Mortality from Nestlé's Marketing of Infant Formula in Low and Middle-Income Countries

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Abstract. Intensive and controversial marketing of infant formula is believed to be responsible for millions of infant deaths in low and middle-income countries (LMICs), yet to date there have been no rigorous analyses that quantify these effects. To estimate the impact of infant formula on infant mortality, we pair country-specific data from the annual corporate reports of Nestlé, the largest producer of infant formula, with a sample of 2.48 million births in 46 LMICs from 1970-2011. Our key finding is that the availability of formula increased infant mortality by 9.4 per 1000 births, 95%CI [3.6, 15.6] among mothers without access to clean water, suggesting that unclean water acted as a vector for the transmission of water-borne pathogens to infants. We estimate that the availability of formula in LIMCs resulted in approximately 66,000 infant deaths in 1981 at the peak of the infant formula controversy.

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1. Introduction

There is strong scientific consensus that breastfeeding is optimal for child health and development (*1-3*). The World Health Organization (WHO) recommends that infants are breastfed within an hour birth, exclusively breastfed for the first 4-6 months of life, and then continue to receive breastmilk for up to two years (*4*). A recent meta-analysis presented evidence on the importance of breastfeeding for child survival due to the unique biological contribution of breast milk to the child's immune response (*5*). The risk of all-cause mortality is substantially lower in children who are exclusively breastfed for the first 5 months of their lives when compared with children who are either partially breastfed or not breastfed at all, receiving breastmilk substitutes instead (e.g. infant formula) (*6*). Children who receive breastmilk instead of a breastmilk substitutes benefit from reduced severity of diarrheal disease and respiratory infections (*7*), benefits in cognitive function (*5*), and longer-term benefits for cardiovascular health (*8*). In 2012, the estimated aggregate economic loss from shortened breastfeeding was $302 billion, and that 820,000 infant lives per year could be saved if breastfeeding were increased to near universal levels (*9*).

Despite the scientifically supported benefits of breastfeeding, the use of infant formula as an alternative to breast milk remains widespread (*10*). Less than half of newborns worldwide are breastfed within an hour of birth, and only 43% are exclusively breastfed from birth to 6 months (*11*). There are many reasons cited for why a mother may choose to use infant formula over breastfeeding, including insufficient or the perception of insufficient breast milk, lack of ability to pump breast milk at work, lack of family support, depression, poverty, and other socio-cultural factors (*12-14*).

A key factor contributing to low rates of breast feeding has been the private sector development and marketing of infant formula (*15*). Globally, the sales of infant formula totaled US$44.8 billion in 2016, and are expected to rise to US$70.6 billion by 2019 (*16*). In the early part of the 20th century, companies in the United States and Europe developed commercial breast milk substitutes, partly in response to demand from women who had difficulty breastfeeding. The use of infant formula rose steadily in the industrialized world with post World War II baby boom breastfeeding rates dropping by half from earlier in the century (*17*). Formula sales in the United States peaked in the 1950s and began to recede in the 1960s due both to lower birth rates and mothers returning to breastfeeding. Infant formula companies then looked to new markets in the developing world to make up falling revenues, raising widespread alarm among public health and humanitarian advocacy groups.

The beginning of the public controversy over infant formula marketing practices in the developing world began in August 1973 when an article, *The Baby Killer*, was published in the New Industrialist. The article stressed the nutritional inadequacy of infant formula relative to breast milk (*18*), and provided examples of specific marketing abuses by Nestlé, the first major formula manufacturer to enter LMICs (*19*) and the largest supplier worldwide (*20*).[1] At the same time, public health researchers documented a large decline in breast-feeding contemporaneous with the introduction of infant formula (Figure 1), and published estimates of infant deaths resulting from the introduction of infant formula into LMICs ranging from annual figures of 1 million to 10 million (*21, 22*). The article and research became catalysts for activism against the infant formula industry, which ultimately led to an international boycott of Nestlé products starting in 1977 and public hearings on the *Nestlé controversy* in the U.S. Senate in May 1978 (*17*).

In response, the World Health Organization and UNICEF organized a meeting of stakeholders out of which the International Code of Marketing of Breast-milk Substitutes (ICMBS) was created and later enacted in 1981 (*23*). Nestlé, faced with the boycott, lawsuits, and increasing public pressure, eventually agreed to abide by the ICMBS in 1984. However, in 1988 the International Baby Food Action Network called for a reinstatement of the boycott after evidence was produced that Nestlé had returned to marketing practices banned by the ICMBS (*24-26, 33*).

Nestlé was accused of providing health clinics with free or low-cost supplies of infant formula, often dispensed by “milk nurses” (saleswomen dressed in nurses uniforms), to encourage new mothers in the use of infant formula (*24-26*). This practice is particularly egregious because formula use among neonates increases the risk that mothers release the prolactin-inhibiting factor, which signals their milk production to shut down, thereby

[1] Nestle has consistently denied allegations of unethical marketing (*17*).

creating a future dependence on breast milk substitutes (*27*). In addition, critics were concerned that Nestlé's marketing included promoting formula to mothers unlikely to have access to clean water and likely to possess limited technical understanding of nutrition, physiology, or disease mechanisms due to relatively little formal education (*19*). Inappropriately prepared formula (e.g. mixed with unclean water, or mixed with too much water), can increase the risk of infant mortality due to the increased likelihood of diarrhea and other intestinal infections (*28*).

