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ABSTRACT

This paper uses data from the three Indian National Family Health Surveys (1992-93, 1998-99, 2005-06) to examine how the relationship between household wealth and child mortality evolved during a time of significant economic change in India. The main predictor is a new measure of household wealth that captures changes in wealth over time. Outcomes include neonatal mortality, postneonatal mortality, child mortality, and under-five mortality. Multivariate analysis is conducted at the national, urban, rural, and regional levels.

Results indicate that the overall relationship between household wealth and mortality weakened over time, as evidenced by the coefficients for under-five mortality at the national level. However, this result is dominated by the relationship between household wealth and neonatal mortality (deaths at ages 0-30 days). Examining mortality exclusively at older ages (deaths between the ages of 1-4 years) for urban and rural areas separately reveals a different pattern. The relationship between household wealth and child mortality actually became stronger in rural areas suggesting that in these areas, the burden of ensuring child survival is increasingly being borne by households, possibly due to a weakening of complementary public inputs into child health.

INTRODUCTION

India is home to almost three-quarters of South Asia‘s population under age five, and 20% of the world‘s under-five population (UNICEF, 2008 a). In 2000 India had more under-five deaths than any other country—over 2.4 million, almost three times as many as the next largest contributor, Nigeria, with 834,000 deaths (Black, Morris et al., 2003). In India more than 1 child in every 18 dies within the first year of life, and more than 1 in every 13 dies before reaching age five (International Institute for Population Sciences and Macro International, 2007).

In 2006, as in the past, India‘s under-five mortality rate (U5MR) was significantly higher in rural areas, at 82 deaths per 1,000 live births, than in urban areas, at 52 deaths per 1,000. Considerable regional disparities within the country exist as well. Southern states, such as Kerala (16 deaths per 1,000 live births), have relatively low under-five mortality, while states in the Central region, such as Uttar Pradesh (96 deaths per 1,000), have the highest under-five mortality.

Under-five mortality is an important development indicator, and these high mortality rates must not deflect attention from the fact that India has made great progress in recent years. The U5MR has been declining steadily. In the five-year period preceding India‘s 2005-06 National Family Health Survey (NFHS), the U5MR was 74 deaths per 1,000 live births, down from the 1998-99 NFHS estimate of 95 per 1,000, and the 1992-93 NFHS estimate of 109 per 1,000. These significant mortality declines occurred during a time of immense economic growth in India. But there is considerable debate on whether this economic growth benefited everyone, and whether it benefited everyone equally.

At the heart of this debate is whether the structural adjustment program of the early 1990s had desirable or undesirable consequences. The economic reforms initiated as part of this program emphasized liberalization, privatization, and a retreat of the state in general. Many have argued that these new policies had an adverse effect on levels of poverty and inequality (Sen, 1996). Conservative estimates suggest that the pace of poverty reduction in the late 1990s was no different than in the previous decade, and that the absolute number of poor remained steady, or even increased slightly in the 1990s. More generous estimates suggest that the number of poor decreased by almost 30 million between 1993-94 and 1999-2000 (Himanshu and Sen, 2005).

There is more consensus on the issue of inequality, with most scholars agreeing that there were increases in inequality at the national level, within and between states, and within and between rural and urban areas (Himanshu and Sen, 2005; Deaton and Dreze, 2002).

Given that child mortality is closely tied to economic welfare, these macro-level trends in mortality and poverty prompt the question of what happened at the micro or household level. If the role of the state indeed diminished, were household factors increasingly responsible for producing improvements in child survival? Suppose that public spending directly or indirectly subsidizes the cost of a household procuring better health outcomes for its children. If it is true that India‘s recent economic growth was not pro-poor and involved a reduction in these subsidies to poorer people, then household income must have become more important over the years as a factor in improving child survival.

In this paper, we take a look at how the relationship between household wealth and child mortality has evolved between the mid-1980s and mid-2000s. The next section discusses the determinants of child survival, paying special attention to material determinants of survival.

Determinants of Child Survival

Historically, mortality reductions in various societies have been achieved through a combination of improved nutrition and economic growth, public health measures such as sanitation, clean water, and promotion of personal health practices, and medical innovations including vaccination, antibiotics, and intensive personalized interventions. Under optimal conditions, over 97% of newborns can be expected to survive until at least age five. Decreases in this survival probability are generally due to social, economic, biological, and environmental forces.

In their influential essay, Mosley and Chen (1984) proposed a comprehensive analytical framework for studying the determinants of child survival in low-income settings. Their emphasis was on integrating the usually distinct approaches taken by social scientists and medical scientists to the study of child health. The framework itself is based on the idea that all social and economic determinants of child morbidity and mortality necessarily operate through a set of proximate determinants, which in turn influence the risk of disease and the outcome of

disease processes. In our paper, to the extent that the data permit, we include a number of proximate and socioeconomic determinants in our model of child survival, with the primary focus on household income, which is an important socioeconomic determinant in Mosley and Chen‘s model.

Child survival is more sensitive than most other health outcomes to the effects of material deprivation (Marmot, 2005). The leading causes of under-five deaths in poor countries include neonatal disorders (preterm births characterized by low birthweight, asphyxia, and tetanus), pneumonia, diarrhea, malaria, and measles. In addition, malnutrition is an underlying cause of nearly half of these child deaths. The solutions to these causes of death are known. Adequate maternal nutrition and treatment of infections during pregnancy improve birthweight and reduce chances of asphyxia (Tucker and McGuire, 2004). Skilled attendance at delivery decreases risks of asphyxia and also of infection during the birthing process. Administering the tetanus toxoid vaccine to pregnant women prevents tetanus infections. Vaccines and antibiotics in combination with better nutrition can eliminate most cases of pneumonia (UNICEF, 2008 b; WHO/UNICEF, 2009). Safe water and sanitation and simple rehydration therapy can prevent diarrheal deaths. Insecticide-treated bednets and malaria prophylaxis can significantly reduce child deaths from malaria. Measles deaths can easily be prevented with a routine measles vaccine.

A major constraint on implementing these solutions is the shortage of resources, at multiple levels. Mosley and Chen (1984) identify a macro-level variable, the political economy, as an important determinant of child health. The mode of production and distribution of benefits, the physical infrastructure, and the political institutions all exert an autonomous influence on child survival through proximate determinants, but they also affect the micro-level determinants of child survival. India has experienced dramatic macroeconomic changes in recent decades, accompanied by microeconomic changes in the welfare of households, which serve as the backdrop for the analyses in this paper. These changes are discussed in the next section.

Economic Change in India

India‘s impressive economic growth over the past three decades has inspired dramatic pronouncements such as ―The Indian giant is rising like Gulliver after being released from the web of threads with which he had been pinned down” (Rothermund, 2008). A series of post-

independence economic policies and developments preceded this impressive growth. These developments have implications for our understanding of trends in the determinants of child survival over the past two to three decades. When India became independent in 1947, the socialist vision of the leadership meant that the state would play a significant role in the economy. The 1950s consequently were marked by an emphasis on state investment in heavy industry such as iron and steel manufacturing, and large infrastructural projects such as dams. The Green Revolution in agriculture in the 1960s jumpstarted a decline in poverty that continued into the 1970s. As an agricultural revolution, it obviously benefited rural areas but its benefits also extended to urban areas through its effects on food prices and wages (Banerjee, Benabou et al., 2006).

The period that our analysis covers starts in the mid-1980s, with the beginnings of deregulation and increased domestic demand, accompanied by the expansionary fiscal stance of the government. Together these led to a breakthrough in GDP growth and was paralleled by continued declines in poverty. While some have claimed that India‘s economic growth in the 1980s left the poor behind and also brought an increase in overall inequality, stronger evidence suggests that the macroeconomic growth did benefit people far below and even near the poverty line, and that growth was not linked to any noticeable increases in inequality (Datt and Ravallion, 2002).

