Mortality Risks, Health Endowments, and Parental Investments in Infancy: Evidence from Rural India

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Abstract

This paper examines how changes in mortality risks affect intra-household resource allocation across siblings with different initial health endowments. Using nationally representative data from rural India, we find evidence of reinforcing investment in child health – children with relatively smaller birth size are less likely to be immunized and breastfed compared to their larger birth size siblings. This pattern of reinforcing investments is exacerbated in areas with high infant mortality. This finding is robust and cannot be explained by either differences in preferences or access to health infrastructure across high- and low-infant mortality areas.

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Key words: Health endowments, Parental investment, Child health

1. Introduction

Both developed and less developed countries have experienced a dramatic decline in infant mortality rates over the last few decades. World infant mortality rate is estimated to have declined from 198 in 1960 to 83 in 2001. However, infant mortality in less developed countries remains high – roughly 10 times the rate in the developed world. Reducing infant mortality in the less developed world is thus one of the most important development challenges. The millennium development goals have set a target to reduce infant mortality rates by two-thirds from 1990 to 2015.

The direct health benefits of reducing infant mortality are obvious. However, reductions in infant mortality might also have spillover effects that are less well understood. In particular, childhood mortality risks are a major source of risk in the returns to childhood investments. Thus, reductions in mortality risks could affect parental investments in children that have long term implications for children's health and economic well being. For example, Dow et al. (1999) show that the incentive to invest in child health depends inversely on the level of mortality risks. They find evidence that the reduction in mortality risks due to the Expanded Programme on Immunization of the World Health Organization increased parental health investments unrelated to immunization. Similarly, Estevan and Baland (2007), argue that high mortality risks could lead to inefficient investments in human capital. They show that the level of child labor could be inefficiently high when survival is uncertain and parents expect cash transfers from their children. This is because, given the uncertain survival of their child, parents tend to favor a certain investment, such as saving, to an uncertain one, such as human capital.

In this paper we add to this literature by examining how mortality risks affect intra-household resource allocation across siblings with different initial health endowments. We argue that changes in background mortality risks due to public health interventions or greater access to medical care disproportionately affect the survival of the weaker sibling. Thus, reductions in mortality risk not only reduce overall risks but also reduce the mortality gap between siblings with high and low initial health endowments. Since mortality risks are one of the important drivers of returns to parental investments, we argue that decreases in mortality risks should also reduce disparities in parental investments across high and low initial health endowment children. We empirically evaluate this prediction using data from rural India. We use birth size as our measure of initial endowment and show that poor households invest relatively less in children who have small birth size compared to their larger birth size siblings. In addition, this pattern of reinforcing investments is exacerbated in areas with high infant mortality. This finding is robust and cannot be explained by either differences in preferences or access to health infrastructure across high- and low-infant mortality areas.

This paper also makes a direct contribution to the empirical literature on the effect of endowment differences on intrahousehold resource allocation (Griliches, 1979; Behrman et al., 1982; Rosenzweig and Schultz, 1982; Rosenzweig and Wolpin, 1988; Pitt et al., 1990; Behrman et al., 1994; Ayalew, 2005; Datar et al., 2006; Rosenzweig and Zhang, 2006).[1] Previous work in this area has generally treated endowments as observable to parents but unobservable to researchers, and most studies have therefore relied on either functional form assumptions about parents' utility or on the absence of omitted variables in health production functions in estimating the relationship between child endowments and parental investments. Notable exceptions are the recent studies by Datar et al. (2005), and Rosenzweig and Zhang (2006) that use birth weight as a proxy for health endowment and conduct a direct test of whether variation in birth weight across siblings generates differences in parental investments. We adopt a similar approach in this paper, but in the absence of good clinical data on birth weight, utilize birth size as reported by the mother as an indicator of children's initial endowment. Birth size is directly observable to parents, and it has also been found to be highly correlated with birth weight (Moreno and Goldman, 1990). Therefore, as in studies by Datar et al. (2006) and Rosenzweig and Zhang (2006), our measure of endowment is likely to be quite close to that used by parents in assessing the initial healthiness of a child. Additionally, we extend these earlier analyses, by explicitly modeling and testing for the effect of background mortality risk on parental investment strategies.

The rest of the paper is organized as follows. In section 2, we describe the data and variables used for this analysis, and discuss our measures for birth size, parental investments, and background mortality. In section 3, we present a simple model of parental investments. In section 4, we present the results from our empirical analysis. Conclusions are presented in section 5.

