What Information Do We Need to Reduce Child Mortality in India?
How Can the NFHS Help?
Comments on Anil B. Deolalikar

Maureen L. Cropper, DECRG-IE

Introduction

To effectively reduce infant and child mortality in India requires three inputs: (1) knowing in which districts and among which groups infant mortality rates are highest, so that interventions can effectively be targeted; (2) understanding which interventions are likely to be most cost-effective in reducing infant mortality; and (3) marshaling the political and institutional capacity to implement the interventions. Anil Deolalikar uses the 1998 National Family Health Survey to address the first two points. He effectively shows in which states and districts infant mortality is highest and among which population groups (e.g., scheduled castes and scheduled tribes) and groups of children (e.g., higher parity females). Deolalikar, however, also uses the survey to quantify the impact of various interventions on infant mortality. These include interventions with a clear connection to infant mortality—tetanus shots and antenatal care for mothers, medical attention at the time of delivery—as well as the impact of infrastructure investments—piped water, toilets, electricity and rural roads—where the causal mechanism is less clear.

The main point of this comment is that while family surveys are excellent for elucidating patterns of infant and child mortality and thus targeting interventions, they are not the best source of information on the effectiveness of interventions to reduce mortality. Indeed, simple regression analysis of family survey data can often produce biased and misleading results that should definitely not form the basis for policy. The best sources of effectiveness information are randomized field trials. Dozens of trials have been conducted in developing countries for interventions to reduce infant and child mortality, such as providing nutritional supplements and tetanus vaccines to mothers, and providing nutritional supplements to children. Using randomized trials to evaluate the impact of infrastructure investments on child health is more difficult, but not impossible.

The remainder of these comments discusses why simple analyses of household data can produce misleading results, and what other sources of effectiveness information are available regarding interventions to reduce infant and child mortality. The analysis is organized in three parts. It begins with an overview of the causes of neonatal mortality, post-neonatal mortality and mortality between ages 1 and 4 in India, and of the interventions that might reduce mortality in each age group. This is followed by a discussion of the use of household datasets such as the NFHS to quantify the impact of interventions known to be related to infant and child mortality and of factors less directly related, such as infrastructure investments. The comment concludes with a brief review of the literature evaluating medical interventions to reduce infant mortality, as well as evaluations of the impact of improved water and sanitation on diarrheal disease.

Causes of Infant and Child Mortality in India

As Mariam Claeson points out in her paper, approximately half of all deaths in India occurring between birth and age 5 occur during the first 28 days of life. Post-neonatal deaths, those occurring between the 29th day of life and a child's first birthday, constitute approximately one-quarter of deaths under the age of 5, with deaths after the first birthday accounting for the remaining 25 percent. The causes of death during the first month of life (neonatal deaths) are somewhat different from the causes of death after the first month, suggesting that different interventions may be required to deal with deaths in each age group.

Autopsies of 1000 neonatal deaths in Bihar (Shrivastava, Kumar and Ojha 2001) attribute 25 percent of these deaths to prematurity/low birth weight, 23 percent to injury/asphyxia at the time of birth and 21 percent to sepsis. No other single cause accounts for more than 4 percent of deaths. In particular, pneumonia accounts for only about 4 percent of deaths and diarrheal disease for about 1 percent. After the first month of life, diarrheal disease and acute respiratory infection account for a much larger share of infant deaths. In a study of 442 infant deaths in the slums of Delhi (Khanna et al. 2003), 22 percent of deaths during the first year of life were attributed to diarrheal disease and 11 percent to acute respiratory infection.

The fact that the most important causes of neonatal v. post-neonatal deaths differ has implications for the interventions that are likely to be effective in preventing deaths in each age group. Interventions that are likely to be most effective in preventing neonatal deaths include programs to improve maternal nutrition, which should increase birth weight and the likelihood that a child is carried to term, and programs to provide antenatal care, including tetanus vaccinations. Medical attendance at delivery, especially for high-risk births, should reduce deaths due to birth injury, asphyxia and sepsis. In contrast, interventions to prevent deaths due to diarrheal disease, such as oral rehydration therapy, or acute respiratory infection, are likely to have an impact on post-neonatal, but not neonatal, deaths.

Differences in the causes of neonatal v. post-neonatal deaths have important implications for the analysis of infant morality using household datasets. First, it is essential in analyzing determinants of infant mortality that a distinction be made between neonatal and post-neonatal deaths. This is possible using the National Family Health Survey since the survey indicates the age at which a child died; however, neither of the papers in this symposium that use NFHS data separates neonatal and post-neonatal deaths in its analysis. Second, it makes little sense to analyze the impact on neonatal mortality of interventions thought to affect diarrheal disease and/or acute respiratory infection since these are not important causes of death in the first month of life. Associations between (e.g.) piped water connections and toilets and neonatal mortality are unlikely to be causal but instead to represent the fact that households with better access to infrastructure may also have better access to antenatal care and/or better maternal nutrition.

