M_{ict}$ allows for interactions between exposure and mediator.[118]

In this model, the controlled direct effect, representing the effect of a one-month increase in the duration of paid maternity leave on the incidence of bloody diarrhea not mediated by breastfeeding duration, was estimated by $\beta_1 + \beta_3 m$. 95% confidence intervals were calculated by bootstrapping with 100 repetitions.

All models in steps 1 and 2 incorporated robust standard errors to account for clustering at the country-level and respondent-level sampling weights to account for individual survey sampling designs. Per DHS guidelines, we applied the de-normalization of the standard weight approach described in the DHS Sampling and Household Listing Manual using information on the number of women aged 15–49 in each survey year from the Population Division of the United Nations.[83 84] Statistical analyses were performed using Stata software version 15 (Stata Corp, College Station, TX).

Step 3: Calculate proportion eliminated

The 'proportion eliminated' measures what proportion of the total effect of the exposure on the outcome would be eliminated had we intervened to set the mediator to a fixed value, M=m, for the population.[119] We calculated the proportion eliminated on the excess risk ratio scale after taking the inverse of the reported risk ratios for the total and controlled direct effects, which were protective (RR<1):

$$PE(m) = \frac{RR^{TE} - RR^{CDE}(m)}{RR^{TE} - 1}$$

4.4 Results

4.4.1 Descriptive statistics

In the study sample, breastfeeding information has the most missing values. Characteristics of observations with and without breastfeeding information are presented in Table 4.2. Observations without breastfeeding information were older, as breastfeeding information was based on maternal recall. The distributions of the

other covariates among observations without breastfeeding information were similar to that among the observations with breastfeeding information.

The weighted proportion of children under five with bloody diarrhea in the two weeks prior to the interview was 1.58% (SD = 0.4) in countries that had changed their policy, as compared with 1.17% (SD = 0.1) in countries that had not. On average, 86.36% (SD = 0.9) and 71.19% (SD = 1.9) of children under five were breastfed for at least six and at least 12 months, respectively, in treated countries, compared with 80.64% (SD = 1.5) and 61.37% (SD = 1.9) in control countries.

On average, each household had six listed members and two children under five years of age. More than 61% of households had improved drinking water sources, and 64% were located in rural areas. The mean age of mothers in the sample was 27 years, with less than four children on average. The mean age of sampled children was 2 years, and they were the third child in the family on average (Table 4.3).

Between 1995 and 2013, the average weeks of paid maternity leave among the 33 countries that did not change the duration of leave was 12.8 (Figure 4.2). Among the seven countries that changed the duration of leave available (i.e., Bangladesh, Kenya, Lesotho, Malawi, Uganda, Zambia, Zimbabwe), paid maternity leave increased on average from 7.1 weeks in 1995 to 13.1 weeks in 2013 (Figure 2.2).

4.4.2 Examination of the parallel trends assumption

In the pre-intervention period before 2000, trends in the natural logarithm of the proportions of children with bloody diarrhea, who were breastfed for at least six months, and who were breastfed for at least 12 months among treated and control countries were approximately parallel (Figures 4.3-4.5). Overall, we found no evidence that the parallel trends assumption was violated.

4.4.3 Mediation analysis

A one-month increase in the legislated duration of paid maternity leave was associated with a 39% (RR 0.61, 95% CI 0.44–0.84) reduction in the risk of bloody diarrhea (Table 4.4). The controlled direct effects are 0.65 (95% CI 0.60–0.70) and 0.66 (95% CI 0.61–0.70), when setting breastfeeding duration to at least six months and at least 12 months, respectively. Breastfeeding for at least six months and 12 months mediated 14% and 17% of this effect, respectively.

4.5 Discussion

Causal mediation analysis, considered as an approach to understand casual mechanisms, is becoming increasingly popular in many disciplines of the social and medical sciences, including epidemiology, psychology, and political science.[120] However, to date, there is limited empirical evidence of its application for the evaluation of health and social policy. Building on an existing study, we tested the causal pathways whereby paid maternity leave policy affected severe childhood diarrhea in LMICs. Our results show that breastfeeding for at least six months and at least 12 months mediated 14% and 17% of the effect of a one-month increase in

the legislated duration of paid maternity leave on childhood diarrhea in LMICs. This is the first study, to our knowledge, to examine the pathways through which paid maternity leave policy affects child health.