In this paper we present, to our knowledge, the first causal estimates of the effect on infant mortality of Nestlé's entrance into LIMC formula markets for the both population overall, and for vulnerable subpopulations believed to be most at risk. Nestlé's phased geographic entry into national infant formula markets over time in LMICs provides plausibly exogenous variation in the market availability of formula conditional on location fixed effects. We exploit this variation to identify the causal effect of formula availability using difference-in-differences and event-history models. We estimate these models by combining data on the timing of formula imports provided in Nestlé's own annual corporate report with data on infant mortality from 2.48 million individual birth records in 48 countries for 1970 through 2011 collected in Demographic and Health Surveys (DHS) (*29*).

2. Data

Infant Formula Availability: Since Nestlé was the first major formula manufacturer to enter LMICs (*19*) and the largest supplier by far worldwide (*20*), we proxy infant formula being available in a country by whether Nestlé was actively marketing and selling formula in that country. Annual data on the countries where Nestlé sells infant formula are found in Nestlé's 1966 to 2014 corporate annual reports, in the Manufacturing and Sale of Products section describing international market activity (Supplementary Materials Figure A). We 8exclude six countries where there was already local production of formula before 1966.

Infant Mortality: We merged Nestlé's information on infant formula availability in a country with individual infant birth and mortality records from the Demographic and Health Surveys (DHS), a set of nationally and regionally representative surveys of women between the ages of 15 and 49, covering a large sample of low and middle-income countries. We identified all DHS countries for which Nestlé began selling formula between 1966 and 2014, creating a sample of all children born within the +/- 5 years surrounding the year formula imports began, and added control countries from the same geographic region as each treatment country, leaving us with a sample of the 18 treated countries and 28 control countries, for a total sample of 2,478,842 children in 46 countries as seen in Table 1.

The DHS survey includes recall data for all children including date of birth, and age at death if the child died, allowing us to construct location and year-specific infant-level mortality data set. We designate any death of a child age 12 months or younger as infant mortality and rescale the variable to deaths per thousand so as to yield rate-comparable estimates (in deaths per 1000 live births) for population prevalence.

Maternal and Household Characteristics: We use several other variables of interest taken at time of survey including children's basic demographic characteristics (sex, birth order, date of birth), and mother's and household's characteristics (education, type of water access, asset quartile measure of wealth, and location). We use two indicators for broadly comparable measures of socio-economic status: a variable indicating that the mother has completed less than primary education, and a variable indicating that a household is below the country median in the DHS's asset index to proxy for household wealth.

Appropriate preparation of powdered infant formula requires combining the powder with clean drinking water; safe water is critically important here because mixing infant formula with unclean water presents a severe health risk to newborn infants. We measure a mother's inability to access clean water using the DHS water source variable that indicates the water source most commonly used by the household. Surface water, the lowest-quality water source in the DHS, is the water source associated with the highest levels of infant mortality regardless of infant formula use (*30*). In our sample, surface water is used by 15.4% of households.

An indicator of surface water as the household's primary water serves as our measure of poor water quality. We assume that any woman currently using unsanitary water was likely to be doing so in the past. However, there is some measurement error in this variable as the steady decrease in unsanitary water use globally over this period implies that there are likely to be observations that had unsanitary water in the past but do not today. Improvements in water quality access in LMICs that have occurred since the birth of children in the dataset would likely attenuate our estimates of the impact on mortality for the sample designated to use unsafe water, implying that our estimates would be lower bound effects.

Macroeconomic Data: To control for the possibility that the timing of Nestlé imports and choice of countries were endogenously related to economic conditions that could also affect infant mortality, we include a set of country-level macroeconomic controls for economic growth and foreign investment. Data on Gross Domestic Product (GDP) per capita and Foreign Direct Investment (FDI) were taken from the World Bank Development Indicators.

3. Identification and Estimation

Nestlé's phased entry over time into national infant formula markets provides plausibly exogenous variation in the market availability of formula conditional on location fixed effects. We exploit this variation to identify the causal effect of formula availability by estimating difference-in-differences models with location and year fixed effects. We interpret the results as Intent-to-Treat (ITT) estimates that capture the average mortality response to the availability of infant formula for purchase proxied by whether Nestlé is actively selling formula in the country. Our estimated treatment effects represent the intersection of adoption of infant formula by mothers within the exposed population and the impacts on infants from consuming the formula. The impact on infant mortality will also vary depending on whether formula is combined with clean water and whether it substitutes for breast milk or for some inferior nutritional supplementation such as water, diluted condensed milk, juice, rice water, or other low-quality substitute.