Problems in Using NFHS Data to Estimate the Impact of Medical and Non-Medical Interventions on Infant Mortality

Quantifying the impact of a particular intervention on infant mortality is difficult using the NFHS, even if a researcher distinguishes between neonatal and post-neonatal mortality and focuses on interventions, such as antenatal care, that have a direct relationship to birth outcomes. The analysis of the impact of various interventions on infant mortality usually takes two forms: An analysis of the impact of individual factors on infant mortality rates, which contrasts infant mortality rates with and without the intervention, and a multivariate analysis that examines the impact of several factors simultaneously.

The first analysis is typified by a series of bar charts in Deolalikar's paper showing how infant mortality rates differ according to various interventions: whether the birth was medically attended, whether the mother received antenatal care, whether she received tetanus shots before pregnancy. Separate bar charts are provided for poor and non-poor states. For example, in poor states, the infant mortality rate is 50 per 1000 for babies born to women who received tetanus shots and 92 per 1000 for infants whose mothers did not. [The corresponding figure for all states is 88 per 1000 v. 45 per 1000.]

These charts are interesting, but cannot be interpreted measuring the quantitative impact of a factor on infant mortality for two reasons: One is that the charts fail to control for *confounding factors* that may be correlated with the intervention in the chart. For example, mothers who received tetanus shots are also likely to have had other forms of antenatal care, such as folic acid and/or iron supplements, and better nutrition. Unless these are controlled for, their impacts will wrongly be ascribed to tetanus vaccines. In this case it is likely that the bar charts overstate the impact of the tetanus vaccine in reducing infant mortality. The confounding problem *may* be solvable if one has good data on the confounding factors and can control for them statistically, a point discussed more fully below.

The second problem is one of *self-selection*: mothers who have obtained tetanus vaccines may know more about factors that are likely to ensure a safe delivery than mothers who did not obtain vaccinations. Mothers with superior knowledge of health have *self-selected* the intervention. This is analogous to the problem of confounding, but the confounding factor (mother's knowledge of health) is likely to remain unobservable and hence cannot be controlled for. Self-selection also makes it likely that the bar charts overstate the impact of tetanus vaccines on infant mortality.

The purpose of the multivariate analysis conducted in Deolalikar's paper is to deal with the confounding problem: it examines the impact of a mother receiving a tetanus vaccination on the probability that her child died, holding other factors constant. In particular, the model controls for whether the mother received antenatal care or not, and for the mother's years of schooling. The problem here is that no information is known about the form of the antenatal care (whether it included folic acid supplements), or about other factors (such as maternal knowledge of health) that may be correlated with obtaining a tetanus vaccination. So, the problems of confounding and self-selection are likely to remain in the multivariate analysis.[1]

Even greater caution in required when using household datasets to quantify the impact of infrastructure investments—such as paved roads, piped water and electricity—on infant mortality. One problem is that the causal link between these interventions and infant mortality is less clear than it is for medical interventions. For example, rural roads may facilitate the staffing of health posts or may make it easier for women to reach hospitals, but they are not sufficient to guarantee that health services are actually received. The link between electricity and infant mortality is unclear, unless, through radio and television, it facilitates the transmission of knowledge about safe delivery practices. Piped water connections, by providing adequate water for domestic and personal hygiene, have a closer connection to diarrheal disease, and thus might affect post-neonatal mortality, but their effectiveness depends on household hygiene habits (e.g., hand washing).

Because of the weak causal link between infrastructure investments and infant mortality—especially neonatal mortality—there is a concern that infrastructure investments may be correlated with factors that are the real determinants of maternal and child health, rather than influencing mortality themselves. For example, it is likely that villages with a paved road to the district capital may have the political voice to attract better health care workers than villages without a paved road; or, that households in villages with electricity are wealthier and, possibly, better educated, than households in villages without electricity. Simply put, the problem of confounding is likely to be greater for infrastructure than for medical interventions.[2]

The Use of Randomized Clinical Trials to Measure the Impact of Interventions to Reduce Infant Mortality

Clinical trials in which the intervention (e.g., nutritional supplements for pregnant women) is randomly assigned to treatment and control groups solve both the problems of confounding and self-selection. Because the treatment is randomly assigned across women, it is by construction uncorrelated with other factors that may affect birth outcomes, both observable (e.g., whether the mother received a tetanus shot) and unobservable (mother's knowledge of practices that will ensure a safe birth).