Previous study has shown that a one-month increase in the legislated duration of paid maternity leave is associated with a 2.2-month increase in breastfeeding duration.[36] In addition, the protective effect of breastfeeding against mortality and morbidity from childhood diarrhea has been widely studied.[114] A systematic review on the benefits of breastfeeding showed about half of all diarrhea episodes would be avoided by breastfeeding.[114] The protective effect of breastfeeding is attributable to the presence of substances unique to human milk that have anti-infective, anti-inflammatory, and immunoregulatory functions. Human milk oligosaccharides (HMO), unconjugated complex carbohydrates that are highly abundant in human milk, have been suggested to prevent the development of gastrointestinal infections by blocking the attachment of pathogens to the infant's mucosa.[121-126] Lactoferrin, one of the major multifunctional agents in human milk, appears to have a major role in blocking bacterial virulence by disruption of the integrity of the bacterial outer membrane.[127] Many different specific secretory antibodies, produced by mothers who have been exposed to such pathogens, are found in human milk and in varying quantities, protecting the infant from developing an infection.[5 127] In addition, children who die from diarrhea often suffer from underlying malnutrition, which makes them more vulnerable to diarrhea infection. Optimal breastfeeding practices can prevent undernutrition associated with repeated infections in low-income settings.[128] Furthermore, breast milk is a safe food source for infants.

Infants who receive only breast milk for the first six months have less exposure to pathogens than non-exclusively breastfed infants, as foods offered to infants are often contaminated with microbial pathogens that could lead to gastrointestinal infection. In our study, despite evidence of strong exposure-mediator and mediator-outcome associations, only a small proportion of the impact of paid maternity leave policy on childhood diarrhea is shown to be mediated through breastfeeding duration. This could be a result of later-life exposures mitigating the benefits of breastfeeding during childhood.

A large proportion of the impact of paid maternity leave policy on childhood diarrhea is not mediated through breastfeeding duration. These effects might be explained by several mechanisms. In many low-resource settings, parents who have to work to provide for the family's basic needs of food, clothing, and shelter, have no choice but to leave their preschool children home alone or in the care of their older siblings.[34] The older siblings, most of the times young children themselves, are not able to provide adequate care for children younger than five. In these situations, young children left home are more likely to become malnourished due to irregular feeding and have a higher risk of being exposed to pathogens in raw or rotten food.[34] In addition, lacking an adult at home lowers the chance of proper medical care when the child is sick. For example, oral rehydration therapy (ORT), a simply made rehydration solution consisting of water, sugar, and salt, can keep children from dehydration due to diarrhea. But the solution has to be administered by an adult who can give the child one sip at a time for hours. Not

taking proper medication increases the chances that children suffer repeated episodes of diarrheal disease and consequent malnutrition.[34]

Several limitations should be noted. First, the difference-in-difference approach relies on the assumption of parallel trends between intervention and comparison groups, in this case in relation to outcomes as well as potential mediators. This assumption is difficult to check visually in the generalized fixed-effects difference-in-differences design with a continuous treatment, as countries experienced policy changes at different time points.[102] We examined the parallel trends assumption but lacked longitudinal pre-intervention data on our outcome and mediators for all sampled countries, as some countries only had one DHS available in the pre-intervention time. However, the trends in the natural logarithm of the outcome and mediators for treated and control countries appeared parallel in the pre-intervention period before 2000, suggesting that the assumption was not violated. Second, although we specified a comprehensive set of covariates at the individual, household, and country levels, residual confounding by time-varying exposure-outcome and mediator-outcome factors is still possible, which may have biased the total and controlled direct effects. For example, Baby-Friendly Hospital Initiative (BFHI) may be an unmeasured mediator-outcome confounder. Women gave birth in a Baby-Friendly Hospital may have more guidance and support on practicing breastfeeding and having access to prenatal and postnatal care might also have affected the risk of diarrhea for newborns. Third, we did not account for changes to other health policies that may have coincided with changes in paid maternity leave policy. For example, reforms making healthcare coverage more universal, which

may have promoted access to preventive interventions, could also affect the risk of childhood diarrhea. Fourth, information related to our outcome, mediators, and a few covariates were collected based on maternal recall. Recall bias may be less of a concern for our outcome measure because mothers were asked to recall a significant event that had happened in the previous two weeks. Breastfeeding measurements in mothers with older children are more prone to recall bias, although this is likely non-differential by treatment status. Fifth, we did not account for other types of leave (e.g., parental leave) that might be available to mothers, but misclassification of our exposure is unlikely because paid parental leave is relatively short (e.g., less than 4 weeks) among the sampled countries. Sixth, the possibility of survivor bias may not be completely ruled out because information on outcome, mediators, and several covariates was only collected on children who were alive at the time of the interview. Seventh, due to the lack of information on policy compliance and implementation, the intent-to-treat estimate obtained in our study may be downwardly biased. Furthermore, ILO reported that 92% of employed women in low-income countries and 85% of employed women in lower- to middle-income countries were informally employed in 2016.[103] An average population effect, as we estimated in this study, is likely to underestimate the true policy effect since women in an informal economy may not be protected by paid maternity leave policy. Finally, generalization of our results may be limited to countries with socio-demographic profiles similar to those of the 40 sampled countries.