2. Data and Measures

We use data from the 1992-93 National Family Health Survey (NFHS). The NFHS surveyed a nationally representative sample of households in India's 26 major states, and the primary respondents were ever-married women in the 13-49 age group. Structured interviews were conducted with the women and the household in which they resided. Detailed information on the survey is available

[1] Behrman et al. (1995) and Behrman (1997) offer excellent reviews of the literature on intrahousehold resource allocation.

at http://www.nfhsindia.org. We use the rural sub-sample of NFHS for our analysis, which has detailed information on 35,318 children between the ages of 0 and 47 months, born to 26,865 mothers who were sampled from the rural primary sampling units. As mentioned before, we would have liked to utilize birth weight information for children as the measure of initial health endowment. However, birth weight is available for less than 10% of the children in our sample[2], whereas information on birth size (small, average, large) is available for more than 98% of the children.[3] Therefore, for the purpose of our analysis, we first restrict our sample to mothers with at least 2 children for whom birth size information is available. Next, we only keep children for whom there is information on at least one of the parental investments examined in the paper. This reduces our sample size to 16,088 children born to 7,891 mothers. The exact sample sizes in our regressions drop further when we exclude observations with missing values for the particular parental investment being examined, and/or with missing values for any of the other variables in our analysis.[4]

We exploit 5 key features of the NFHS for the purposes of this paper. First, the NFHS collected detailed information on each child born to an interviewed woman since January 1988/1989. That is, information was collected on children even if they had died by the time of the survey. For women who had more than one live birth during this 4 year period (1988-89 to 1992-93), information was obtained on the 3 most recent live births. This allows us to examine intrafamily resource allocation decisions over a relatively short time horizon, during which major changes in the socio-economic circumstances of a family are unlikely to occur. This is important because one might be concerned that between-sibling differences in birth size and health investments might simply be a consequence of changes in the family's socioeconomic circumstance at the time of birth of the various siblings.

Second, we have information on birth size for almost all surveyed children, and use this as a proxy for a child's initial endowment. In some ways, birth size may be a better measure of initial health endowment for our analysis

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[2] Missing data on birth weight for a large part of our rural sample is mainly due to the fact that most deliveries in rural India take place outside of health facilities and are done by traditional mid-wives who typically do not measure the newborn's weight at birth.

[3] Moreno and Goldman (1990) report that relative size at birth as reported in the Demographic and Health Surveys (DHS) was of reasonably high quality, and was well correlated with measured birth weights.

[4] In analyses not reported here, we also used the 1998-99 wave of the NFHS (NFHS-2) to estimate similar models, but our estimates from NFHS-2 lacked precision due to a significantly smaller final sample of mothers and children. Hence, we only report results from using NFHS-1 in this paper.

compared to actual birth weight. Birth size is mother-reported and therefore, captures the perceived "healthiness" of the child. Ultimately, it is this perception that is likely to influence parent's decisions, regardless of what the child's actual endowment may be. In rural households, where the majority of births take place outside the formal health care system, birth size may be the only indicator of the live infant's healthiness to the parent.

Third, the NFHS collected information on two key health investments that parents make in their children during infancy and early childhood – breastfeeding and immunizations. This information was collected for each child in the family who was born within the last 4 years, allowing us to estimate family fixed-effect models.

Fourth, the availability of information on maternal and child characteristics, as well as on prenatal investments at the time of each child's birth allows us to control for observable difference across siblings that may be correlated with birth outcomes as well as parental investments.

Finally, the birth history information obtained from each mother allows us to construct a village level measure of infant mortality that captures the background mortality risk for infants in each village.

The main outcomes of interest in our study are health investments that parents make in their children during infancy. In particular, we focus on immunizations and breastfeeding:

1. Whether the child received all age appropriate doses of Polio vaccination.
2. Whether the child received all age appropriate doses of non-Polio, i.e., BCG and DPT vaccinations.
3. Whether the child was breastfed for at least 6 months.

Health investments such as breastfeeding and immunizations during a child's first year are highly recommended (American Academy of Pediatrics, 2000) and are also included as objectives in the various child health programs of the Department of Family Welfare in India (Ministry of Health and Family Welfare, 2006). In order to increase immunization coverage, the Government of India started the Universal Immunization Program (UIP) in 1985-86, which aimed to vaccinate at least 85% of all infants by 1990 against the 6 vaccine-preventable diseases or VPDs (tuberculosis, diphtheria, pertussis, tetanus, poliomyelitis, and measles). The Innocenti Declaration on the Protection, Promotion, and Support of Breastfeeding (1990), and the WHO Working Group on Infant Feeding (WHO, 1991) made several recommendations, which state that infants should be exclusively breastfed for 4 to 6 months. Also, previous research has shown that breastfeeding protects children from a number of diseases including gastrointestinal tract infections, and atopic eczema (Kramer et al., 2001). A systematic review of evidence by the WHO on the optimal duration of exclusive breastfeeding finds that exclusive breastfeeding for at least 6 months can reduce child morbidity from gastrointestinal infections (Kramer and Kakuma, 2002).