Growth in GDP continued into the 1990s but the decade started with a fiscal crisis that necessitated a series of reforms. These included fiscal consolidation and stabilization, tax reforms, agricultural sector reforms, and policy changes related to industry, foreign investment, trade and exchange rates, and the public and financial sectors (Jha, 2004). What happened to poverty and inequality in the 1990s following these economic reforms is less clear than what happened in the 1980s. Some have argued that poverty levels continued to decline at the previous decade‘s pace (Datt and Ravallion, 2002), while others have argued that poverty declined much more rapidly in the 1990s (Bhalla, 2000). Still others have argued that the decline stalled and the poverty rate may have even increased (Sen, 2001). While the question of poverty decline has been contentious, there is more consensus on inequality in the 1990s (for a discussion, see Pal and Ghosh, 2007). Several scholars agree that inequality increased along several dimensions—at the national level, between states, within states, within rural areas, within urban areas, between rural and urban areas, and so forth (Himanshu and Sen, 2005; Deaton and Dreze, 2002).

The Role of the State

The fact that the increases in economic inequality followed the introduction of economic reforms that emphasized privatization, liberalization, and globalization directs our attention to the Coburn thesis (Coburn, 2000). Coburn urges scholars to look beyond the relationship between socioeconomic status (SES) and health, and beyond health inequalities, to examine the causes of SES inequalities themselves. His explanation for SES inequalities centers on the rise of neo-liberalism and its undermining of the welfare state. The basic assumptions of neo-liberalism are that markets are the best and most efficient allocators of resources, that societies are composed of autonomous individuals motivated chiefly by economic considerations, and that competition is the major market vehicle for innovation. Arguably, India adopted this philosophy (at least partially) starting in the mid-1980s.

The rise of neo-liberalism is also historically tied to the decline of the welfare state, which has the ability to correct inequalities generated by the market, through labor market policies, social welfare measures, and the decommodification of education and health, for example (Coburn, 2000). In India, the role of the state did in fact diminish following the reforms. Public investment as a percentage of GDP was much lower in the 1990s compared with the 1980s, as public investment did not keep pace with GDP growth (D‘Souza, 2007). Also, the annual growth rate of total government spending was lower in the 1990s compared with the 1980s (Murty and Soumya, 2009). Public investments in health declined. Central government spending on public health fell between 1990 and 2001. Transfers to states as a proportion of the total budget of the Ministry of Health and Family Welfare declined sharply, from about 57% to 44%. Health is constitutionally a state subject in India and is thus financed primarily by the state governments. By the early 2000s, budgetary allocations by states to the health sector were almost a third lower than in the mid-1980s (National Commission on Macroeconomics and Health, 2005).

The state has an important role to play in improving child health, in many ways—for example, by ensuring food security, providing physical infrastructure, implementing disease-control measures, and offering subsidies (Mosley and Chen, 1984). Specifically, public programs can affect health outcomes in three ways (Schultz, 1984):

1. They can reduce the price of health inputs, either directly by subsidizing goods and services, or indirectly by increasing access to them, thereby reducing the costs and time involved in using the services.
2. They can provide information on how to produce health more efficiently. This might include information on new inputs or best practices with traditional inputs—for example, how long to breastfeed or how to sterilize baby formula—that yield better health outcomes for a given expenditure.
3. They can alter the health environment, without directly affecting other opportunities available to people. Malaria control and smallpox eradication are often cited as examples. Such exogenously introduced changes in health conditions or technology affect everyone living in the area, regardless of their economic status or educational attainment.

Public goods thus complement household investments in child health. As an example, consider health spending. One important element of child health is health care, both preventive and curative. Generally, governments and households jointly bear the costs of health care. In 2001-02, the Government of India commissioned a systematic study of health spending, producing the first national health accounts for India. The results indicated that 65-75% of total health spending (including both adults and children) came from households, almost three times the amount spent at all levels of government (Economic Research Foundation 2006). This shows an inordinately high burden on households. In developed countries government health expenditures usually far exceed private spending, while in developing countries the ratio of public to private health spending is about 2:1. India‘s health care spending pattern, therefore, is truly an exceptional case among low-income countries as well as developed countries.

Research Question/Hypothesis

We know that child survival in India has improved over time, on average. If these improvements occurred despite the apparent retreat of India‘s welfare state, it is possible that there were (more than) compensatory changes in the role of household-level factors. We thus

examine changes over time in the role that household wealth[1], an important household-level factor, has played in influencing child survival. The primary hypothesis is that household wealth became more important as a determinant of child health from one survey to the next. Urban/rural and regional disparities in levels and trends in economic development as well as in child survival lead us to investigate this hypothesis at these geographic levels as well. If household wealth has indeed become a more important determinant, this would imply an increase in inequalities in child survival—suggesting missed opportunities for public intervention that could have improved equity.

While a vast body of research documents the relationship between household economic well-being and child survival (Wagstaff et al., 2004), only a handful of studies document this relationship in India in recent years. All of these studies find significant differentials in child survival, health, and healthcare outcomes at the various levels of geographic aggregation (Gwatkin et al., 2007; Mohanty and Pathak, 2008; Pathak, 2009; Gaudin and Yazbeck, 2005; Pande and Yazbeck, 2003). Our study makes an important contribution to this literature by virtue of a unique combination of factors: (i) the use of mortality as an outcome; (ii) multivariate analysis conducted in conjunction with bivariate analysis; (iii) a long study period spanning the years 1992-2005; and (iv) last but most important, beyond examining within-year inequalities, a focus on examining the _absolute‘ relationship between wealth and child survival. Previous studies have looked at relative inequalities in child health outcomes within a single survey year and then have compared these relative inequalities across years. We use instead a measure of wealth that keeps the reference group constant, to estimate the changing effect of wealth on child survival.

[1] While ideally we would use household income as a predictor, it is difficult to measure accurately and consequently not measured in most demographic surveys in developing countries. See Rutstein and Johnson (2004) for an excellent discussion.

DATA

Data for this analysis come from the Demographic and Health Survey (DHS) series known as the National Family Health Surveys (NFHS) in India. The NFHS program started in the early 1990s and has become an important source of data on India‘s population, health, and nutrition at the national and state levels (IIPS and Macro International, 2007). To obtain reliable estimates at the state level, a stratified random sampling design was used within each state. In rural areas the sample was selected in two stages, where primary sampling units (PSU) or villages were selected first with probability proportional to population size (PPS), followed by selection with equal probability of households within PSU. In urban areas the sample was selected in three stages. First, wards were selected with PPS, followed by selection of one census enumeration block (CEB) within each ward, again with PPS. Finally, households were randomly selected within each selected CEB[2].

One of the fundamental aims of these surveys was to obtain reliable estimates of the parameters of interest at various geographic levels (states, urban/rural, metropolitan cities), so target sample sizes were determined based on the lowest level of aggregation at which estimates were needed. This meant that ultimately the national sample size was unusually large by survey standards. In 1992-93, interviews were conducted with a 99% nationally representative sample of 89,777 ever-married women age 13-49 living in 88,562 households, in 24 states and Delhi (then a union territory). In 1998-99, the survey covered a nationally representative sample of 89,199 ever-married women age 15-49 living in 91,196 households, in 26 states. In 2005-06, interviews were conducted with 124,385 women age 15-49 living in 109,041 households, in the 29 states of India (http://www.nfhsindia.org).