In conclusion, few quasi-experimental evaluations have applied causal mediation methods to examine the pathways linking public policies to population health. Demonstrating the use of causal mediation methods within difference-in-differences analysis, we illustrate that mediation analysis can be useful for examining how the policy might impacts health outcomes by changing intervening behaviors. Additional research is needed to assess other pathways linking paid maternity leave policy to childhood diarrhea and other child health outcomes. Further studies should also examine population-level mediators related to behavior changes, rather than individual-level mediators. From a policy perspective, these studies could help develop effective early-life interventions to ensure positive health outcomes for mothers and infants in LMICs.

4.6 Tables and figures

Table 4.1. Sample description

Country	DHS survey years	Birth Years available (Min, Max)	Sample Size	Average percentage of children with bloody diarrhea in the past two weeks [c]	Average percentage of children were breastfed at least six months [c]	Average percentage of children were breastfed at least twelve months [c]
Bangladesh	2004, 2007, 2011, 2014	1999, 2014	22,361	0.37%	86.58%	73.28%
Kenya	2003, 2008, 2014	1998, 2014	19,084	1.51%	87.96%	69.33%
Lesotho	2004, 2009, 2014	1999, 2014	6,972	1.32%	79.37%	61.20%
Malawi	2000, 2004, 2010	1995, 2010	33,362	1.26%	87.95%	75.13%
Uganda	2000, 2006, 2011	1995, 2011	14,469	3.79%	84.47%	65.84%
Zambia	2001, 2007, 2013	1996, 2014	22,157	1.94%	88.62%	76.29%
Zimbabwe	2005, 2010, 2015	2000, 2015	7,853	1.58%	78.50%	57.37%
All Treated Countries [a]			126,258	1.58% (SD = 0.004)	86.36% (SD = 0.009)	71.19% (SD = 0.019)
Armenia	2000, 2005, 2010	1995, 2010	2,849	0.13%	56.71%	31.78%
Benin	2001, 2006, 2011	1996, 2012	20,672	0.28%	84.97%	68.35%
Bolivia	2003, 2008	1998, 2008	15,290	2.80%	84.97%	65.45%
Burkina Faso	2003, 2010	1998, 2010	13,093	0.93%	81.38%	65.05%
Cameroon	2004, 2011	1999, 2011	15,368	2.79%	86.50%	67.07%
Chad	2004, 2014	1999, 2015	9,367	2.10%	77.10%	56.29%
Colombia	2000, 2005, 2010	1995, 2010	29,582	1.54%	72.31%	46.16%
Congo	2005, 2011	2000, 2012	6,254	0.78%	77.21%	51.95%
Democratic Republic of Congo	2007, 2013	2002, 2014	13,038	1.58%	78.68%	59.43%
Dominican Republic	2002, 2007, 2013	1997, 2013	21,352	0.69%	53.69%	29.77%
Egypt	2000, 2005, 2008, 2014	1995, 2014	34,956	0.22%	82.92%	65.62%
Ethiopia	2000, 2005, 2011	1995, 2011	18,934	1.00%	83.83%	69.73%
Gabon	2000, 2012	1995, 2012	4,866	1.51%	74.41%	40.93%
Ghana	2003, 2008, 2014	1998, 2014	7,639	1.59%	83.56%	65.33%
Guinea	2005, 2012	2000, 2012	7,227	1.22%	80.37%	63.50%
Haiti	2000, 2005, 2012	1995, 2012	11,784	2.85%	81.61%	58.17%
Honduras	2005, 2011	2000, 2012	13,737	1.46%	77.64%	55.99%
Indonesia	2002, 2007, 2012	1997, 2012	33,233	0.05%	81.10%	65.31%
Jordan	2002, 2007, 2012	1997, 2012	16,365	0.49%	72.32%	45.99%
Liberia	2007, 2013	2002, 2013	7,234	4.55%	83.57%	61.61%
Madagascar	2003, 2008	1998, 2009	15,731	0.63%	88.54%	74.05%
Mali	2001, 2006, 2012	1996, 2013	22,109	0.32%	83.43%	68.71%