Data on immunization were collected in the NFHS through the mother questionnaire for children in the age group of 2-35 months. Mothers were asked about the immunizations received by each of her eligible children, and where possible, this information was verified by cross-checking against the child's vaccination card. Specifically, the survey asked whether the child had received BCG, DPT (all doses), Polio (all doses) and Measles vaccinations. We distinguish between 2 types of immunization coverage – Polio and non-Polio. Since both the timing as well as completeness of vaccinations are important, we follow Datar et al.'s (2006) approach and denote a child as having "full age appropriate coverage" for polio or non-polio vaccinations using Government of India's Recommended Immunization Schedule (Table 1). Thus, for example, a child who is 3 months old, and has BCG, DPT1 and 2, and Polio1 vaccines would be classified as having "fully age appropriate coverage" under the non-Polio vaccine category, but would be classified as not having "fully age appropriate coverage" for the Polio vaccine. This approach allows us to distinguish between children who receive age appropriate coverage and children who are immunized at an older (or younger) age and therefore are exposed to the risk of VPDs for a longer duration of time (or are physiologically not ready for vaccination).

Mothers were asked about their breastfeeding behavior for each of their 3 most recent live births in the past 4 years. The survey questions did not ask about exclusive breastfeeding, but instead focused on any breastfeeding, including when it was initiated and how for long it was done. Following the WHO guidelines, our breastfeeding measure captures whether the child was breastfed for at least 6 months. For the breastfeeding analysis, we restrict our sample to children 6 months and older.

The means and standard deviations of the parental investment variables and other explanatory variables are reported in panels A and B of table 2 – for children in our analysis (those with at least one sibling), and the original sample of children respectively. These suggest that children in our analysis are quite similar to those in the original sample with respect to parental investments as well as other attributes. Based on the summary statistics for our analysis sample (panel A), we find that only about 35% of the children were fully immunized against polio, while only a quarter were fully immunized against non-polio diseases. In contrast, nearly 3 quarters of the children were breastfed for at least 6 months. This suggests that breastfeeding was fairly widespread in rural India, compared to immunization.

Birth size information for each child in the NFHS was reported by the mother retrospectively. Specifically, mothers were asked to report whether a particular child was "large", "average", or "small" when he/she was born, for each of her 3 most recent live births within the 4 years preceding the survey. The median number of months between the child's birth and the mother's report of that child's birth size, or the "recall" period in our sample is 22 months or about 2 years.[5] Nearly a quarter of all children in our sample were smaller than average size at birth (small-at-birth). Additionally, the median age of the mother at birth was 22 years, the median birth order was 3, and exactly half the children were male.

There exists a substantial amount of within-family variation in birth size and parental investments in our data. Table 3 reports the percentage of families with intra-family variation in birth size and health investments. More than 26% of the families in this sample have across-sibling variation in birth size and in age-appropriate polio coverage, and 22% of the families have variation across siblings in age-appropriate non-polio coverage. About 41% of the families have at least one child who was breastfed for 6 months and at least one child who was not.

Finally, we measure background mortality risk by constructing a village level infant mortality rate. Using retrospective birth history data, we aggregate the number of children born in a village within the previous 4 years across all women who were interviewed in that village, and also the number of children who died before the age of one to construct an infant mortality rate for each village in our sample. We classify a village as having high background mortality risk if the infant mortality rate for that village exceeds the median infant mortality rate in the distribution, which is 7% (same as the mean).

3. Theoretical Framework

In this section, we outline a simple model of parental investment in children's health when children's survival is uncertain. We focus on a particular form of discrimination in parental decisions that is conditioned on a child's initial health endowment and is additionally influenced by the infant's background mortality risk. Theories of intra-household resource allocation are inconclusive regarding parental behavior, since they suggest that parents might either adopt a reinforcing strategy (Becker and Tomes, 1976), or they may choose to compensate for low initial endowments by investing more in their less endowed children (Behrman et al., 1982). However, given the preponderance of evidence in favor of reinforcing behavior from both developed and developing countries, we adopt a stylized

[5] This is comparable to the median recall period for birth weight in Datar et al.'s (2006) study that used the National Longitudinal Study of Youth 1979 – Child Data. A recent study using data from the United Kingdom (Tate et al., 2005) found that 82% of mothers reported their baby's weight within 30 grams (~one ounce) of the registration weight and 92% reported their baby's weight within 100 grams when the recall period was about 9 months.

version of the Becker and Tomes (1976) model that predicts that parental investments reinforce initial health endowment differences.[6] In particular, we assume that parents' utility function exhibits equal concern for the health of all children. We also assume that parents do not care about equity in investments; investments only matter in that they increase the health of children. Finally, we assume that the health production function is a separable function of initial endowment and parental investments. These assumptions are made for ease of exposition and do not alter the main prediction of the model that reduction in mortality risks reduces disparities in parental investments across high and low initial endowment siblings.

