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Population Studies

ISSN: 0032-4728 (Print) 1477-4747 (Online) Journal homepage: http://www.tandfonline.com/loi/rpst20

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To cite this article: Øystein Kravdal (2004) Child mortality in India: The community-level effect of education, Population Studies, 58:2, 177-192, DOI: 10.1080/0032472042000213721

To link to this article: http://dx.doi.org/10.1080/0032472042000213721

Population Studies, Vol. 58, No. 2, 2004, pp. 177–192

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Child mortality in India: The community-level effect of education

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When assessing the health benefits of increased education in less developed countries, many researchers have been concerned about the omission of important determinants of an individual's education from the models. The study presented here shows that one should also be concerned about the limitations of the individual-level perspective. According to a multilevel discrete-time hazard model estimated with data from the National Family Health Survey II, the average education of women in a census enumeration area has a strong impact on child mortality, in addition to the effect of the mother's own education. The lower child mortality associated with women's autonomy is taken into account in this estimation. Results from similar models for various health and health-care variables suggest that the effect of community education, like that of individual education, operates through the use of maternity services and other preventive health services, the child's nutrition, and the mother's care for a sick child.

Keywords: autonomy; care; child; community; education; health; mortality; multilevel

[Submitted June 2003; Final version accepted February 2004]

A large number of studies from many less developed countries have shown a strong negative association between mother's educational level and child mortality. Nevertheless, there is still considerable uncertainty about the actual total strength of the impact of education, let alone its underlying mechanisms and its variation between different settings. One important reason for the uncertainty, as pointed out by many authors (e.g., Hobcraft 1993), is that a woman's education is determined by her parents' resources and attitudes and various other factors that may also have a bearing on mortality, and that are often unavailable or inadequately measured in the data that are used. However, this is not the only measurement issue that deserves attention. One should also be concerned about the possibility that an individual-level perspective may fail to reveal the entire impact of education, for there may be a beneficial effect of the education of other women in the community above and beyond that of the mother's own education. In that case, an expansion of education would reduce mortality not only because more women would enter an educational category associated with lower mortality, but also because everyone, including those who themselves remained uneducated, would benefit from the generally higher level of education in the community. Such a community-level contribution was seen in recent analyses of fertility from Africa (Kravdal 2002) and India (Moursund and Kravdal 2003), and a similar effect of literacy was shown for India by McNay et al. (2003). Studies in developed countries have shown that education and other socio-economic resources in the community have an impact on health and mortality (e.g., Pickett and Pearl 2001; Sampson et al. 2002; Wen et al. 2003), but the possible importance of community education has been ignored in the literature on child mortality in less developed countries.

The otherwise excellent paper by Desai and Alva (1998) may serve as an interesting illustration of the lack of attention to the effect of community education. Their goal was to show that the effect of mother's education may be severely biased in the simple models that are often estimated. They first included a rural/urban indicator and various individual variables linked with (although not necessarily determinants of) education and found that the effect was substantially weakened. Realizing that a number of unobserved factors at the community level might also be linked with both education and mortality, their next step was to include community fixed effects instead of the rural/urban indicator, which further

ISSN 0032-4728 print/ISSN 1477-4747 online/04/020177-16 © 2004 Population Investigation Committee
DOI: 10.1080/0032472042000213721

reduced the education effect. However, this approach does not take into account the possibility that one particular community factor, namely, other people's education, might influence mortality. In this fixed-effects approach, any effect of other people's education is essentially excluded along with all other community factors (though it was touched on implicitly in the concluding discussion).

The objective of the study presented here is to establish whether the education of other women in the community is of substantial importance for child mortality in India, where the national average of deaths before age 5 for the period 1994–99 was 95 per 1,000 (International Institute for Population Sciences [IIPS] and OCR Macro 2000). The analysis is based on a large, clustered sample of about 90,000 women interviewed in the National Family Health Survey (NFHS) of 1998–99. Various potential determinants of education must be taken into account in such an analysis, of course. One factor that is particularly likely to be linked with education, although not exclusively as a determinant, is women's autonomy. While the statistical evidence is fairly meagre, a subordinate position for women, which is a general characteristic of Southern Asia, is believed to contribute to high child mortality (for early contributions, see, e.g., Dyson and Moore 1983; Mason 1984; Caldwell 1986). The estimates of the effects of autonomy that are presented here, based on data that include more questions on women's position than most other Demographic and Health Surveys, should therefore be an important by-product of the analysis.

Similar models are estimated for some health and health-care variables that are presumed important for mortality, to obtain an impression of the mechanisms that may be involved in the relationship between community education and mortality. Ideally, it would have been better to include such proximate determinants of mortality in the mortality model, but this cannot be done because most of them are available only for children who had survived up to interview.