Mozambique	2003, 2011	1998, 2011	11,345	0.65%	81.35%	61.16%
Namibia	2000, 2006, 2013	1995, 2013	8,165	1.54%	74.74%	52.82%
Nepal	2001, 2006, 2011	1996, 2012	13,362	1.33%	87.97%	75.63%
Niger	2006, 2012	2001, 2012	10,464	1.43%	79.38%	61.73%
Nigeria	2003, 2008, 2013	1998, 2013	37,168	1.71%	82.79%	62.91%
Peru	2000, 2004, 2007, 2009, 2010, 2011, 2012	1995, 2012	80,005	1.33%	86.53%	66.88%
Philippines	2003, 2008, 2013	1998, 2013	13,048	0.37%	69.46%	48.16%
Rwanda	2000, 2005, 2010, 2014	1995, 2015	19,855	0.89%	84.74%	67.21%
Senegal	2005, 2010, 2012, 2014, 2015	2000, 2015	19,187	1.22%	77.30%	56.02%
Sierra Leone	2008, 2013	2003, 2013	8,122	2.55%	77.72%	55.63%
Tanzania	2004, 2010, 2015	1999, 2016	16,410	0.79%	84.25%	68.35%
All Control Countries [b]			577,811	1.17% (SD = 0.001)	80.64% (SD = 0.015)	61.37% (SD = 0.019)

[a] treated countries are countries that experienced a change in the duration of paid maternity leave between 1995 and 2013.

[b] control countries are countries that did not experience a change in the duration of paid maternity leave between 1995 and 2013.

[c] average weighted by Demographic and Health Survey weight.

Table 4.2. Demographics and characteristics of the independent variables among children with and without breastfeeding information. Values are numbers (percentages) unless stated otherwise

	With breastfeeding information (N = 696,343)	Without breastfeeding information (N = 239,784)
Children with bloody diarrhea	9,333 (1.34)	4,082 (1.70)
Mean (SD) number of listed household members	6.64 (0.25)	7.14 (0.57)
Mean (SD) number of children under 5 years of age living in household	1.92 (0.08)	2.10 (0.13)
Household wealth		
poorest	180,144 (25.87)	60,614 (25.28)
poorer	155,497 (22.33)	50,805 (21.19)
middle	139,778 (20.07)	46,645 (19.45)
richer	120,159 (17.26)	43,292 (18.05)
richest	100,765 (14.47)	38,428 (16.03)
Drinking-water source		
improved source	423,131 (60.76)	153,812 (64.15)
Place of residence		
Rural	447,410 (64.25)	155,921 (65.03)
Mean (SD) mother's education, years	5.41 (0.55)	5.11 (0.59)
Mean (SD) mother's age at childbirth, years	26.92 (0.19)	26.84 (0.17)
Mean (SD) mother's number of living children	3.20 (0.09)	3.46 (0.11)
Child's sex		
Female	345,241 (49.58)	118,083 (49.25)
Mean (SD) child's age at interview, years	1.72 (0.05)	2.69 (0.04)
Mean (SD) child's birth order	3.32 (0.12)	3.31 (0.12)

Table 4.3. Demographics and characteristics of the independent variables in the study sample, 1996–2014, N = 977,084. Values are numbers (percentages) unless stated otherwise

		Missing data (%)
Mediators		
Being breastfed at least 6 months	577,593 (61.18)	25.42
Being breastfed at least 12 months	447,753 (47.43)	25.42
Household- and individual-level covariates		
Mean (SD) number of listed household members	6.85 (3.90)	0
Mean (SD) number of children under 5 years of age living in household	1.99 (1.20)	0
Household wealth		
poorest	242,705 (25.71)	0
poorer	207,912 (22.02)	0
middle	187,947 (19.91)	0
richer	165,021 (17.48)	0
richest	140,499 (14.88)	0
Drinking-water source		
improved source	581,798 (61.63)	4.13
Place of residence		
Rural	608,615 (64.47)	0
Mean (SD) mother's education, years	5.26 (4.79)	0.04
Mean (SD) mother's age at childbirth, years	26.89 (6.71)	0
Mean (SD) mother's number of living children	3.31 (2.03)	0
Child's sex		
Female	467,340 (49.5)	0
Mean (SD) child's age at interview, years	1.97 (1.42)	0
Mean (SD) child's birth order	3.36 (2.33)	0
Country-level covariates		
Mean (SD) GDP per capita, PPP (constant 2011 international $)	3918.96 (3220.03)	0.91
Mean (SD) health expenditure, total (% of GDP)	10.30 (7.61)	0.81
Mean (SD) health expenditure per capita (constant 2011 international $)	41.41 (19.44)	0.81
Mean (SD) labor force participation rate, female (% of female population ages 15+)	57.30 (18.08)	0.81
Mean (SD) unemployment female (% of female labor force)	9.17 (7.48)	0.81