3.1 Basic model

Our basic model is similar to the traditional "unitary" economic models of intra-household resource allocation (Alderman et al. 1995). Parents derive utility from their own consumption and the health of their children.[7] We assume that there are 2 children in the household – one with a higher initial health endowment than the other.[8] The parents' decision problem can then be written as follows:

$$\textit{Maximize}: U = U(H, Y), \quad U' > 0, U'' < 0$$

$$\textit{Subject to}: H = [\theta_1 h_1 + \theta_2 h_2], M \geq v(x_1 + x_2) + Y$$

Where, h_i is the health of child *i* and θ_i is the survival probability of child *i*. In the basic model, survival probabilities are determined solely by children's innate healthiness or initial endowment, i.e., $\theta_i = g(e_i)$, $g' > 0, g'' < 0$. We assume that the health of child *i* is a separable function of the child's initial health endowment (e_i) and parental inputs (x_i) into the health of child *i*: $h_i = e_i + f(x_i)$. Parents exhibit equal concern for the health of all children and thus only care about the composite health (*H*) of their children. Finally, *v* is the relative price of parental inputs and *Y* is composite consumption.

The first order conditions with respect to x_1 and x_2 yield: $\frac{\theta_1}{\theta_2} = \frac{f'(x_2)}{f'(x_1)}$

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[6] See Datar et al. (2006) for a summary of the literature.

[7] Traditional models of intrahousehold resource allocation include the child's wealth in adulthood in the parental utility function. In our model, child health is a significant predictor of survival into adulthood, at which point the adult child's wealth becomes the parent's source of consumption.

[8] The predictions from this model can be easily extended to families with more than 2 children. In the case of households with a single child, the resource allocation decision involves tradeoffs between the child's health and consumption of other goods.

The first order conditions imply that parents undertake health investments up to the point where marginal returns from such investments are equalized across the 2 children. If $e_1 > e_2$, then $\theta_1 > \theta_2$, since, $\theta_i = g(e_i)$, and $g' > 0$. Therefore, from equation (1), $f'(x_1) < f'(x_2)$ or, $x_1 > x_2$. Thus, the model predicts that parents will choose to invest more in the health of the better endowed child, i.e., they will adopt a reinforcing strategy. In the basic model described above, parental beliefs about a child's survival are a function of health endowments alone. Below, we extend this model to examine the likely effect of background mortality risk on parental investment behavior.

3.2 Effect of background mortality risk

We now assume that the child's survival probability depends upon the background mortality risk and his or her own endowment. In particular, the survival probability is decreasing in the background mortality risk (*m*), but the extent to which it decreases is a decreasing function of the child's initial endowment i.e. $\theta_i = g(e_i, m)$, $g_e > 0, g_m < 0,$ and $g_{em} < 0$. Therefore, when the background mortality risk increases, the survival probabilities of both children will decrease, but will decrease less for the better endowed child. Consequently, in a village with a higher background mortality risk, the less endowed or low birth size child is relatively worse off than before as far as parental beliefs about her survival are concerned. Since the gap between θ_1 and θ_2 increases (in absolute terms) with θ_2 declining more than θ_1, the left hand side of the first order condition will increase. Concavity of the health production function implies that at the new optimum, x_1 will be even higher than x_2. Hence, the model predicts that increases in background mortality risk will strengthen the reinforcing pattern of parental investments. This prediction is clearly the result of our assumption that the gap between θ_1 and θ_2 increases with mortality risk. Ultimately, the validity of this assumption is an empirical question which we test in the subsequent sections.

4. Empirical Strategy

The theoretical model described above generates the following demand equations for parental health inputs that show that parental investments into their child's health are a function of the child's endowment, background mortality risk, price of parental inputs, and income:

$$x_i^* = x_i^*(e_i, m, \nu, M) \quad i=1,2 \qquad (1)$$

An econometric model for these input demand functions can be written as follows:

$$I_{if} = \beta_1 small_{if} + \beta_2 small_{if} * highmortality_f + \beta_3 X_{if} + \gamma_f + \phi_i + \varepsilon_{if} \qquad (2)$$

where "*i*" indexes child, and "*f*" indexes family. The dependent variable, *I*, is an indicator for whether a child received a specific parental investment or not. A child's own endowment is captured by the variable *small*, which is an indicator for whether the child was smaller than average birth size.[9] The variable *highmortality* is a village level indicator for whether the infant mortality rate in that village was greater than 7%. The vector X_{if} includes other child- and family-specific characteristics that may influence parental investment, child survival and birth outcomes (e.g. gender, income, price of health inputs). In addition to these "observed" characteristics are a set of unobservable factors that affect parental investments – γ_f represents unobserved endowments and environmental influences (pre- and post-natal) common to all siblings in a family and ϕ_i represents unobserved child-specific factors that are correlated with parental investments and birth outcomes. Finally, ε_{if} is an idiosyncratic error term. The key parameters of interest in equation (2) are β_1 and β_2. β_1 captures the effect of own-endowment on parental investment. β_2 captures the additional effect of own-endowment in areas where the background mortality risk is high.[10] The model that we estimate, however, is the following:

$$I_{if} = \alpha_1 small_{if} + \alpha_2 small_{if} * highmortality_f + \alpha_3 X_{if} + \gamma_f + \nu_{if} \qquad (3)$$

where, $\nu_{if} = \phi_i + \varepsilon_{if}$. While the mother fixed-effect γ_f controls for the influence of all unobserved family specific factors correlated with parental investment and birth outcomes, one might be concerned that the error term may still include sibling-specific factors that are correlated with parental investment and birth outcomes. Below, we discuss 3 reasons why such concerns are minimized, if not eliminated. First, we include a number of sibling-specific controls in X_{if} such as gender, birth month, birth order, mother's age at birth, and a host of prenatal investments in child *i* such as whether the mother received iron folic tablets

[9] Dow et al. (1999) also use this as their measure of low birth weight.

[10] The direct effect of *highmortality*, which does not vary across siblings within a family, cannot be estimated in this model due to the inclusion of the family fixed effect.

during pregnancy, whether she was given tetanus injections before birth, and the trimester of her first antenatal visit. Inclusion of these covariates will absorb a lot of the important sibling-specific heterogeneity contained in the error term. Second, the siblings within a family are all born within a relatively short time period. This significantly reduces the likelihood that aspects of family circumstance, not already captured by our covariates, changed enough between the birth of the 2 siblings to affect their birth size and parental investments. Third, if the bias from sibling-specific heterogeneity remains the same across high and low infant mortality villages, then the estimated α_2 will be unbiased, because α_2 captures the differential effect of being small in high mortality areas.[11]

We estimate equation (3) using linear probability models and adjust the standard errors for clustering at the family level (Bertrand et al 2004).

5. Results

We begin by reporting estimates from a special case of the model in equation (3) that assumes there are no differences in parental response to birth size across high- and low infant mortality areas i.e. $\alpha_2 = 0$. Panel A in Table 4 reports the estimated effects of being smaller-than-average birth size on the likelihood of receiving age-appropriate polio and non-polio immunizations and breastfeeding for at least 6 months. We find that children with smaller birth size are significantly less likely to be immunized against both polio and non-polio diseases relative to their larger birth size siblings; smaller birth size siblings have a 4 and 3 percentage point lower likelihood of being immunized against polio and non-polio diseases, respectively, and both these effects are significant at the 1% level. However, a child's relative birth size does not significantly affect her chances of being breastfed for at least 6 months. Among other covariates in the model, gender, maternal age and prenatal investments are associated with immunizations, but not with breastfeeding. Boys[12] and siblings born when the mother is younger and when she took tetanus injections and iron folic tablets

[11] To see this, let δ_1 and δ_2 be the estimated coefficients on *small* from 2 separate regressions that estimate equation (3) using the low mortality and high mortality subsamples, respectively. The difference $\delta_2 - \delta_1$ is equal to the estimate α_2 from equation (3). If $\delta_1 = \beta_1$+bias and $\delta_2 = \beta_1 + \beta_2$+bias then $\delta_2 - \delta_1 = \beta_2$.

[12] To examine the hypothesis that parental response to birth size differences between their children might depend upon whether the small birth size child is a boy or girl, we tested for the interaction between birth size and gender in an alternate specification (results available from the authors upon request). The interaction effect was not statistically significant, and all other estimated parameters were same as before.

during pregnancy have a significantly greater likelihood of receiving polio and non-polio immunizations. For breastfeeding, first borns are less likely to be breastfed for 6 months and younger mothers are less likely to breastfeed for 6 months or more.

Panel B in Table 4 reports estimates from the model in equation (3). The interaction term tests whether parents residing in villages with a high infant mortality rate are more likely to adopt a reinforcing strategy compared to parents in villages with lower background mortality. Our results confirm this hypothesis. In high infant mortality villages, a small birth size child is about 6 and 4 percentage points less likely to be immunized for polio and non-polio vaccines, respectively, compared to her better endowed siblings. However, there is no significant effect of a child's birth size on immunizations in low infant mortality villages. Further, the same reinforcing pattern in parental investments is now observed for breastfeeding as well. In high mortality villages, a small birth size child is about 4 percentage points less likely to be breastfed for at least 6 months compared to her larger birth size siblings. As in the case of immunizations, there is no significant effect of birth size on breastfeeding in low mortality villages.[13]

6. Robustness Checks

In this section we report results from 3 robustness checks. The first analysis tests the sensitivity of our main results to presence of other small-at-birth siblings in the household. The second analysis examines whether our results are driven by differential preferences for discrimination across high- and low- infant mortality villages. And finally, our third analysis tests whether our results are explained by differences in health infrastructure availability across high- and low- infant mortality villages.