Specifically, we estimate the following difference-in-differences model using a linear probability specification:

$$m_{ijkct} = \beta N_{ic} + \alpha_k + \gamma_t + \lambda_{ic} + \varphi_i + \boldsymbol{\mu}'\boldsymbol{Z_j} + \boldsymbol{\phi}'\boldsymbol{C_{ct}} + \epsilon_{ijkct} \quad , \tag{1}$$

where m_{ijkct} is an indicator variable equal to 1000 if child *i* died during or prior to his or her 12th month of life to a mother in DHS region *k,* in country *c,* and in year *t j* and equals zero is the child lived through its 12th month of life,; β is the treatment effect and is the coefficient on N_{ic}, which indicates whether the child *i* was born in the five year period after Nestlé began selling formula in country c; α_k represents a regional fixed effect; γ_t is a fixed effect for year of the child's birth; λ_{ic} is a vector of country·birth-month fixed effects to control for country-level seasonality in mortality; φ_i is a gender·birth order fixed effect for child *i*; $\boldsymbol{Z_j}$ is a vector of mother and household-level characteristics that include household water access, mother's education, and whether the household is in the lowest wealth quartile in the country; $\boldsymbol{C_{ct}}$ is a vector of macroeconomic controls that includes GDP per capita and Foreign Direct Investment in country c in year t, and ϵ_{ijkct} is the error term. We cluster the standard errors at the level of the first-level DHS administrative unit, and weight the data using the DHS survey weights.

We test whether the treatment effects are different for households that use surface water versus clean sources of water, low educated mothers versus high educated mothers, and poor households versus non-poor households. Specifically, we estimate versions of equation (1) with interactions of βN_{ic} with indictors separately for surface water, low education, and poverty.

Finally, we estimate an "event study" version of the difference-in-difference model that allows the treatment effects to vary in the years prior to and following formula introduction. Specifically,

$$m_{ijkct} = \alpha_k + \gamma_t + \lambda_{ic} + \varphi_i + \boldsymbol{\mu}'\boldsymbol{Z_j} + \boldsymbol{\phi}'\boldsymbol{C_{ct}} + \sum_{T=\bar{t}-m}^{\bar{t}+m} \tau_T \, T_{cT} + \epsilon_{ijkct} \,, \quad (2)$$

where coefficients in (2) are as in (1) except that τ_T is a set of $2m$ + 1 coefficients that represent a child's birth in different years within the event window surrounding the introduction of infant formula within a country. We use an event window in (2) that ranges from five years before (T = -5) to five years after (T = +5) Nestlé began selling formula. The event-study estimations allow us to examine pre-treatment trends before formula introduction and whether introduction of formula creates a break in these pre-treatment trends.

4. Results

Table 2 reports estimates of the average treatment effects for the mortality effect of formula from our difference-in-differences models. First, we note that drinking surface water, having low maternal education, and being in a below median poverty household all significantly predict increased mortality in all model specifications. Our estimates indicate that a child born into a household in the bottom quartile of income that uses surface water as its major source of drinking water, where the mother has less than primary education and lives in poverty has a 40.1 per 1000 live births higher probability of infant mortality, or 55% higher than the mean mortality rate of the sample.

The introduction of infant formula shows no statistically significant average impact on infant mortality for the population as a whole (Table 2, Model 1). However, our results show large and significant infant mortality deaths from formula introduction concentrated in vulnerable sub-populations. Specifically, infant formula availability had a significantly negative effect on mortality of infants born in households that used surface water (Table 2, Model 2). The availability of formula increased infant mortality by 12.9 per 1000 for households that used surface water relative to higher-quality water using households. The net effect of formula availability is an increase of 9.4 infant deaths per 1000 among mothers with poor-quality water.

We test whether exposure to surface water is a proxy for socioeconomic status by adding interactions of formula availability with indicators for both low maternal education and below-median asset poverty (model 3). We find that the estimate is practically unchanged, and that mother's education and wealth are insignificant. Thus, our results indicate it is the combination of infant formula availability and lack of clean water access rather than poverty that drives our results.

Although the combination of formula introduction and women's education itself is insignificant, we investigate whether uneducated mothers without clean water access were more likely use infant formula in ways that put infant lives at risk, following reports that less-educated mothers did not know that the surface water mixed with the formula needed to be boiled or purified in some other way (*19*). We investigate this using a triple interaction of formula availability with surface water and low mother's education (model 4) and indeed find that the elevated infant mortality from formula introduction is concentrated among low-literacy mothers in surface-water using households. Estimating the effect of formula availability on just that group (model 5) confirms this result and shows an even stronger difference of 14.2 per thousand relative to the high-quality water counterfactual group.

Our event study estimates in Figure 2 show estimated differences in mortality between those eventually treated countries and those not treated for the years before and after formula imports began. We estimated the model for infants born to two types of mothers, those using surface water and those using non-surface (higher quality) water. There are minimal and statistically insignificant differences in infant mortality for treatment and control countries for surface water and non-surface water households in the years prior to the introduction of infant formula, minimizing concerns over possibly confounding non-parallel pre-trends in the difference-in-differences estimates reported in Table 2. The introduction of Nestlé formula, however, generates a visibly distinct increase in infant mortality in surface-water households relative to high-quality water households, one that peaks three years after introduction, suggesting a wave of mortality coinciding with increasing market penetration.