Table 4.4. Effect of paid maternity leave policy and potential mediators on the risks of bloody diarrhea for children under five, N = 662,240

	Total effect	Effect with mediator 1 (breastfeeding at least 6 months)	Effect with mediator 2 (breastfeeding at least 12 months)
	Risk Ratio (95% CI)	Risk Ratio (95% CI)	Risk Ratio (95% CI)
Exposure			
1-month increase in legislated length of paid maternity leave	0.61 (0.44, 0.84)	0.67 (0.58, 0.77)	0.67 (0.61, 0.74)
Mediator			
Breastfeeding at least 6 months		3.34 (2.31, 4.82)	
Paid maternity leave × Breastfeeding 6 months		0.97 (0.86, 1.10)	
Breastfeeding at least 12 months			1.99 (1.59, 2.48)
Paid maternity leave × Breastfeeding 12 months			0.98 (0.91, 1.05)
Household- and individual-level covariates			
Number of listed household members	1.03 (1.01, 1.04)	1.03 (1.02, 1.03)	1.02 (1.02, 1.03)
Number of children under 5 years of age living in household	0.98 (0.95, 1.02)	1.00 (0.98, 1.03)	1.00 (0.98, 1.03)
Household wealth			
poorest	Ref	Ref	Ref
poorer	0.87 (0.79, 0.96)	0.85 (0.81, 0.90)	0.85 (0.81, 0.90)
middle	0.77 (0.70, 0.85)	0.76 (0.71, 0.81)	0.76 (0.71, 0.81)
richer	0.66 (0.57, 0.76)	0.66 (0.61, 0.71)	0.65 (0.61, 0.71)
richest	0.51 (0.41, 0.64)	0.48 (0.43, 0.54)	0.49 (0.44, 0.54)
Drinking-water source			
unimproved source	Ref	Ref	Ref
improved source	0.93 (0.86, 1.00)	0.93 (0.89, 0.97)	0.93 (0.89, 0.98)
Place of residence			
urban	Ref	Ref	Ref
rural	1.06 (0.94, 1.20)	0.99 (0.94, 1.05)	0.99 (0.93, 1.04)
Mother's education (years)	0.96 (0.94, 0.97)	0.96 (0.96, 0.97)	0.96 (0.96, 0.97)
Mother's age at childbirth (years)	0.98 (0.97, 0.98)	0.98 (0.97, 0.98)	0.98 (0.97, 0.98)
Mother's number of living children	0.91 (0.86, 0.95)	0.90 (0.88, 0.93)	0.91 (0.89, 0.94)
Child's sex			
Male	Ref	Ref	Ref
Female	0.92 (0.87, 0.98)	0.92 (0.89, 0.96)	0.92 (0.89, 0.96)

Child's age at interview (years)	1.14 (1.02, 1.26)	1.01 (0.99, 1.03)	0.96 (0.94, 0.99)
Child's birth order	1.16 (1.11, 1.21)	1.16 (1.13, 1.18)	1.15 (1.12, 1.18)
Country-level covariates			
GDP per capita, PPP (constant 2011 international $)	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)
Health expenditure, total (% of GDP)	0.98 (0.93, 1.04)	0.97 (0.96, 0.99)	0.97 (0.96, 0.99)
Health expenditure per capita (PPP) (constant 2011 international $)	0.91 (0.81, 1.01)	0.93 (0.91, 0.95)	0.93 (0.91, 0.95)
Female labor force participation rate (% of female population 15+)	0.95 (0.84, 1.09)	0.95 (0.94, 0.97)	0.96 (0.94, 0.97)
Unemployment female (% of female labor force)	0.95 (0.87, 1.04)	0.95 (0.93, 0.97)	0.95 (0.93, 0.97)