6.1. Controlling for the Presence of Other Small-at-Birth Siblings in the Household

As pointed out in Datar et al. (2006), other siblings' endowments could also impact the amount of investment parents make in child *i*. Presence of other less-

[13] We also estimated equation (3) with a continuous measure of infant mortality at the village level instead of the indicator for high mortality. The results were similar to those reported above. Additionally, we compared villages above the 75th percentile in the distribution of the infant mortality rate with those below the 25th percentile, instead of looking at villages above and below the median. Once again, results were similar suggesting a stronger reinforcing pattern in villages with high background mortality risk.

endowed siblings in the household might increase or decrease the level of parental investment in a child because, first, the realization of a low endowment child might raise parental concern for all children and therefore increase the levels of all subsequent investments, and second, parents' *ability* to either reinforce or compensate for endowment differences would depend upon the endowments of other children in the household who compete for the same limited family resources. Since a child's endowment is likely to be correlated with that of his or her siblings, failure to control for siblings' endowment may lead to biased estimates of the effect of birth size on parental investments.

To check the robustness of our results, we reestimate equation (3) with the inclusion of another dummy variable that captures whether the child has any siblings who were also small-at-birth and are currently alive (results reported in Table 5). This variable is measured during the first year of child *i*'s life, when majority of the immunization and breastfeeding investments are made. The value of this variable varies across siblings. We find that the presence of other small-at-birth siblings does not have any significant effect on parental investments in a child – as shown by the estimated coefficients on "any small-at-birth siblings present". Moreover, the effect of birth size on immunizations remains virtually unchanged – both in terms of magnitude and the direction of effects.

6.2. Do Preferences for Discrimination Explain the Stronger Reinforcing Effects in High Mortality Villages?

It may be possible that villages that have a high background mortality risk are also those that have generally higher preferences for discrimination. If this were true, the evidence of stronger reinforcing effects in high mortality villages might be the result of such preferences rather than the result of background mortality *per se*. To test this alternate explanation, we examine intra-household gender differences in parental investments across high- and low- infant mortality villages. If the stronger reinforcing effects in high mortality villages are driven purely by preferences for discrimination then we should find that parents in high mortality villages are more likely to discriminate between their sons and daughters.

Table 6 reports estimates from models that include an additional interaction term for male child and high background mortality. There are 3 notable results from this analysis. First, our main finding that parents in high mortality villages are more likely to reinforce birth size differences remains unchanged. Second, consistent with the prior literature, we also find that parents are significantly more likely to immunize their sons compared to daughters. And finally, the insignificant coefficient on the male-high mortality interaction suggests that parents in high mortality villages do not have any different preferences for gender discrimination compared to parents in low mortality villages.

6.3. Does Differential Availability of Health Infrastructure Explain the Stronger Reinforcing Effects in High Mortality Villages?

One might be concerned that villages with high infant mortality also have inadequate health infrastructure. If this were true, the evidence of stronger reinforcing effects in high mortality villages might be the result of differential health infrastructure availability rather than the effect of background mortality *per se* (Oster, 2006). To address this concern, we examine whether the interaction between *small* and *highmortality* is significantly different in villages that have at least a Primary Health Center (PHC) compared to villages that do not have a PHC. [14]

Table 7 reports estimates from models that include a triple interaction term for *small*, *highmortality*, and an indicator for whether there is a PHC or bigger health facility in the village. Two main results stand out from this analysis. First, parents' response to differences in their children's birth size is not influenced by whether there is a PHC present in the village. And second, the triple interaction term is statistically insignificant for all investments suggesting that the stronger reinforcing effect found in high mortality villages is not explained by differences in health infrastructure availability.[15]

Finally, note that there could be concerns with unobserved economic shocks that affect both birth size and parental investments. Therefore, we performed 2 tests to see if unobserved economic shocks were driving our results. First, we re-estimated our models with births spaced within 2 years of each other and second, we estimated models with and without child level covariates. Our results are robust to both these tests. The point estimates from test 1 are similar to the full sample, although the standard errors are larger as we drop more than 50% of the observations due to the restriction of closer spaced births. The results from test 2 show that our results are virtually unchanged when we add child level covariates, including prenatal investments. Both these tests suggest that it is unlikely that our results are driven by unobserved economic shocks. These results are not reported in the interest of brevity but are available on request.

[14] Using NFHS data, Datar et al (2007) found that presence of a PHC or bigger health facility in the village had a significant impact on immunizations, but smaller sizes facilities had no effect.