Finally, we test for any effect of Nestlé agreeing to abide by the International Code of Marketing of Breast-milk Substitutes in 1984. Model (6) reports the results of restricting the sample to only children born after 1984, finding that the impact on infant mortality from the introduction of Nestlé formula post-1984 for surface water households changes slightly from 9.40 to 8.34 but remains high and statistically significant ($p < 0.01$), providing no evidence that the international marketing code changed mortality dynamics.

5. Robustness

Table 3 shows four alternative specifications and robustness checks for our main results. Model (1) reproduces the results from our preferred specification in main results in Model (2) in Table 2 for comparison purposes. Model (2) replicates the same specification using mother-level, instead of region-level fixed effects, allowing us to better control for maternal and family characteristics. Identification, however, relies on the differential effect of formula on mortality across two or more children born within the same family over the sample period, implying that identification is driven by differences in older versus younger siblings and a reduced the sample size. The coefficient on formula availability remains virtually unchanged, and the effect of formula among surface water exposed infants decreases slightly to 8.9 deaths per 1000.

We also estimate the same specifications using country-level fixed effects in model (3). The coefficient on formula availability remains insignificant, but the effect of formula availability on surface water households increases to 14.15, or a net effect of an increase in 11.42 infant deaths per 1000 among surface water households, indicating a slightly greater impact than our regional-fixed effect estimations.

The DHS data relies on mothers' recall to answer questions related to infant births and deaths, which may add noise to our estimate and increase measurement error when the window surrounding the introduction of formula predates DHS surveys by many years. In model (4) we limit the treatment sample to the subset of 11 countries that were surveyed by DHS within fifteen years of the beginning of Nestlé sales. We see that the results again remain essentially unchanged.

6. Discussion

The Nestlé controversy, one of most notorious allegations of corporate malfeasance in the modern era, has been driven by concerns that the controversial marketing practices used Nestlé to sell infant formula in LMICs had a large impact on infant mortality. In this research, we combine information from Nestlé's annual corporate reports on country level activity with infant mortality from 2.48 million births in 46 countries to estimate the effect of infant formula availability on infant mortality. Although we find insignificant effects on infant mortality for the population as a whole, we find a large and statistically significant increase in infant mortality among households without access to clean water, especially for infants of less-educated mothers, corroborating many of the observations of health practitioners made during the peak of the infant formula controversy.

The strengths of our study include the large number of countries for which there are longitudinal data available, the use of corporate data to identify the year of Nestlé's entry into a country, and a very large sample of births over a long time period. Other strengths include our ability to exploit the phased entry into LIMC markets over time to identify causal effects using difference-in-differences models, confirmation of parallel pre-trends in the event-history specifications, and the robustness of our estimates to a wide variety of alternative specifications.

There are also limitations. First, we use only data from Nestlé, and although the company has the largest market infant formula share in LMICs, we do not have data from other infant formula manufacturers. Second, we only have data on whether infant formula is being marketed in a country and not on the intensity of the marketing or its penetration, nor on formula use. Third, we are limited to using infant mortality data and do not have data on child morbidity; given the large effects of infant formula in immune system function, we are missing the calculation of effects of infant formula consumption on diarrhea, respiratory functioning and other types of infant morbidity.

How many infant deaths resulted from the introduction of Nestlé infant formula to mothers with poor access to clean water? We estimate the number of deaths for 1981, arguably the peak year of the controversy when media attention was the highest. We do this by multiplying the 47.8 million 1981 live births that occurred in Nestlé formula sales countries by the fraction of those households with surface water in those countries and by our estimate of the impact of formula on infants from households with only unclean surface water access, i.e. 0.0094 from Table 2. This yields an estimate of 65,676 infant deaths with a 95% confidence interval of [24,868, 106,485], lower than earlier estimates of one million or more, but unquestionably a substantial loss of human life.

We compare the magnitude of the effect on infant mortality due to infant formula to the effect sizes of other factors impacting infant mortality in LMICs. Specifically, we compare our results to the effects of having an uneducated mother, lacking post-natal care, experiencing a loss of 10% of a country's GDP, lacking access to clean water generally, and having no pre-natal care (Figure 3). Our estimated infant-mortality effects of formula availability on surface-water-using households are on the same order of magnitude as these other threats to infant life. For example, the introduction of infant formula to mothers without access to clean water results in an increase in infant mortality that is roughly similar to a loss in 10% of GDP, and somewhat greater than the effect of unclean water itself or the absence of prenatal care.

Many of these deaths could have been avoided if more mothers had breastfed. There are a number of effective antenatal and postnatal behavioral change interventions that improve breastfeeding practices and thereby reduce infant formula use (*35*). Examples include education and counseling during the prenatal period as well as hospital and home-based support in the postpartum period (*36, 37*), and effects of which can be enhanced by including fathers (*38*). A very effective program is the Baby Friendly Hospital Initiative, which bans promotion of bottle feeding infants post-partum and supports breastfeeding immediately after birth and throughout the crucial first few days (*38*).