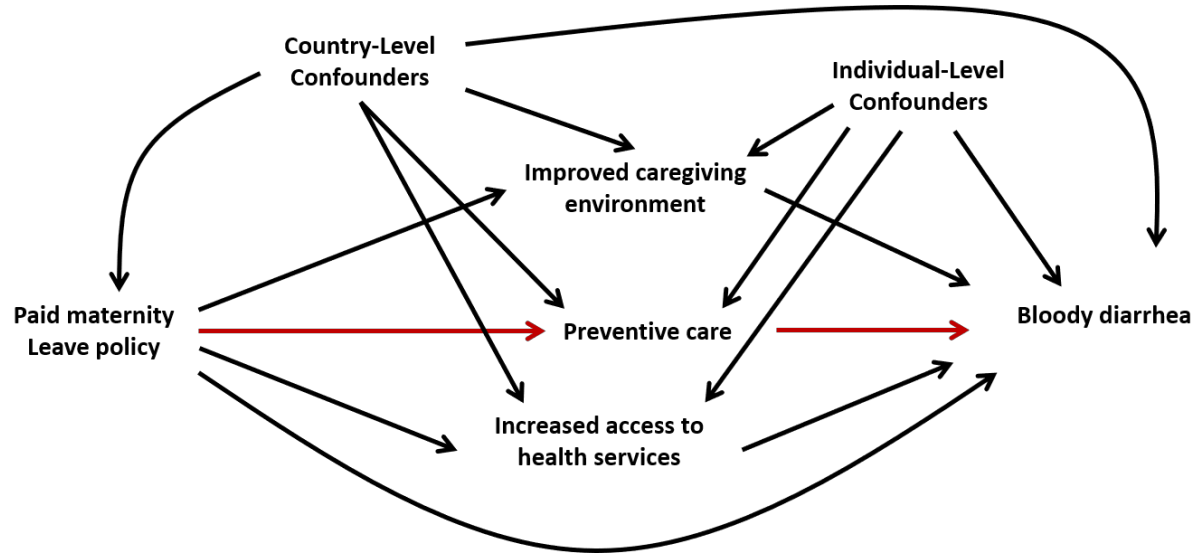

Figure 4.1. Theory of how paid maternity leave would affect childhood diarrhea incidence

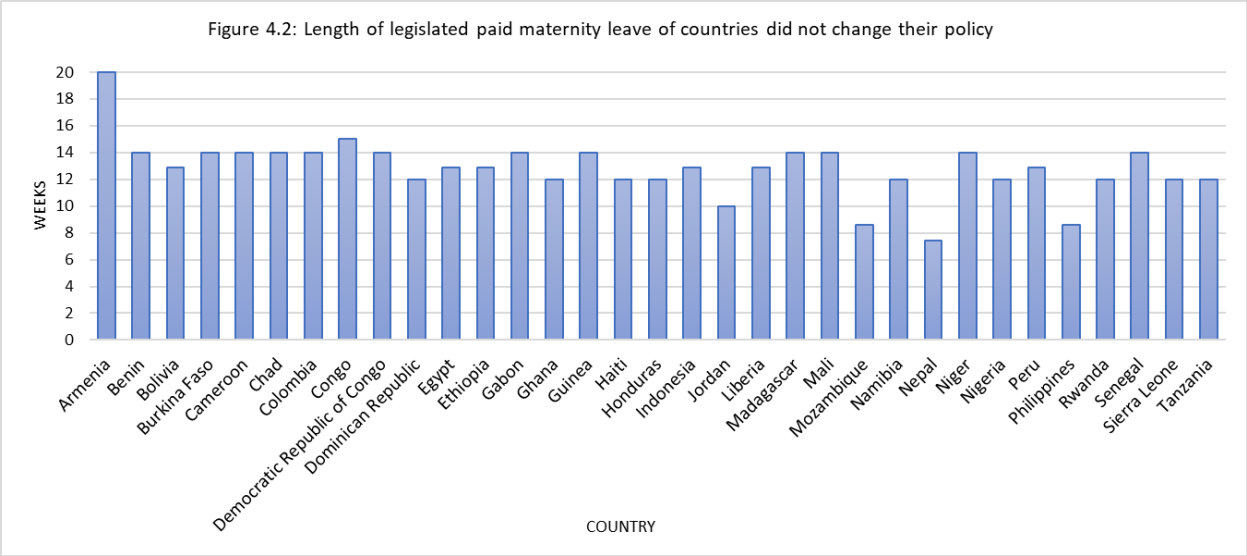

Figure 4.2. Length of legislated paid maternity leave of countries did not change their policy