Four survey instruments were used: a woman‘s questionnaire, a men‘s questionnaire, a household questionnaire, and in rural areas a village questionnaire. Relevant to our study are the data tabulated from responses to the women‘s and household questionnaires. Women who were usual residents of the selected household or visitors who stayed in the selected household the night before the survey are interviewed using the woman‘s questionnaire. Information on children and mortality comes from the complete birth history recorded for all interviewed

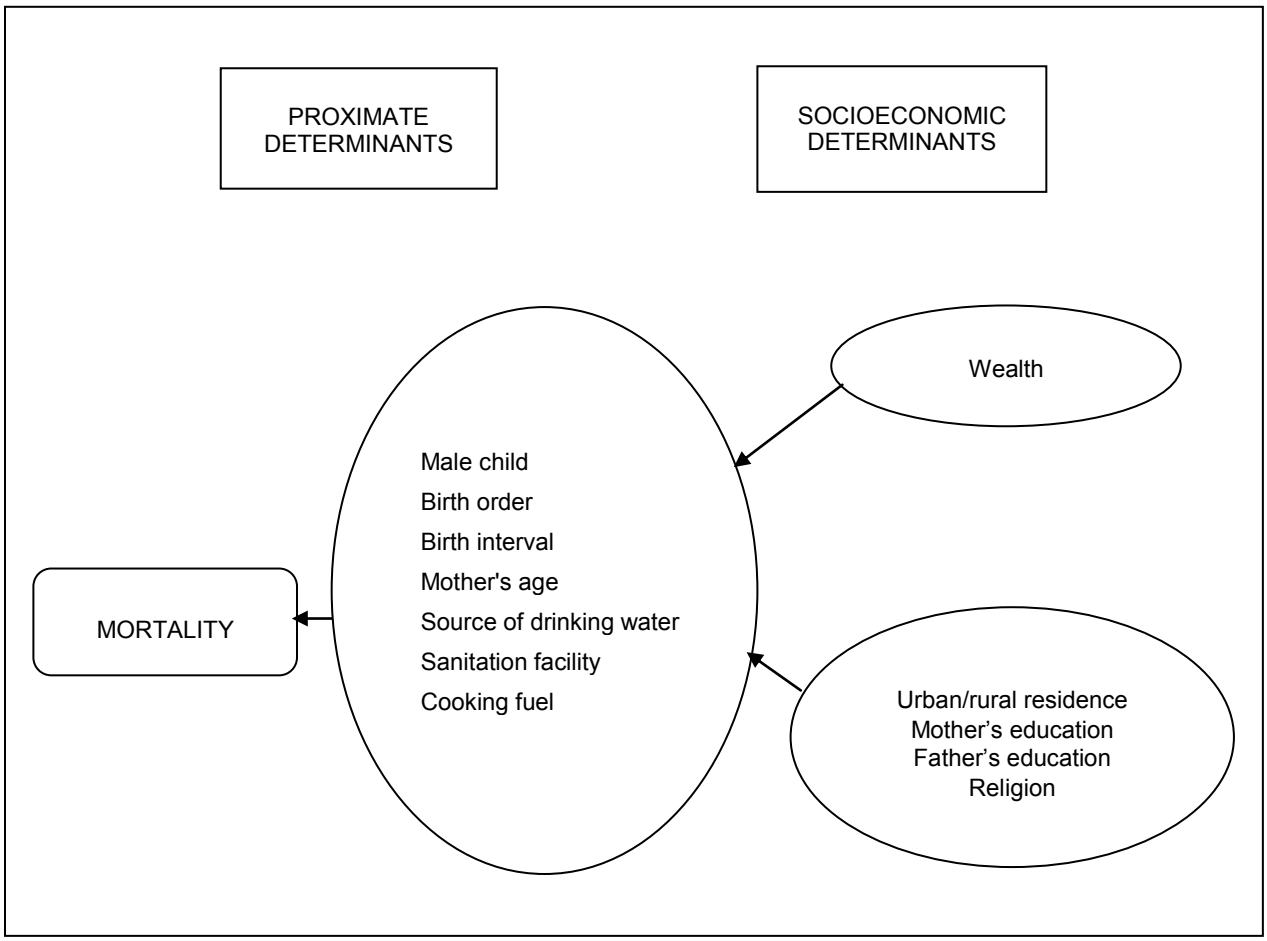
[2] For more details on sample selection and information on the different levels of stratification, see the final reports for each of the surveys, available at www.measuredhs.com.

women. Information on assets and housing characteristics that form the basis of the wealth measure comes from the household questionnaire, which can be answered by any adult resident of the household. From all three surveys combined, 1.1% of births were dropped due to missing values on at least one of the covariates (1,869 out of 167,458 total births, for a final sample of 165,589 births).

Measures

The various dependent and independent measures used in this analysis are described in this section. See Figure 1 for a conceptual model.

Figure 1: Conceptual Model of Determinants of Child Mortality



The *dependent variables* in the model are:

1. Neonatal mortality – Deaths at age 0-30 days (from birth till before completed age 1 month)
2. Postneonatal mortality – Deaths at age 1-11 months (from completed age 1 month till before completed age 12 months)
3. Child mortality – Deaths at age 1–4 years (from completed age 1 year till before completed age 60 months).
4. Under-five mortality – Deaths under age 5 years (from birth till completed age 60 months)

The *socioeconomic determinants* included in the model are:

1. Household wealth, as measured by a principal components approach to data on multiple household assets and characteristics – the dwelling‘s construction material, i.e. a kachha house made of mud, thatch, or other low-quality material, a semi-pucca house made of partly low-quality and partly high-quality materials, or a pucca house made of high-quality materials throughout, including the floor, roof, and exterior walls (IIPS and Macro International, 2007); source of drinking water; sanitation facility; cooking fuel; and whether the household owns a fan, radio, television, sewing machine, refrigerator, clock, bicycle, motorcycle, and car.
2. Whether the household is in an urban or rural area; level of mother‘s and father‘s schooling (education in single years classified as no schooling if 0 years, primary if 1 to 6 years, secondary if 7 to 12 years, post-secondary if greater than 12 years); and religion (whether the household head is Hindu, Muslim, or other).

The *proximate determinants* included in the model are:

1. Sex of the child; birth order of the child; the interval between the previous birth and the index child‘s birth in months (marriage to birth interval in the case of first births); and mother‘s age in years at the time the index child was born.

2. Whether the household uses an improved source of drinking water - where an improved source is defined as private or public piped water, tubewell, or borehole (WHO/UNICEF, 2010); whether the household uses improved sanitation - for comparability across surveys, an improved sanitary facility is defined as one with a flush toilet; and whether a solid cooking fuel is used - where solid fuels are defined as wood, coal, dung, agricultural residues, or shrubs/straw.