---

[1] An additional problem is that it may be difficult statistically to disentangle the impact of individual factors on mortality, even if they can be measured, due to high correlation among them. Collinearity among explanatory variables can result in coefficients that are statistically insignificant, even when there exists a true relationship between the factors and infant mortality.

[2]As Deolalikar notes, Jalan and Ravallion (2003) have used propensity score matching to deal with this problem in evaluating the impact of piped water connections on diarrheal disease using household survey data. This entails constructing an index that measures the likelihood that a household has access to piped water and matching households without access to piped water to those that do based on the score. This approach is, however, more difficult to implement when measuring the impact of multiple interventions (treatments), as is done in Deolalikar's paper.

Clinical trials have been conducted in India and in other parts of South Asia to quantify the impact of nutritional supplements for pregnant women, including folic acid, iron, vitamin A and beta-carotene, on fetal health (Christian et al. 2003). Trials have established the efficacy of vitamin A and zinc supplements in preventing malnutrition and in reducing both morbidity and mortality among children aged 6 months to two years (Nalubolu and Nestel 1999). The benefits of breast feeding in reducing post-neonatal mortality have also been established. The justly famous field trials of Bang et al. (1999; Brown 2000) have demonstrated that a package of home-based neonatal care, including management of sepsis, can reduce infant mortality at low cost (5.30 USD per child).[3]

What is the impact of infrastructure services on infant mortality and child health? Are improved water and sanitation services as cost-effective as nutritional supplements, encouraging breast feeding or providing better antenatal care? Fewtrell and Colford (2004) provide a review and meta-analysis of randomized trials for various water and sanitation interventions in developing countries. Their meta-analysis indicates that home drinking water disinfection systems reduce the incidence of diarrheal disease by 39% [95% CI: 19% - 54%], while hand-washing reduces diarrheal disease by incidence by 44% [95% CI: 7.5%-66%]. Randomized trials or evaluations using quasi-experimental designs are more difficult to conduct for water supply and sanitation interventions. Increasing water quantity was associated with a small but statistically insignificant impact on diarrheal disease incidence in the studies reviewed by Fewtrell and Colford; however, the authors identified only two well-designed studies of the impact of piped water connections on diarrheal disease, and only one acceptable study of the impact of improved sanitation on diarrheal disease. Evaluating the impact of sanitation and water quantity is clearly an area where more research is required.

The literature on the impact of medical interventions on infant mortality is, however, well developed. The findings of the medical literature are in fact well known, and underlie India's Integrated Child Development Service (ICDS) program, which is designed to improve the nutritional status of pregnant and lactating women and young children. The failure of this program to effectively deliver these services is well documented (Ghosh 2004), and reinforces Maitreyi Das's point that much of the problem in reducing infant mortality lies not in knowing what to do, but in marshaling the institutional capability to effectively deliver these services.

[3] Infant mortality fell from 76 to 39 per 1000 in treatment villages, while it fell from only 77 to 75 per 1000 in control villages.

References

Bang, A.T. et al. (1999). "Effect of Home-Based Neonatal Care and Management of Sepsis on Neonatal Mortality: Field Trial in Rural India," *Lancet*, 354(9194): 1955-1961.

Brown, B. (2000). "Digest: Home-Based Neonatal Care by Village Health Workers in Rural India Reduces Deaths from Bacterial Infection," *International Family Planning Perspectives*, 26 (2).

Christian, P. et al. (2003). "Effects of Maternal Micronutrient Supplementation on Fetal Loss and Infant Mortality: A Cluster-Randomized Trial in Nepal," *American Journal of Clinical Nutrition*, 78(6):1194-1202.

Fewtrell, L. and J.M. Colford, Jr. (2004). *Water, Sanitation and Hygiene: Interventions and Diarrhea, A Systematic Review and Meta-Analysis*, HNP Discussion Paper, The World Bank, August.

Ghosh, S. (2004). "Child Malnutrition," *Economic and Political Weekly*, October 2.

Jalan, J. and M. Ravallion (2003). "Does Piped Water Reduce Diarrhea for Children in Rural India?" *Journal of Econometrics*, 112:153-173.

Khanna, R. et al. (2003). "Community Based Retrospective Study of Sex in Infant Mortality in India," *British Medical Journal*, 327:126.

R. Nalubolu and P. Nestel (1999). *The Effect of Vitamin A Nutriture on Health, A Review*. Washington, DC: USAID-International Life Sciences Institute.

Shrivastava, S.P., A. Kumar and A.K. Ojha (2001). "Verbal Autopsy Determined Causes of Neonatal Deahts," *Indian Pediatrics* 83:1022-1025.