Even with interventions that promote breastfeeding, some mothers will undoubtedly choose to use formula. One message that emerges from our analysis is the critical importance of making sure that mothers who choose to use formula, use it safely. Clear instructions comprehensible to mothers of all education levels need to be included in marketing materials, and for households that do not have access to clean water, chlorine tablets could be included in the powdered formula or the pre-mixing of formula with clean water.

Finally, infant mortality may be averted by regulating unethical marketing practices. The international community's response to concerns over marketing was to create the International Code of Marketing Breastmilk Substitutes (ICMBS) (*31*), which has recently been extended to include inappropriate marketing of all foods to infants and young children (*32*). However, compliance with the ICMBS is voluntary and violations of banned marketing practices continue. A global watch-dog group, "Breaking the Rules, Stretching the Rules 2017" documented over 800 violations of the ICMBS by 28 formula companies in 79 countries between 2014-2017 (*34*). The violations range from promotions claims that mislead consumers, and surreptitious methods to influence doctors and other health professionals, such as sponsoring medical conferences and partnering with health-promoting NGOs. To combat these abuses, WHO, UNICEF and the International Baby Food Action Network have called for countries to enact ICMBS legislation with stringent enforcement mechanisms and penalties for nonadherence, and to closely monitor adherence (*16*).

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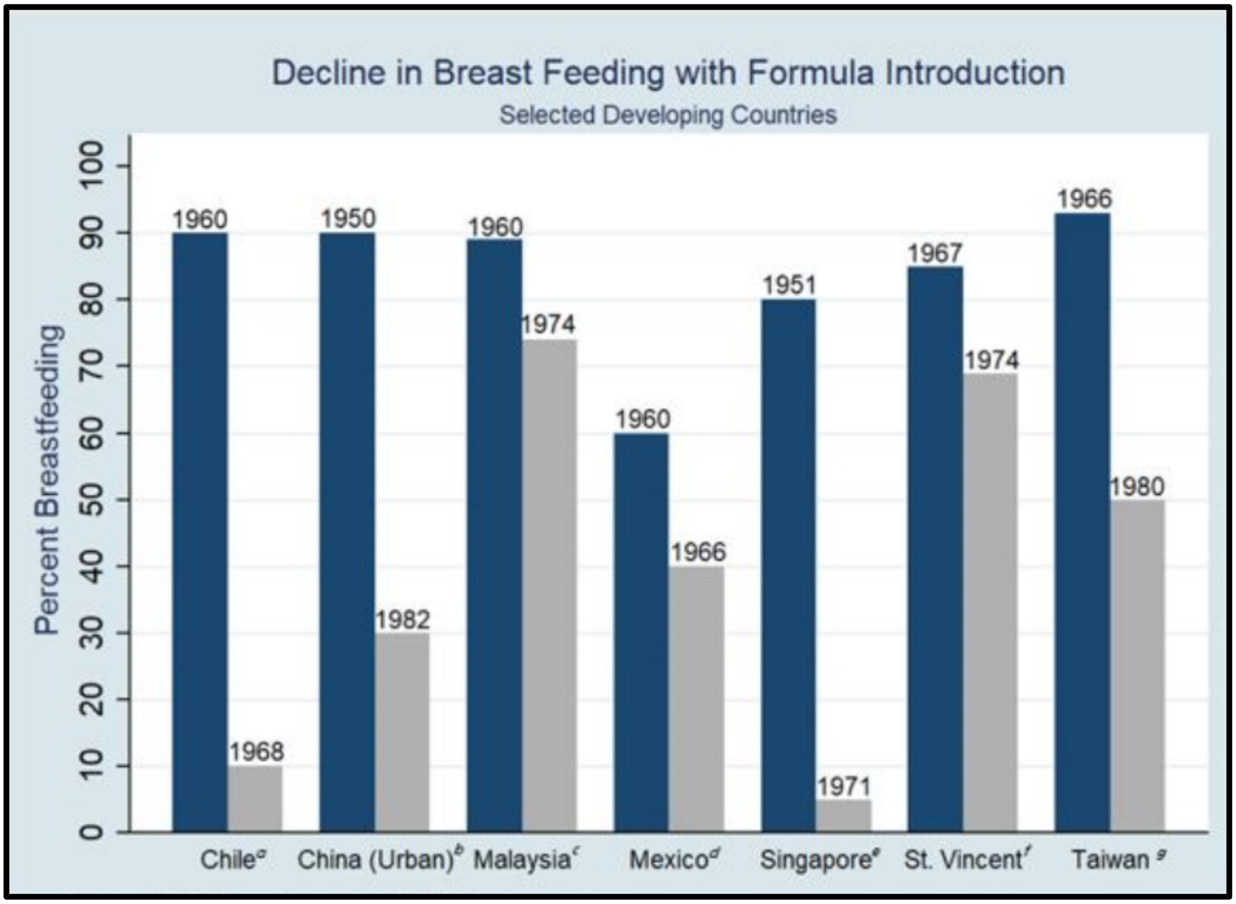
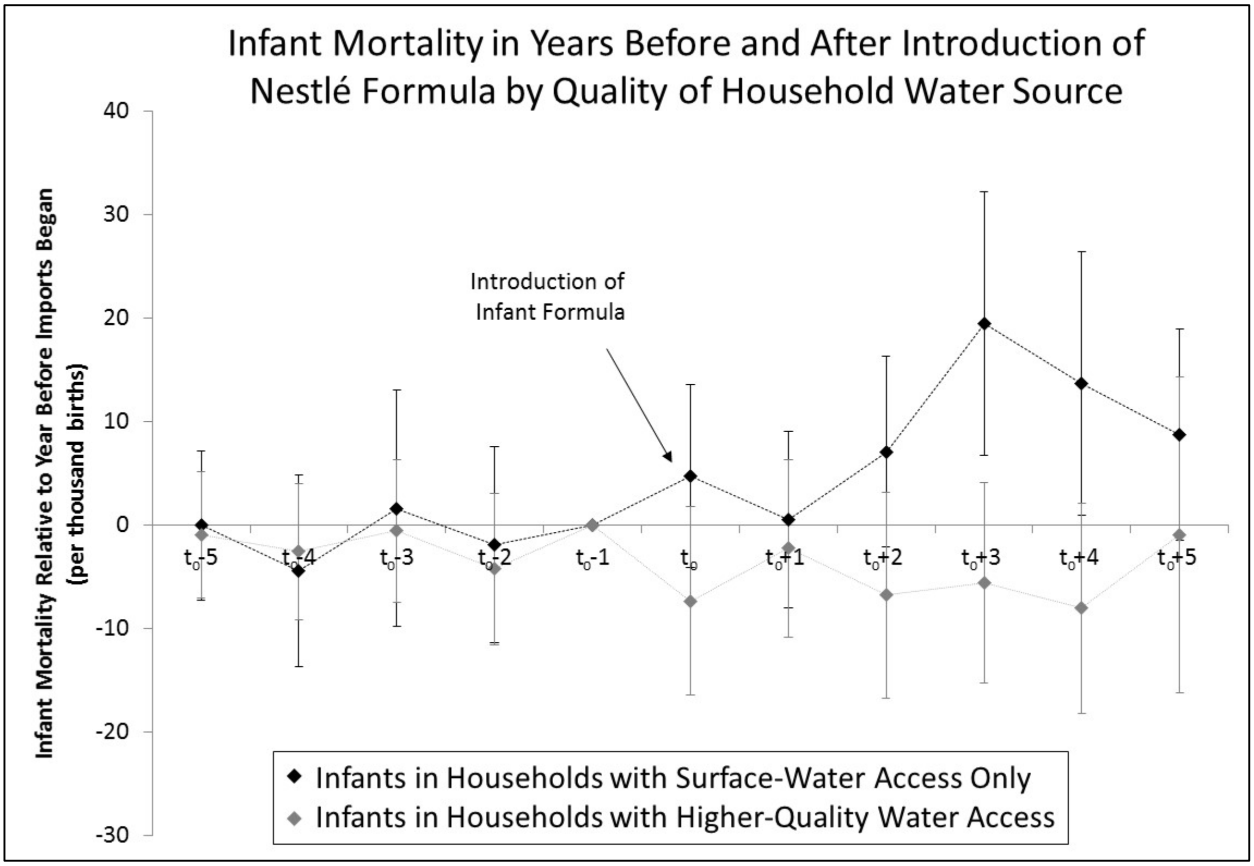
Figure 1:

Breastfeeding rates before (blue) and after (grey) infant formula became available in selected countries



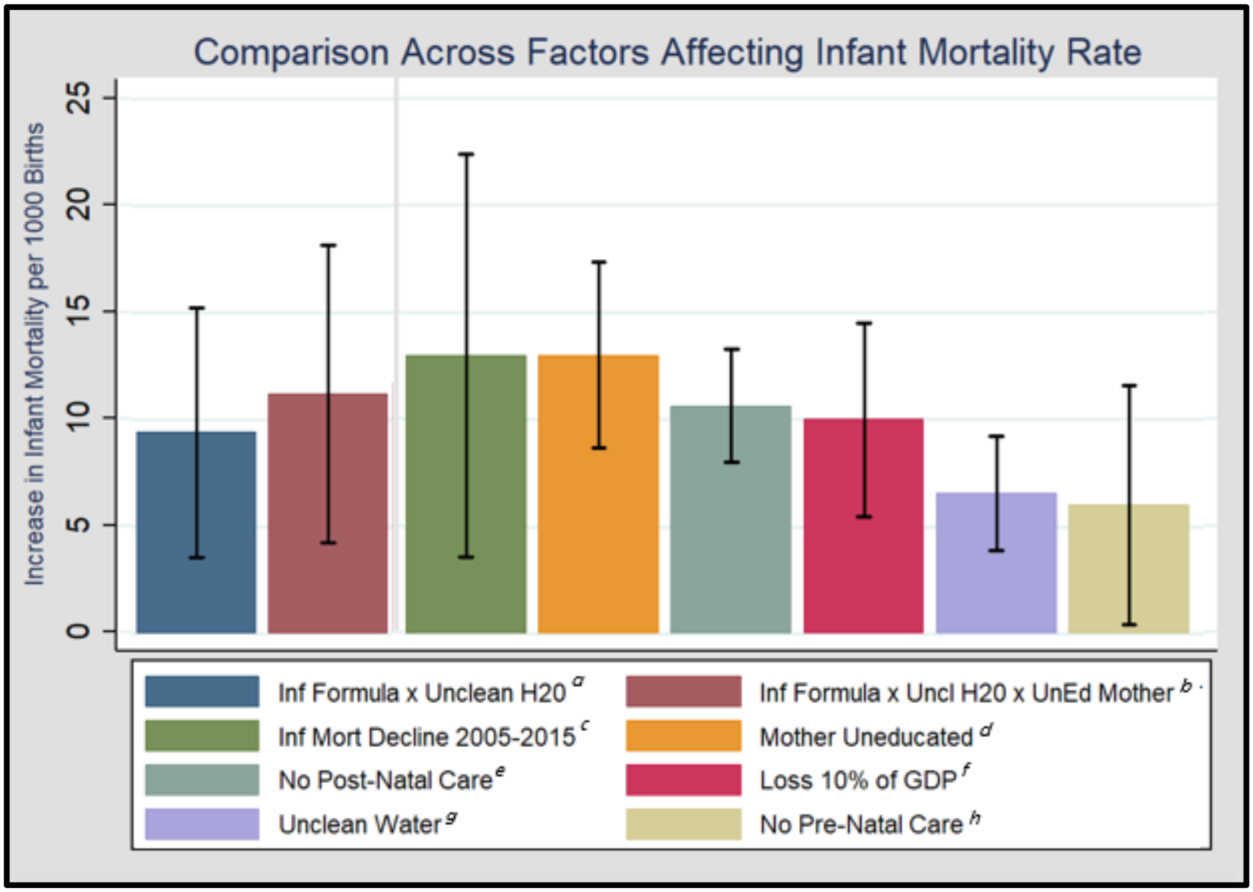
[a] (27) [b] (40) [c] (41) [d] (27) [e] (42) [f] (43) [g] (41)

Figure 2:
Event-History Estimates of the Effect of Infant Formula Availability on Infant Mortality



Notes: These figures plots the estimated differences and 95% C.I.s for infant mortality rates (×1,000) in surface and high-quality water treatment households relative to controls in the years before and after Nestlé starting marketing infant formula in treatment countries, as specified in equation (2). The estimates are normalized to 0 in the year prior to entry (t_0 -1).

Figure 3: Comparison of Effects of Factors Affecting Infant Mortality



[a] Region level fixed effect estimate presented in Table 2.

[b] Region-level fixed effect estimate presented in Table 2

[c] *(44)*

[d] *(45)*

[e] *(46)*

[f] *(47)*

[g] *Region level fixed effect estimate presented in Column (1) of Table 2.*

[h] *(48)*

Note: Error bars represent 95% confidence intervals except (*b*) which gives standard deviation of 10-year infant mortality decline across countries.

Table 1: Descriptive Statistics

Region	Country	First year of Nestlé sales	*N*	Infant Mortality Rate (per 1000 births)	Household drinks surface water	Mother did not complete primary school	Poor HH (lacking TV, radio, or electricity)
Asia	Bangladesh	1993	94,040	89.0	3.6%	74.2%	51.4%
	Cambodia	1998	65,053	92.8	35.1%	71.5%	32.5%
	Indonesia	1972	86,667	103.9	10.1%	58.3%	20.4%
	Pakistan	1990	34,105	95.8	5.0%	80.6%	14.9%
	Sri Lanka	1981	9,179	33.1	7.0%	32.1%	25.5%
	Vietnam	1997	9,558	27.4	18.5%	26.3%	11.5%
Sub-Saharan Africa	Cameroon	1992	35,876	84.4	33.5%	51.3%	33.9%
	Congo DRC	2011	33,462	133.9	39.9%	91.7%	33.5%
	Guinea	1993	8,645	103.2	34.5%	85.1%	55.8%
	Madagascar	1972	19,765	131.4	2.77%	89.4%	23.1%
	Senegal	1974	204	121.1	25.6%	50.3%	18.6%
	Swaziland	1971	7,050	100.5	18.8%	63.4%	55.8%
	Zambia	1969	20,961	79.1	15.0%	61.5%	10.5%
Americas	Dom. Rep.	1971	3,891	116.4	0.0%	55.5%	9.8%
	Ecuador	1970	119,228	78.6	0.1%	65.5%	4.0%
North Africa	Egypt	1988	55,718	25.1	4.7%	7.6%	2.4%
	Jordan	1999	20,534	59.6	5.4%	85.8%	8.5%
	Morocco	1992	94,040	89.0	3.6%	74.2%	51.4%
Control Countries		-	1,854,906	94.2	16.5%	64.5%	27.8%
Full Sample			**2,478,842**	**91.9**	**15.4%**	**64.1%**	**26.6%**

Notes: This table reports the year Nestlé started selling infant formula by country and means values of key characteristics the DHS surveys in the year before entry for treatment countries and the average of sample years for the control countries. Means were computed using sample weights provided by the DHS. Control countries include Armenia, Azerbaijan, Burkina Faso, Cote d'Ivoire, El Salvador, Ethiopia, Gabon, Ghana, Guatemala, Kazakhstan, Liberia, Malawi, Maldives, Mali, Namibia, Nicaragua, Niger, Nigeria, Paraguay, Philippines, Rwanda, Tanzania, Thailand, Togo, and Yemen.