Results are presented at the national, urban/rural, and regional levels. The regional classification of states is as follows:

1. North – Delhi, Haryana, Himachal Pradesh, Jammu & Kashmir, Punjab, Rajasthan, Uttarakhand
2. Central – Chhattisgarh, Madhya Pradesh, Uttar Pradesh
3. East – Bihar, Jharkhand, Orissa, West Bengal
4. Northeast – Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura
5. West – Goa, Gujarat, Maharashtra
6. South – Andhra Pradesh, Karnataka, Kerala, Tamil Nadu

METHODS

Wealth Index

First, to generate the principal socioeconomic measure of interest, household wealth, we use data on household assets and housing characteristics to conduct principal components analysis (PCA). PCA is a multivariable statistical technique to transform information from several variables into a smaller number of _dimensions‘. The idea is that an underlying variable, in our case wealth, can be predicted by the observed data on assets and housing. PCA gives us a way to generate weights or coefficients on those observed data. From an initial set of n correlated variables, PCA creates m uncorrelated components PC, where each component is a linear weighted combination of the initial variables X (Rutstein and Johnson, 2004; Vyas and Kumaranayake, 2006).

$$PC_1 = b_{11}X_1 + b_{12}X_2 + \cdots + b_{1n}X_n$$

$$\ldots$$

$$PC_m = b_{m1}X_1 + b_{m2}X_2 + \cdots + b_{mn}X_n$$

An eigenvector is a vector that, when a matrix is multiplied by that vector, the result is the vector multiplied by a scalar. That scalar is the eigenvalue of that eigenvector. The eigenvectors of each of the m correlation matrices above give us the weights or factor score (b) for each principal component. The eigenvalue of each vector gives us the amount of the total variance in our variables that each principal component explains. The first component explains the most variation in the data and is unrelated to the second component, which explains additional variation, and so on until the mth component. The more highly correlated the assets, the fewer components required to explain variation in the latent wealth variable. Using just the first component is usually adequate to capture economic status as represented by asset information. The marginal gain from including higher-order components is small and in addition presents difficulties of interpretation (Houweling et al., 2003; McKenzie, 2003; Filmer and Pritchett, 2001).

Since we are interested in changes in the effect of household socioeconomic status on child health over time, we need a metric to value the wealth of households over time, without the content of that metric changing. The usual wealth quintiles employed in studies using DHS data

only tell us about the gap between the richer and poorer households. In our trend analysis, however, we need to take into account the possibility that the poorest households in one year may be better or worse off than the poorest households in the next survey. If we used the relative wealth index, we would only know the effect of being wealthier with reference to the poorest household in a single survey year, rather than relative to the poorest household in all three survey years (1992-93, 1998-99, and 2005-06). The procedure we employed to produce an absolute measure of wealth (as opposed to a relative measure) is as follows:

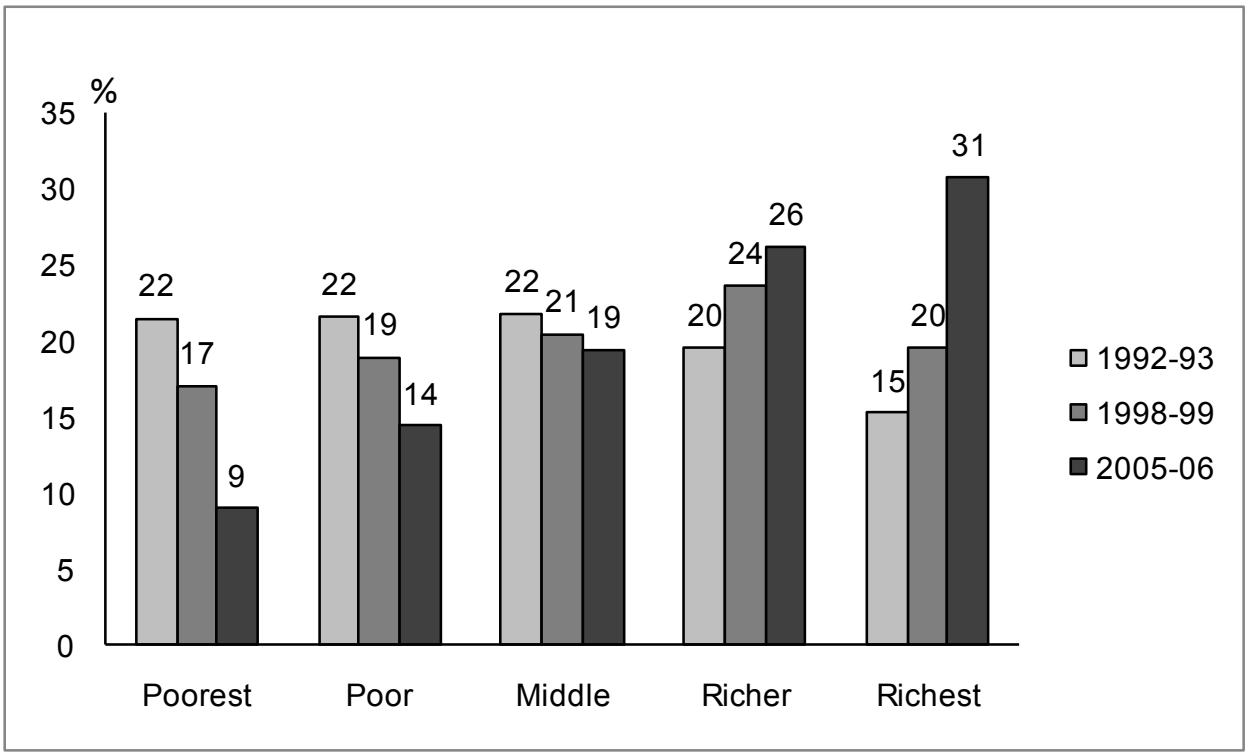
1. We start with the matrix of information on ownership of 13 assets/housing characteristics in the 1992-93 data (the 13 that are common to all three surveys).
2. We then find the eigenvector of factor scores associated with the first principal component of wealth in the 1992-93 data.
3. Next, we multiply the factor score (b) for each asset by the indicator variable indicating whether or not each household in the 1992-93 data owns that asset.
4. We sum the factor scores to yield a wealth score for every household in the 1992-93 survey.
5. We rank the households on this score and then divide them into five quintiles at 20% cutoffs[3].
6. We then use the same eigenvector of factor scores from the 1992-93 survey to generate a continuous wealth scores for households in the next two surveys.
7. The same values of the wealth score that form the quintile cutoffs in the 1992-93 survey are used to divide the households in these other surveys into five groups each.

These groups in later surveys would no longer necessarily contain 20% of the households if there were improvements or declines in levels of household wealth. For example, improvements in wealth would lead to movement of households from lower groups to higher

[3] The official quintiles included in the publicly available data are based on household *population*, not households, because most analyses are concerned with poor people, not poor households. We think our analysis is more related to households, and thus we create quintiles of households. Although our quintiles do not align perfectly with the official ones, our wealth score for each household is highly correlated with the official score - close to a 99% correspondence.

ones, thus diminishing the size of lower wealth groups and increasing the size of higher wealth groups. Indeed, this turns out to be true. Figure 2 shows that, over the course of the three surveys, the bottom three groups shrunk and the top two increased in size. There is a distinct pattern in changes in the size of groups. The biggest decline is in the poorest group, and the decline becomes progressively smaller over the next two groups. The groups increase in size starting with the fourth quintile, but the biggest gain is in the top quintile. Given that the wealth score is based on a limited set of fairly basic items, in one sense this tells us that many more households in India now have access to basic necessities.

Figure 2: Distribution of children across wealth groups



Discrete Time Logistic Model

The multivariable analyses are performed in an event-history framework that extends the proportional hazards model to discrete time. While the survival process is a continuous one and death can occur at any time in a child's life, our data are discrete in nature. For example, in the NFHS questionnaire information on age at death for deaths at and after age 2 is recorded in years. This results in deaths grouped at discrete intervals, thus calling for a model more suited to discrete-time processes. In such a model, the entire length of time that each child is observed is divided into smaller intervals, and the dependent variable is recorded as a series of binary outcomes denoting whether or not the death occurred in that time interval.