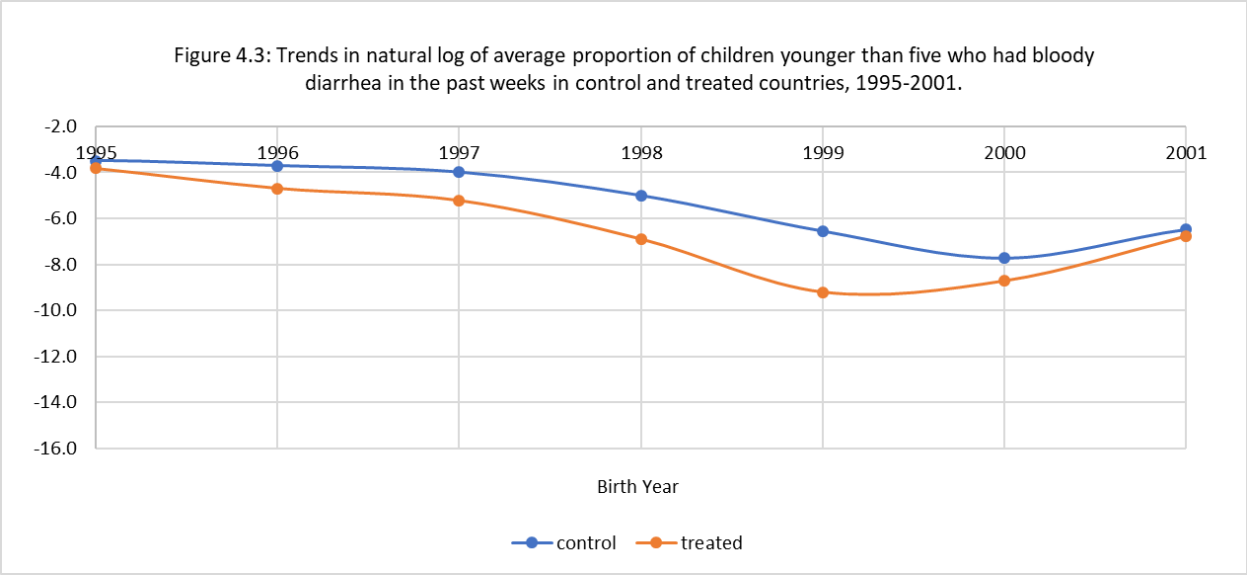

Figure 4.3. Trends in natural log of average proportion of children younger than five who had bloody diarrhea in the past weeks in control and treated countries, 1995-2001

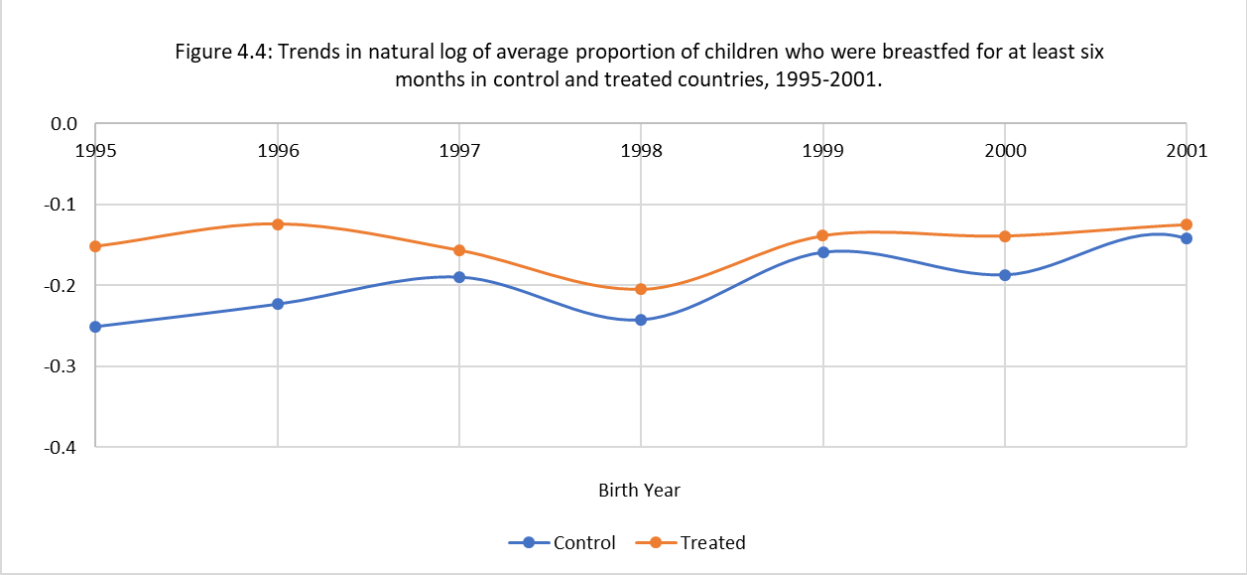

Figure 4.4. Trends in natural log of average proportion of children who were breastfed for at least six months in control and treated countries, 1995-2001