[15] We obtained similar results by reestimating the regressions reported in tables 6 and 7 with a continuous measure of infant mortality at the village level (instead of the indicator for high mortality).

7. Conclusions

In this paper, we examined the relationship between a child's initial health endowment, measured by birth size, and parental investments that promote child health, when infants' survival is uncertain. Using data from rural Indian households, we estimated mother fixed-effects models to examine whether there were any systematic differences in health investments such as immunizations and breastfeeding across children who were relatively larger-at-birth compared to their small-at-birth siblings. We found that parents adopted a reinforcing strategy of investments in child health whereby larger-at-birth children were significantly more likely to be immunized and breastfed for 6 months compared to their small-at-birth siblings. In addition, this reinforcing pattern in parental investments was especially observed in areas with high infant mortality. In villages with high infant mortality, small-at-birth children in a family were 4-6 percentage points less likely to receive these health investments compared to their large-at-birth siblings.

These results show that children's endowment differences as well as background mortality risk can have sizeable impacts on intra-household resource allocations in a developing country. They also show that reductions in mortality can not only improve overall population health but also reduce health disparities. Reductions in mortality affect less endowed and weaker children more than healthy children. Thus, they create unique incentives for parents to invest in weaker children, consequently reducing health disparities.

The results also highlight that public health investments do not crowd out private investments in child health. In fact, they are complements. For example, public health interventions that improve birth weight are likely to encourage parental investments such as immunizations and breast feeding. Dow et al. (1999) make a similar argument in their study that showed that women were more likely to increase inputs into birth weight when the United Nation's Expanded Programme of Immunization (EPI) was implemented. By decreasing the probability of child mortality from any of the 6 vaccine preventable diseases, the EPI increased mothers' incentives for improving birth outcomes.

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Appendix

Table 1: Government of India's Recommended Immunization Schedule

Age (weeks)	Age (months)	BCG	DPT	Polio	Measles	Age Appropriate Coverage for all India
Birth	0	X		X[1]		BCG
6 weeks	1.5		X	X		BCG + DPT1 + Polio1
10 weeks	2.5		X	X		BCG + DPT1-2 + Polio1-2
14 weeks	3.5		X	X		BCG + DPT1-3 + Polio1-3
36 weeks	9.0				X	BCG + DPT1-3 + Polio1-3 + Measles

[1] Polio vaccination at birth is recommended in all institutional deliveries and in all endemic areas.

Source: Universal Immunization Program Division, Department of Family Welfare, Min. of Health & Family Welfare http://cbhidghs.nic.in/hii2003/12.01.htm

Table 2: Summary Statistics

	Panel A: Analysis sample				Panel B: Full sample			
Variable	Mean	Median	Std. Dev.	Obs.	Mean	Median	Std. Dev.	Obs.
Parental investments								
Age appropriate Polio coverage	0.35	0	0.48	16015	0.38	0	0.49	35174
Age appropriate non-Polio coverage	0.25	0	0.43	15757	0.27	0	0.44	34590
Breastfed for at least 6 months	0.72	1	0.45	15984	0.78	1	0.42	34980
Explanatory variables								
Small-at-birth	0.23	0	0.42	16088	0.22	0	0.41	34760
Sex of child (Male =1)	0.50	1	0.50	16088	0.51	1	0.50	35318
Birth order	2.71	3	1.11	16088	2.58	3	1.20	35318
Month of birth	6.82	7	3.39	16088	6.79	7	3.41	35318
Age of Child if alive (months)	22.90	22	15.15	14348	22.67	22	13.93	32408
Any small-at-birth siblings present in household	0.08	0	0.27	16088	0.04	0	0.19	35318
Mother's age at birth (years)	23.37	22	5.26	16088	23.82	23	5.78	35318
Given iron folic tablets during pregnancy	0.44	0	0.50	16082	0.45	0	0.50	35145
Tetanus injections before birth	1.20	1	1.22	15996	1.26	1	1.23	34960
First antenatal visit in 1st trimester	0.18	0	0.38	16088	0.19	0	0.40	35318
First antenatal visit in 2nd trimester	0.27	0	0.44	16088	0.27	0	0.44	35318
First antenatal visit in 3rd trimester	0.11	0	0.31	16088	0.11	0	0.31	35318
Background variables								
High infant mortality in village	0.56	1	0.50	16088	0.54	1	0.50	35318
Health infrastructure (at least PHC) in village	0.16	0	0.36	16088	0.17	0	0.37	35318

Source: National Family Health Survey – Wave I (1992-93)

Note: Summary statistics have been adjusted with sampling weights

Table 3: Within family Variation in Birth size, Parental Investments, and Other Variables