Consider first T, a discrete random variable indicating the time of death. The probability mass function for T can be written as

$$f(t) = \Pr(T = t_i)$$

and represents the probability of a death occurring at time t_i. The survivor function of T can be written as

$$S(t) = \Pr(T \geq t_i)$$

denoting the probability that survival time T is equal to or greater than some time t_i. Relating the concepts of failure and survival is the hazard rate or the risk of death

$$\mathrm{h(t)} = \frac{\mathrm{f\ (t)}}{\mathrm{S\ (t)}}$$

which is a ratio of the probability of failure to the probability of survival. Thus in the discrete time method, the hazard is not a rate but a conditional probability. In other words, the hazard function gives us the probability of death *conditional* on survival up to the start of a time interval.

$$h(t) = \Pr(T = t_i | T \geq t_i)$$

Now the probability of death can be made conditional on a set of covariates, just as it is conditional on survival.

$$h(t|\boldsymbol{x}) = \Pr(T = t_i | T \geq t_i, \boldsymbol{x})$$

Since the dependent variable takes a binary form, one could use the logistic distribution to relate the dependent variable to the covariates (Box-Steffensmeier and Jones, 2004). The logit function can then be written as

$$\log\left(\frac{h\,(t\mid \mathbf{x})}{1-h\,(t\mid \mathbf{x})}\right)=\beta_0+\beta_1 x_{1i}+\cdots+\beta_k x_{ki}$$

which is the ratio of the probability of occurrence of death to the probability of nonoccurrence The logit coefficients β_k represent the relationship of each covariate to the log-odds of death. Exponentiating these coefficients will thus yield the increase or decrease in the odds of death associated with a change in the respective covariate.

The logit discrete-time model makes the assumption that the baseline hazard is flat, whereas in all likelihood the hazard probability changes with age. In our data where each child contributes multiple records (because we split their lives into episodes), there generally is some type of temporal dependence between the repeated measures on the ith child. To account for this duration dependence, we include temporal dummy variables in the regression. Following a visual analysis of the pattern of the baseline hazard, we also included a second-order duration term to better model its shape.

Survival analysis presents the distinct advantage of allowing censored observations to contribute to analysis time, thus maximizing the use of available data. Children that die contribute information regarding the probability of failure, f (t), and those that survive through the entire relevant age range or are censored by the survey date contribute information regarding the probability of survival, S (t) (Box-Steffensmeier and Jones, 2004). Observation time is divided into seven-day intervals for the neonatal period (0-30 days), one-month intervals for the postneonatal period (1-11 months), and three-month intervals for child (1-4 years) and under-five mortality. Consequently, a child who exits at age 3 years and 2 months contributes 38 months of observation time to the analysis and is considered to have existed in the last three-month period, thus excluding the last two months from survival time.

Clustering

We use an estimator of the variance that is robust to the fact that cluster samples, unlike simple random samples, violate the assumption of independence of observations. Households are not drawn randomly from a listing of all households in the country. Rather, households are chosen randomly within a cluster, thus violating the assumption of independence of observations and leading to incorrect estimates of the standard errors (Rogers, 1993). This in turn leads to

incorrect inferences about the significance of the coefficients attached to the independent variables in the regression model. Parameter estimates are not affected by this violation. The robust variance estimator is specified using the vce (cluster) option in Stata 11. Cluster membership is specified using the cluster ID as the group-membership variable. Note that there are additional layers of clustering—of children within women, and of women within households. In our pooled sample we have a total of 165,589 births from 116,034 women residing in 107,329 households. The average number of children per woman is 1.43, and per household is 1.37. Including all children of all interviewed women from all households in our sample poses the same problem as clustering of households within primary sampling units. However, accounting for clustering of children and women shows results not much different from results of analyses accounting for clustering of households[4].

Weighting

The principal component analyses are conducted using household data and are consequently weighted using household weights. The woman weights provided in the NFHS are generally normalized weights, i.e. the sampling weight is multiplied by the sampling fraction. When data are pooled, these weights are no longer correct and must be de-normalized. Since the woman files from all three NFH surveys are pooled for the multivariable analysis, weights need to be adjusted. The factor by which weights are multiplied is a product of (i) the proportion of women in the pooled sample that are from that survey[5], and (ii) the ratio of the total number of women in the pooled sample to the sum of the mid-year populations of women age 15-49 in 1992, 1998, and 2005 (population data accessed from the International Data Base of the U.S. Census Bureau).

[4] It may be that accounting for clustering at higher levels automatically considers clustering at lower levels, at least partially.
[5] This is calculated separately for each survey and applies only to women from that particular survey.

RESULTS

Tables 1A and 1B show mortality rates as well as means of the various determinants of child health that are included as control variables in our model, at various geographic levels. All types of mortality declined between the first and last survey at the national level, in urban areas, in rural areas, and in each region. Among the independent variables, most notably, the proportion of households with an improved source of drinking water and improved sanitation facility increased between surveys, while the proportion using a solid fuel for cooking declined. Education levels of both fathers and mothers also improved considerably from one survey to the next.

Table 1A: Mortality rates and means of determinants (proportions unless otherwise indicated)

	National			Urban			Rural		
	1992-93	1998-99	2005-06	1992-93	1998-99	2005-06	1992-93	1998-99	2005-06
MORTALITY (Deaths per 1000 live births)									
Neonatal mortality	0.05	0.04	0.04	0.03	0.03	0.03	0.05	0.05	0.04
Postneonatal mortality	0.03	0.02	0.02	0.02	0.02	0.01	0.03	0.03	0.02
Child mortality	0.03	0.03	0.02	0.02	0.02	0.01	0.04	0.03	0.02
Under-five mortality	0.11	0.10	0.07	0.07	0.06	0.05	0.12	0.11	0.08
PROXIMATE DETERMINANTS									
Male child	0.51	0.52	0.52	0.51	0.52	0.53	0.51	0.52	0.52
Birth order (number)	2.99	2.87	2.76	2.66	2.47	2.33	3.09	2.99	2.91
Birth interval (months)	34.06	33.04	33.76	33.19	33.06	33.67	34.32	33.04	33.79
Mother's age (years)	24.27	23.95	24.26	24.47	24.30	24.48	24.22	23.86	24.18
Improved source of drinking water	0.67	0.77	0.84	0.87	0.93	0.93	0.61	0.72	0.81
Improved sanitation facility	0.16	0.18	0.31	0.54	0.58	0.73	0.05	0.07	0.16
Solid fuel used for cooking	0.83	0.81	0.80	0.49	0.37	0.40	0.93	0.94	0.94
SOCIOECONOMIC DETERMINANTS									
Urban household	0.23	0.22	0.25	0.26	0.27	0.28	0.18	0.18	0.21
Mother's education									
No education	0.65	0.57	0.50	0.40	0.32	0.28	0.73	0.64	0.58
Primary	0.14	0.17	0.17	0.17	0.18	0.16	0.14	0.17	0.17
Secondary	0.17	0.22	0.28	0.34	0.38	0.42	0.13	0.18	0.23
Higher	0.03	0.03	0.05	0.09	0.12	0.13	0.01	0.01	0.02
Father's education									
No education	0.37	0.31	0.30	0.20	0.16	0.17	0.42	0.35	0.35
Primary	0.20	0.20	0.18	0.18	0.17	0.16	0.20	0.21	0.19
Secondary	0.36	0.40	0.42	0.45	0.48	0.48	0.34	0.38	0.40
Higher	0.07	0.08	0.10	0.17	0.19	0.19	0.05	0.06	0.07
Religion									
Hindu	0.79	0.79	0.78	0.70	0.71	0.73	0.82	0.82	0.80
Muslim	0.15	0.16	0.17	0.23	0.23	0.22	0.13	0.14	0.16
Other	0.05	0.05	0.05	0.07	0.06	0.06	0.05	0.04	0.04
N	49,396	54,878	67,041	11,182	12,059	17,004	38,214	42,820	50,038