Table 2. Effect of Infant Formula Availability on Infant Mortality

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Infant Formula Available	-1.469	-3.543	-2.693	-1.941	-3.004	-2.988
	(2.249)	(2.475)	(2.802)	(2.852)	(2.397)	(3.017)
Formula x Surface Water		**12.94*** **	**12.87*** **	6.176		**11.33*** **
		(3.169)	(3.224)	(4.452)		(3.448)
Formula x Low Education Mom			-2.697	-4.006		
			(3.055)	(3.284)		
Formula x Lowest Wealth Quartile			2.856	2.814		
			(2.497)	(2.504)		
Formula x Surface Water x Low Ed				**9.821** **	**14.21*** **	
				(5.305)	(3.500)	
Surface Water	**6.544*** **	**5.339*** **	**5.339*** **	**5.335*** **	**5.641*** **	**7.691*** **
	(1.367)	(1.405)	(1.401)	(1.401)	(1.373)	(1.244)
Low Education Mother	**23.57*** **	**23.57*** **	**23.85*** **	**23.86*** **	**23.37*** **	**21.97*** **
	(1.167)	(1.167)	(1.226)	(1.226)	(1.172)	(1.188)
Lowest Wealth Quartile	**9.958*** **	**9.965*** **	**9.727*** **	**9.725*** **	**9.955*** **	**8.378*** **
	(0.946)	(0.944)	(0.976)	(0.976)	(0.944)	(1.024)
Sample Size	2,478,842	2,478,842	2,478,842	2,478,842	2,478,842	2,054,604

Notes: Each column reports the results of a separate regression. All models additionally include fixed effects for first subnational administrative region, gender, sex-specific birth order of child, country-specific birth month, and year as well as linear controls for log per capita GDP and per capita GDP growth observed at year of birth. Standard errors clustered at the level of first subnational administrative region. ** (p<0.05) *** (p<0.01)

Table 3. Alternative Specifications and Robustness Checks

	Table 2 Column (2)	Mother-Level Fixed Effects	Country-Level Fixed Effects	Sample Limited to 11 Closest Recall
	(1)	(2)	(3)	(4)
Infant Formula Available	-3.543	-3.524	-2.732	-4.635
	(2.475)	(2.786)	(2.427)	(2.798)
Infant Formula x Surface Water	**12.94*****	**8.939****	**14.15*****	**13.00*****
	(3.169)	(4.193)	(3.774)	(3.425)
Surface Water	**5.339*****		**3.931****	**5.704*****
	(1.405)		(1.538)	(1.432)
Low Education Mother	**23.57*****		**27.98*****	**23.01*****
	(1.167)		(1.472)	(1.202)
Lowest Wealth Quartile	**9.965*****		**12.59*****	**9.893*****
	(0.944)		(1.148)	(0.962)
Sample Size	2,478,843	2,271,037	2,478,843	2,344,061

Notes: Each column reports the results for a separate regression. Column (1) is the same as column 2 from Table 2 for comparison purposes. Model (1) includes fixed effect for first subnational administrative region. Model (2) replaces those with mother fixed-effects and therefor the main effect of surface water, low education, and wealth are subsumed in the fixed effects. Model (3) replaces those with country-level fixed effects. Model (4) estimates model (1) restricting treatment to the sample of countries with a DHS survey conducted within 15 years of Nestle entry. Model (5) estimates model (1) restricted to the sample of countries for which Nestle entered after 1984 plus controls All models additionally include fixed effects gender, sex-specific birth order of child, country-specific birth month, and year as well as linear controls for log per capita GDP and per capita GDP growth observed at year of birth. Standard errors clustered at the level of first subnational administrative region. ** ($p < 0.05$) *** ($p < 0.01$).

Supplemental Online Appendix

Data Nestle participation in country infant formula markets are taken from a table listing import and production of different categories of Nestlé products across all countries in which the company operates, a table which has stayed remarkably consistent over the five decades of data we examine (Figure A). While this section has had slightly different titles over time, the layout and structure has been consistent throughout (See Figures A below). We identify the specific category in each year in which baby formula is reported, a category which changes over time and in some cases explicitly identifies infant formula and in others groups it under “Milk-based Dietetic Products” and similar headings which we cross-reference from within the reports. We are able to specifically identify the year Nestlé infant formula imports begin based on the coding of the reports and the year infant formula begins to appear as an import into a given country.

Figure A