Continuous Variables	Percent of total variance explained by within-family variation
Number of Tetanus injections before birth	29.05%
Mother's age at birth (years)	9.40%
Birth order	33.14%
Month of birth	87.44%
Age of Child if alive (months)	100.00%
Dichotomous variables	Percent of families with within variation
Age appropriate Polio coverage	26.47%
Age appropriate non-Polio coverage	22.00%
Breastfed for at least 6 months	40.81%
Small-at-birth	26.49%
Any small-at-birth siblings present in household	15.52%
Given iron folic tablets during pregnancy	14.54%
First antenatal visit in 1st trimester	15.60%
First antenatal visit in 2nd trimester	24.53%
First antenatal visit in 3rd trimester	12.72%
Sex of child (Male =1)	51.32%

Table 4: Effect of Birth Size and Background Mortality on Parental Investments

	Age appropriate polio coverage	Age appropriate non-polio coverage	Breastfed for 6 months
	(1)	(2)	(3)
PANEL A			
Small-at-birth	-0.038***	-0.032***	-0.01
	(0.01)	(0.01)	(0.01)
Observations	15679	15269	8571
Number of mothers	7,616	7,418	4,240
PANEL B			
Small-at-birth	-0.006	-0.009	0.009
	(0.02)	(0.02)	(0.01)
Small-at-birth * High IMR in village	-0.057***	-0.042**	-0.041**
	(0.02)	(0.02)	(0.02)
Observations	15,679	15,269	8,571
Number of mothers	7,616	7,418	4,240

Notes: Estimates are from mother fixed-effects models that include the following covariates: mother's age at birth, whether the mother received iron folic tablets during pregnancy, number of tetanus injections received by the mother during pregnancy, dummies for the trimester of first antenatal care visit, and dummies for birth order and birth month. Figures in parentheses are standard errors. * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

Table 5: Sensitivity of Birth Size Effects to Presence of Other Small-at-Birth Siblings in the Household

	Age appropriate polio coverage	Age appropriate non-polio coverage	Breastfed for 6 months
	(1)	(2)	(3)
Small-at-birth	-0.045***	-0.036***	-0.007
	(0.012)	(0.011)	(0.011)
Any small-at-birth siblings present	-0.024	-0.013	0.006
	(0.017)	(0.017)	(0.014)
Observations	15,679	15,269	8,571
Number of mothers	7,616	7,418	4,240

Notes: Estimates are from mother fixed-effects models that include the following covariates: mother's age at birth, whether the mother received iron folic tablets during pregnancy, number of tetanus injections received by the mother during pregnancy, dummies for the trimester of first antenatal care visit, and dummies for birth order and birth month. Figures in parentheses are standard errors. * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

Table 6: Effect of Background Mortality Risk on Gender Differences in Parental Investments

	Age appropriate polio coverage	Age appropriate non-polio coverage	Breastfed for 6 months
	(1)	(2)	(3)
Small-at-birth	-0.006	-0.009	0.009
	(0.02)	(0.02)	(0.01)
Small-at-birth * High IMR in village	-0.060**	-0.038	-0.042**
	(0.03)	(0.02)	(0.02)
Male child	0.046***	0.036***	0.009
	(0.01)	(0.01)	(0.01)
Male * High IMR in village	-0.012	-0.02	0.00
	(0.02)	(0.02)	(0.01)
Observations	15,679	15,269	8,571
Number of mothers	7,616	7,418	4,240

Notes: Estimates are from mother fixed-effects models that include the following covariates: mother's age at birth, whether the mother received iron folic tablets during pregnancy, number of tetanus injections received by the mother during pregnancy, dummies for the trimester of first antenatal care visit, and dummies for birth order and birth month. Figures in parentheses are standard errors. * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

Table 7: Effect of Health Infrastructure Availability on Parental Investments

	Age appropriate polio coverage	Age appropriate non-polio coverage	Breastfed for 6 months
	(1)	(2)	(3)
Small-at-birth	-0.003	-0.007	0.013
	(0.018)	(0.017)	(0.014)
Small-at-birth * High IMR in village	-0.056**	-0.037*	-0.037*
	(0.024)	(0.022)	(0.020)
Small-at-birth * at least PHC in village	-0.017	-0.007	-0.014
	(0.038)	(0.039)	(0.032)
Small-at-birth * at least PHC * High IMR	-0.012	-0.03	-0.021
	(0.055)	(0.057)	(0.048)
Observations	15,679	15,269	8,571
Number of mothers	7,616	7,418	4,240

Notes: Estimates are from mother fixed-effects models that include the following covariates: mother's age at birth, whether the mother received iron folic tablets during pregnancy, number of tetanus injections received by the mother during pregnancy, dummies for the trimester of first antenatal care visit, and dummies for birth order and birth month. Figures in parentheses are standard errors. * Significant at 10%, ** Significant at 5%, *** Significant at 1%.