Table 1B: Mortality rates and means of determinants (proportions unless otherwise indicated)

	North			Central			East			Northeast			West			South		
	1992 - 93	1998 - 99	2005 - 06	1992 - 93	1998 - 99	2005 - 06	1992 - 93	1998 - 99	2005 - 06	1992 - 93	1998 - 99	2005 - 06	1992 - 93	1998 - 99	2005 - 06	1992 - 93	1998 - 99	2005 - 06
MORTALITY (Deaths per 1000 live births)																		
Neonatal mortality	0.04	0.04	0.03	0.06	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.04	0.04	0.03
Postneonatal mortality	0.03	0.03	0.02	0.03	0.03	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.02	0.01	0.01	0.02	0.01	0.01
Child mortality	0.03	0.03	0.02	0.05	0.04	0.03	0.03	0.03	0.02	0.05	0.03	0.02	0.03	0.02	0.01	0.02	0.02	0.01
Under-five mortality	0.09	0.09	0.07	0.14	0.13	0.10	0.12	0.10	0.07	0.13	0.09	0.08	0.08	0.06	0.05	0.08	0.07	0.05
PROXIMATE DETERMINANTS																		
Male child	0.53	0.53	0.54	0.51	0.51	0.51	0.52	0.52	0.51	0.49	0.53	0.50	0.51	0.52	0.53	0.50	0.51	0.53
Birth order (number)	2.84	2.88	2.72	3.40	3.41	3.27	3.07	2.94	2.89	3.42	2.91	2.75	2.65	2.49	2.25	2.50	2.22	2.02
Birth interval (months)	33.79	32.24	32.61	35.04	32.97	33.58	34.96	34.55	34.41	31.29	30.97	35.79	31.63	31.79	33.36	33.96	33.21	33.77
Mother's age (years)	24.53	24.61	24.61	25.25	24.50	24.89	24.26	24.05	24.02	24.79	24.69	25.18	23.19	23.04	23.58	23.24	23.06	23.48
Improved source of drinking water	0.70	0.77	0.82	0.67	0.78	0.86	0.68	0.79	0.86	0.45	0.54	0.61	0.73	0.80	0.88	0.64	0.76	0.81
Improved sanitation facility	0.18	0.26	0.36	0.10	0.10	0.22	0.12	0.15	0.22	0.10	0.13	0.31	0.29	0.32	0.49	0.23	0.22	0.43
Solid fuel used for cooking	0.79	0.75	0.75	0.92	0.89	0.87	0.82	0.93	0.93	0.93	0.89	0.84	0.67	0.59	0.57	0.83	0.74	0.70
SOCIOECONOMIC DETERMINANTS																		
Urban household	0.26	0.27	0.28	0.18	0.18	0.21	0.17	0.12	0.15	0.12	0.10	0.15	0.36	0.38	0.43	0.29	0.28	0.37
Mother's education																		
No education	0.66	0.61	0.54	0.78	0.70	0.63	0.69	0.65	0.59	0.58	0.47	0.36	0.50	0.40	0.30	0.52	0.38	0.29
Primary	0.13	0.14	0.14	0.09	0.14	0.14	0.15	0.15	0.18	0.22	0.25	0.26	0.19	0.21	0.17	0.19	0.22	0.20
Secondary	0.17	0.20	0.26	0.10	0.13	0.19	0.14	0.17	0.21	0.18	0.26	0.34	0.27	0.34	0.46	0.26	0.35	0.42
Higher	0.04	0.04	0.06	0.02	0.03	0.04	0.02	0.02	0.02	0.02	0.02	0.04	0.03	0.05	0.07	0.04	0.05	0.09

Cont'd..

Table 1B: Cont'd

	North			Central			East			Northeast			West			South		
	1992 - 93	**1998 - 99**	**2005 - 06**	**1992 - 93**	**1998 - 99**	**2005 - 06**	**1992 - 93**	**1998 - 99**	**2005 - 06**	**1992 - 93**	**1998 - 99**	**2005 - 06**	**1992 - 93**	**1998 - 99**	**2005 - 06**	**1992 - 93**	**1998 - 99**	**2005 - 06**
Father's education																		
No education	0.35	0.29	0.27	0.38	0.32	0.33	0.43	0.39	0.39	0.38	0.33	0.29	0.26	0.20	0.16	0.36	0.27	0.24
Primary	0.15	0.17	0.15	0.18	0.19	0.16	0.19	0.20	0.20	0.27	0.25	0.26	0.23	0.22	0.17	0.23	0.23	0.19
Secondary	0.42	0.45	0.48	0.37	0.40	0.41	0.31	0.33	0.33	0.31	0.35	0.38	0.44	0.48	0.55	0.34	0.40	0.45
Higher	0.08	0.09	0.10	0.08	0.08	0.09	0.07	0.07	0.08	0.05	0.06	0.07	0.07	0.11	0.12	0.08	0.10	0.12
Religion																		
Hindu	0.79	0.76	0.76	0.85	0.84	0.83	0.78	0.78	0.75	0.54	0.50	0.51	0.78	0.81	0.80	0.80	0.80	0.81
Muslim	0.06	0.13	0.14	0.14	0.15	0.16	0.20	0.20	0.22	0.28	0.28	0.26	0.15	0.13	0.14	0.14	0.13	0.13
Other	0.14	0.11	0.10	0.01	0.01	0.01	0.02	0.02	0.03	0.18	0.22	0.23	0.07	0.06	0.06	0.06	0.06	0.05
N	**5,800**	**7,044**	**8,738**	**14,643**	**16,165**	**19,906**	**11,018**	**12,067**	**16,877**	**2,145**	**2,007**	**2,519**	**6,537**	**7,221**	**8,390**	**9,253**	**10,375**	**10,611**

Table 2 shows the results of the bivariate analysis, or changes in mortality levels by wealth group, at the national level for illustrative purposes. This table tells us several things. First, within survey year across wealth groups, there is a clear wealth gradient in mortality—poorer groups always have higher mortality than wealthier groups. Second, across years within wealth groups, the bigger declines in mortality have occurred in the poorer groups. (Of course, these groups had higher mortality to begin with and thus had more potential for improvement).

Table 2: Mortality rates (deaths per 1000 live births) by wealth group

	National				
	Wealth groups based on NFHS-1 cutoffs			Absolute decline	Relative decline
	1992-93	1998-99	2005-06	from 92 to 05	from 92 to 05
MORTALITY					
Neonatal mortality					
Lowest	0.06	0.05	0.05	-0.01	-18.22
Second	0.06	0.05	0.05	-0.01	-20.60
Middle	0.05	0.05	0.04	0.00	-8.70
Fourth	0.03	0.04	0.04	0.00	6.72
Highest	0.03	0.03	0.03	0.00	-1.01
Poorest/Richest ratio	2.26	2.08	1.86	-0.39	-17.39
Postneonatal mortality					
Lowest	0.04	0.03	0.03	-0.01	-32.49
Second	0.03	0.03	0.02	-0.01	-35.85
Middle	0.03	0.02	0.02	0.00	-17.37
Fourth	0.02	0.02	0.01	-0.01	-31.27
Highest	0.01	0.01	0.01	0.00	-29.84
Poorest/Richest ratio	2.93	3.11	2.82	-0.11	-3.77
Child mortality					
Lowest	0.05	0.05	0.03	-0.03	-50.47
Second	0.04	0.04	0.03	-0.01	-32.73
Middle	0.03	0.03	0.02	-0.01	-19.49
Fourth	0.02	0.02	0.01	-0.01	-43.27
Highest	0.01	0.00	0.00	0.00	-43.44
Poorest/Richest ratio	7.55	10.91	6.62	-0.94	-12.44
Under-five mortality					
Lowest	0.15	0.14	0.10	-0.05	-33.20
Second	0.13	0.12	0.10	-0.04	-28.34
Middle	0.11	0.10	0.09	-0.01	-14.03
Fourth	0.07	0.07	0.06	-0.01	-16.41
Highest	0.05	0.04	0.04	-0.01	-15.61
Poorest/Richest ratio	3.25	3.36	2.57	-0.68	-20.85

The table also shows a simple ratio of mortality in the poorest group to mortality in the richest group for each year, for under-five mortality as a whole, child mortality, postneonatal mortality, and neonatal mortality. Child mortality shows the highest poor/rich ratios and thus the greatest wealth-based inequality. Conversely, neonatal mortality shows the lowest poorest/richest mortality ratios. However, poor/rich ratios in both child mortality and neonatal mortality have declined over the survey period, and by equal amounts (approximately 22% each).