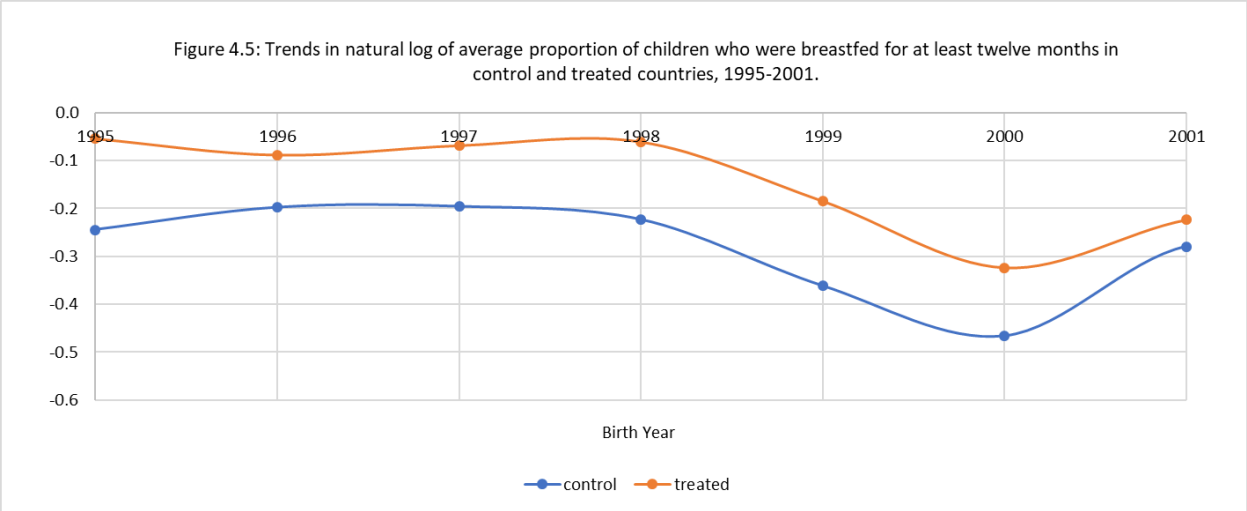

Figure 4.5. Trends in natural log of average proportion of children who were breastfed for at least twelve months in control and treated countries, 1995-2001

Chapter 5. Conclusion and public health implications

Raising children is a time-intensive activity and a cherished goal for many families. Maternity is an especially vulnerable time for working women. The most-up-to-date convention C183 of the ILO mandates all countries, regardless of income, guarantee women at least 14 weeks of paid maternity leave.[13] Globally, around 830 million women in the workplace do not have adequate maternity protection[85]. Almost 80% of them are in Africa and Asia, where a significant percentage of the population resides in low-resource settings.[85] With the knowledge obtained from this dissertation, we gained additional insights into understanding how an increase in paid maternity leave policy affects children's health in LMICs. These findings could potentially be used for establishing policy frameworks.

Our first study (Chapter 2) demonstrated a 7.4 percentage-point (95% CI 3.2–11.7) increase in the prevalence of early initiation of breastfeeding, a 5.9 percentage-point (95% CI 2.0–9.8) increase in the prevalence of exclusive breastfeeding, and a 2.2-month (95% CI 1.1–3.4) increase in breastfeeding duration for each month increase in the legislated duration of paid maternity leave policy. Since many studies have suggested that breastfeeding has clear short- and long-term benefits [5 129], implementing longer paid maternity leave policy in LMICs could improve well-being in many perspectives for both mothers and children. The potential benefits include reducing morbidity and mortality due to infectious diseases in childhood and a risk of diabetes and obesity in adulthood for breastfed individuals, as well as lower risk of breast cancer before menopause, ovarian

cancer, osteoporosis, coronary heart disease, and diabetes for breastfeeding women [53-55 130 131].

Our second and third studies (Chapter 3–4) showed a 39% (RR 0.61, 95% CI 0.44–0.84) reduction in the risk of bloody diarrhea for each additional month increase in paid maternity leave policy. Breastfeeding for at least six and 12 months were found to mediate this effect by 14% and 17%, respectively. Given an estimated global burden of 34.6 million severe diarrhea episodes, this relative reduction could have a substantial public health impact.

Caveats considered, the findings in this dissertation suggest possible mechanisms for lowering childhood diarrhea incidence in LMICs. Previous work has found that longer paid maternity leave policy lowers infant mortality in LMICs.[28] Since diarrhea is the fourth-leading cause of death in children under five years of age, our findings suggest a possible instrument for reducing mortality.

From a policy planning perspective, further work is needed to examine the impact of paid maternity leave on other aspects of child health and whether there are shared effects across maternity leave and other preventive interventions. Further studies may also seek to examine whether the increase in breastfeeding duration is longer than the increase in maternity leave duration because of threshold effects. Specifically, future studies could examine whether a certain minimum length of leave is needed to encourage breastfeeding initiation and whether it is easier to continue breastfeeding while working once an infant has reached a certain age.

Such research could contribute to developing better early-life interventions to improve health outcomes for mothers and infants in LMICs.

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