To understand these patterns better, and understand changes at the urban/rural and regional levels, we move to a multivariable analysis, the results of which are show in Table 4 (coefficients on control variables not shown). Generally, the odds ratios for all types of mortality are below 1.0, suggesting that children from wealthier households have lower odds of dying than children from poorer households. These odds ratios can be interpreted as the effect of a standard deviation change in the wealth score. Remember that the wealth variable in these models is a continuous wealth score. Summary statistics (mean, standard deviation, minimum, and maximum) for the unstandardized wealth scores at each level of geographic aggregation are shown in Table 3. At the national level, it ranges from -2.34 to 7.54, with a mean of 0.08 in 1992, 0.48 in 1998, and 1.34 in 2005. Since a unit increase in this wealth score is somewhat difficult to interpret, a standardized version is used in the regressions as a measure to test our hypotheses.

For under-five mortality as a whole, a one standard deviation increase in the wealth score results in a 23% decline in the odds of mortality in 1992, at the national level. By 2005, a one standard deviation increase led to only a 14% decline in the odds. One standard deviation in the national wealth score is 2.58, which implies that around four standard deviations would take us from the minimum to the maximum value of the national wealth score distribution. Wealth effects are stronger in rural areas, and in the Western region. There is evidence of a trend of weakening wealth effects over time on under-five mortality at most geographic levels, except in the North where it stayed strong.

Table 3: Summary statistics for the unstandardized wealth measure

	National	Urban	Rural	North	Central	East	Northeast	West	South
1992									
Mean	0.08	-0.12	0.24	0.28	-0.17	-0.17	0.25	-0.02	-0.08
Median	-0.70	0.06	-0.46	-0.06	-1.00	-0.90	-0.52	-0.59	-0.72
S.D.	2.27	2.24	2.09	2.28	2.12	2.03	2.21	2.30	2.10
Min	-2.34	-4.59	-1.72	-3.37	-2.08	-1.84	-1.75	-3.07	-2.38
Max	7.54	4.13	11.59	5.67	8.53	9.44	10.02	6.01	7.75
Range	9.87	8.72	13.32	9.04	10.61	11.28	11.77	9.09	10.13
N	**59,013**	**15,939**	**43,074**	**13,277**	**14,009**	**9,807**	**6,591**	**6,263**	**9,066**
1998									
Mean	0.48	0.47	0.72	0.43	0.14	0.11	0.73	0.76	0.92
Median	-0.18	0.65	-0.09	0.17	-0.74	-0.76	-0.01	0.77	0.66
S.D.	2.37	2.00	2.36	2.30	2.24	2.25	2.34	2.22	2.26
Min	-2.34	-4.59	-1.72	-3.37	-2.08	-1.84	-1.75	-3.07	-2.38
Max	7.54	4.13	11.59	5.67	8.53	9.44	10.02	6.01	7.75
Range	9.87	8.72	13.32	9.04	10.61	11.28	11.77	9.09	10.13
N	**55,897**	**14,307**	**41,590**	**13,155**	**12,305**	**9,680**	**7,738**	**5,533**	**7,486**
2005									
Mean	1.34	0.76	1.50	1.02	1.38	1.06	2.04	1.68	2.13
Median	0.90	1.06	0.71	0.90	0.39	-0.13	1.37	1.93	2.07
S.D.	2.58	1.95	2.74	2.29	2.82	2.69	2.72	2.35	2.39
Min	-2.34	-4.59	-1.72	-3.37	-2.08	-1.84	-1.75	-3.07	-2.38
Max	7.54	4.13	11.59	5.67	8.53	9.44	10.02	6.01	7.75
Range	9.87	8.72	13.32	9.04	10.61	11.28	11.77	9.09	10.13
N	**50,677**	**19,160**	**31,517**	**7,972**	**12,666**	**7,969**	**9,444**	**5,500**	**7,126**

We then look at mortality at the smaller age intervals within under-five mortality. Wealth effects are much weaker for neonatal mortality than mortality at older ages. For neonatal mortality, there are no real wealth effects remaining by the third survey, except in the Western region where they remain strong. Interestingly, wealth never mattered for neonatal mortality in urban areas.

Wealth effects are strongest for child mortality. A one standard deviation increase in wealth is associated with a 45% decline in the odds of child death. This is clearly an extremely large effect. Wealth effects on child mortality are larger in urban areas than in rural areas (unlike in neonatal mortality). However, the effect is no longer significant by the third survey in urban areas but actually becomes stronger in rural areas. In fact, the effect becomes stronger in rural areas right after the first survey. At the regional level (which includes both urban and rural areas), the largest effects of wealth on child mortality are in the South and the West, and they are

all large and clearly significant. At the regional level, there is no pattern of strengthening wealth effects, as expected. However, there is no real weakening of effects either, with coefficients remaining very large in size—for example, in the North the coefficient goes from.55 in the first survey to 0.57 in the last survey.

Wealth effects on postneonatal mortality lie in between neonatal mortality and child mortality in terms of size as well as number of coefficients that are significant. Wealth only affects postneonatal mortality in rural areas (as in the case of neonatal mortality). Regional results are very mixed, with no clear pattern.

Table 4: Relationship between wealth and mortality net of proximate and socioeconomic determinants, in pooled NFHS 1, 2, and 3 sample (odds ratios)

	National	Urban	Rural	North	Central	East	Northeast	West	South
Neonatal mortality									
Wealth - 1992	0.82 ***	0.88	0.84 ***	0.92	0.82 *	0.91	0.79	0.70 *	0.91
Wealth - 1998	0.89 **	0.93	0.90 **	0.74 ***	0.92	0.82	1.05	0.94	0.98
Wealth - 2005	0.93	0.97	0.96	0.84	0.92	1.22	0.95	0.69 *	1.05
Postneonatal mortality									
Wealth - 1992	0.81 ***	0.96	0.81 ***	0.91	0.73 *	0.70 *	0.69	0.96	0.77
Wealth - 1998	0.75 ***	0.92	0.77 ***	0.81	0.67 **	0.84	0.86	0.74	0.66 *
Wealth - 2005	0.82 **	0.94	0.85 *	0.98	0.79	0.72 *	0.66	1.02	0.58 *
Child mortality									
Wealth - 1992	0.55 ***	0.57 ***	0.69 ***	0.55 ***	0.48 ***	0.76	0.40 *	0.47 **	0.33 ***
Wealth - 1998	0.53 ***	0.58 ***	0.62 ***	0.54 ***	0.52 ***	0.50 *	0.60	0.49 **	0.39 ***
Wealth - 2005	0.59 ***	0.73	0.64 ***	0.57 *	0.56 **	0.58	1.13	0.48 *	0.39 **
Under-five mortality									
Wealth - 1992	0.77 ***	0.85 **	0.80 ***	0.84 **	0.74 ***	0.82 *	0.67 **	0.69 **	0.79 **
Wealth - 1998	0.78 ***	0.86 **	0.81 ***	0.72 ***	0.76 ***	0.78 **	0.94	0.82	0.80 **
Wealth - 2005	0.86 ***	0.93	0.89 **	0.84 *	0.82 **	1.02	0.89	0.71 **	0.83

***p<.001, **p<.01, *p<.05

Note 1: Wealth here is a standardized version of the continuous wealth score. The mean of the wealth score is subtracted from each child's wealth score, and divided through by the standard deviation.

Note 2: Coefficients on control variables not shown. Variables include sex of child, birth order, previous birth interval, mother's age at birth of index child, whether sanitation facility is improved, whether source of drinking water is improved, whether cooking fuel is solid, whether residence is urban, mother's education, father's education, religion of household head.

Note 3: The coefficients on the interaction terms shown here are calculated as a linear combination of the main effect and the interaction effect

DISCUSSION

Effects

Household wealth is an important predictor of mortality at all ages in all three surveys, but the associations are weakest for mortality at younger ages. This finding is consistent with the general literature. Variations in the causes of death at younger and older ages may explain the differences in the strength of wealth as a predictor of mortality. The weaker association of wealth with neonatal mortality than child mortality can largely be ascribed to the effects of genetics, birth accidents, and other endogenous causes that are quite rare for mortality beyond the neonatal period. Among the older group there is more exposure time for socioeconomic factors including household wealth to affect health and survival. The fact that the wealth coefficients for postneonatal mortality lie in between the coefficients for neonatal mortality and child mortality further validates this finding. In the postneonatal period (age 1-11 months) children are still quite young, and thus both biological and socioeconomic factors exert an influence on their survival.

There are other possible explanations. As neonatal mortality declines, infants that die may be a somewhat more selective group, increasingly comprising those who are inherently more vulnerable. While one could argue that this is true in the case of child mortality as well, the potentially greater importance of biological factors in neonatal mortality makes the selectivity argument more appropriate for neonatal mortality6. Even if this selectivity was indeed occurring with child mortality, one could argue that the increasing effects of household wealth on child mortality over time were somewhat dampened by this type of selectivity. In other words, had it not been for the increasing selectivity on biological vulnerability, the effect of wealth on child mortality might have become even stronger over time.

Wealth is related to neonatal mortality only in rural areas. This could be related to the fact that health services that particularly affect younger infants, for example antenatal care and delivery assistance, are less available in rural areas than in urban areas. Household wealth could thus make more of a difference in rural areas by giving wealthier rural households the ability to seek out crucial, hard-to-access health services that could help lower neonatal mortality. The fact

[6] We readily acknowledge that these aforementioned biological factors are quite possibly closely related to socioeconomic factors. We are only suggesting that the biological conduits from these socioeconomic factors to mortality may be stronger in the neonatal period than in childhood.

that wealth is related to child mortality in both urban and rural areas underscores the greater universal importance of household-level socioeconomic determinants to mortality at older ages.

Trends

Our hypothesis was that household wealth effects would strengthen over time. We find that this is true in the case of child mortality in rural areas. While the wealth effect for under-five mortality declined in both urban and rural areas, this pattern is dominated by the weakening wealth effects on neonatal mortality, which is the largest component of under-five mortality. Focusing on child mortality, we see an increasing wealth effect, but only in rural areas. We know that the growth in India that started in the 1990s was biased towards urban areas and towards the manufacturing and service sectors. The shift of governmental focus away from the agricultural sector and rural areas in general may explain why the wealth effect would sharpen only in rural areas. As hypothesized, household wealth effects could have become stronger because there was a worsening of public health provision, health care facilities, and other relevant services such as roads.

An example is the public distribution system (PDS), which provides wheat, rice, and sugar at affordable prices to enhance food security. Improved food security can reduce malnutrition among children, thus lowering under-five deaths. The PDS is India‘s most far-reaching safety net in coverage, and also the most expensive in terms of public expenditure (Radhakrishna and Subbarao, 1997). One of the many criticisms leveled against the PDS since the 1970s was that it had an urban bias, with the program disproportionately benefiting people in urban areas (Howes and Jha, 1992). In 1997 the government introduced the Targeted Public Distribution System (TPDS), with the aim of redistributing income by providing more food to the poor and at cheaper prices than to the non-poor. The move from a universal system to a targeted system was motivated both by concerns for program efficacy as well by as the liberalization imperative to shrink the role of the government, in this case in the food grains sector.

Five years after the introduction of the TPDS, a high-level committee reported that the move from the PDS to the TPDS ~~in~~may have served to blunt the efficacy of the PDS in meeting

its original goal of price stabilization, while not delivering fully in terms of the new concern to focus subsidies to the poor… It penalized states with relatively low incidence of income poverty but relatively high incidence of calorie deficiency. At the same time, it did not reach the poor in states where the PDS was weak prior to its introduction. We feel that it is essential to go back to a universal PDS" (Ministry of Consumer Affairs and Food & Public Distribution, 2002). This acknowledgment of even greater failure of a system already known to perform especially poorly in rural areas fits well with our hypothesis of an increase in the role of private wealth in child health as public investment declined, and with our finding of this increased wealth effect only in rural areas.

Note that this argument does not necessarily contradict the finding that wealth effects on child mortality were stronger in terms of size in urban areas, and in relatively more urban, prosperous regions like the South and the West. One possible explanation is that urban areas and prosperous regions have higher levels of economic inequality and a more heterogeneous population, which could result in greater wealth-based health inequality.

Other Factors

One important question to ask in the discussion of our results would be: To what extent did changes in other important factors known to impact child survival affect the results? For example, use of antenatal care and the proportion of women giving birth in a health care facility or with assistance from a skilled attendant have increased. While these factors were not included in our multivariable models, this is not necessarily a limitation of this study. We think of these factors as being on the pathway from wealth to mortality. The changing effects of wealth may well be capturing the changing use of antenatal and delivery care. And in fact we argue that policy can have an impact on variables such as these and thus reduce the burden on households (and their wealth) of purchasing these services

Limitations

This study has some limitations. The wealth index is generally only recommended for use as a ranking mechanism, not as an absolute measure. It is limited in its ability to measure

multiple dimensions of household economic well-being, and trends in those dimensions. Also, it is more a measure of long-term as opposed to short-term economic welfare. This matters if child survival is more responsive to short-term measures of welfare, such as household income. Also, although our hypothesis stems from an observation of economic growth and general indicators of a change in the role of the state, we did not conduct a direct test of the role of government and cannot render any kind of verdict on the government‘s performance in terms of service provision. Changes in the relationship between household wealth and child mortality could have occurred due to factors other than changes in the effectiveness of the public sector.

CONCLUSIONS

Household wealth is an increasingly important predictor of child mortality in India, especially in rural areas. This points to the need for an emphasis on equity in health outcomes, as well as a focus on reducing overall infant and child mortality. Further, this study presents one form of evidence that the anti-rural, anti-agriculture bias that has characterized India‘s recent economic policy is not without consequences, and requires serious consideration and correction.

Extensions to this research include additional tests of our central hypothesis about changes in the wealth-health link. One could test for changes in the effects of household wealth on outcomes of immunization, antenatal care, and other child health care. These are important inputs into infant and child health, and they have potentially different relationships to household wealth. Another important extension is a decomposition analysis to partition the sources of change in mortality into changes in the levels of the determinants versus changes in the effects, in order to identify the relative importance of the sources of change.

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