Theoretical considerations

Possible determinants of education, and various causal channels that education may operate through in affecting mortality, are reviewed below and illustrated in Figure 1. The account should not be seen as exhaustive however. Other factors may also play a role, the variables that are mentioned may have additional effects, and it is possible to argue for alternative directions of causality.

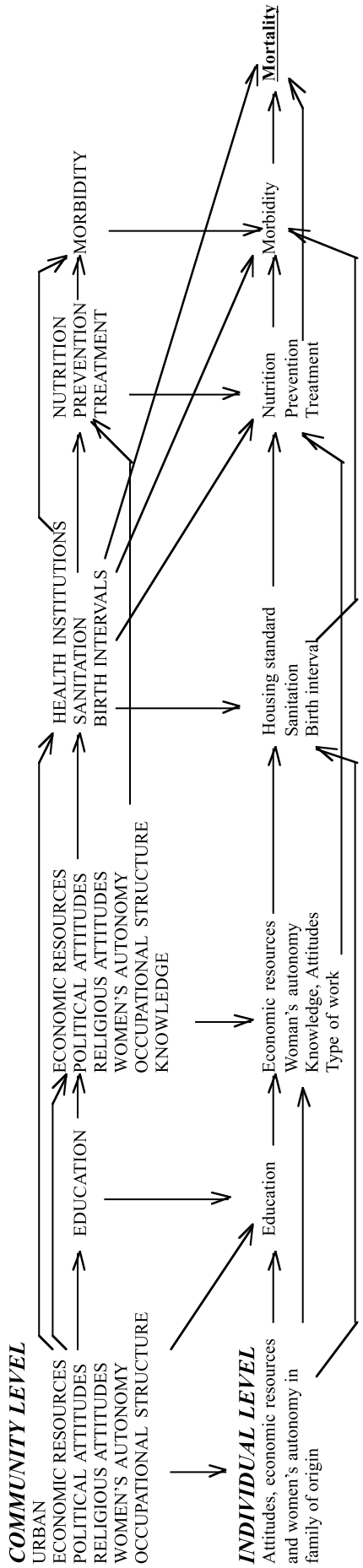

Figure 1 How different variables may contribute to a statistical association between education and child mortality
Note: Community variables are written in capital letters. The figure includes blocks of variables, but all variables within a block do not necessarily operate through the indicated arrows

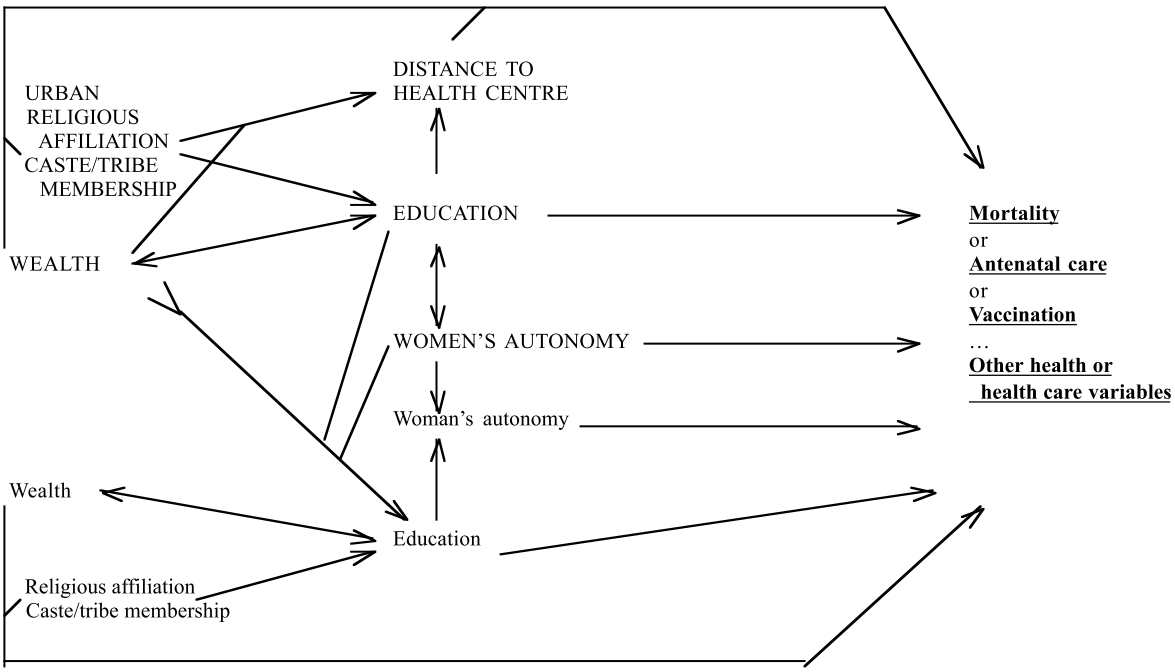

Figure 2 How covariates used in the analysis of the association between education and child mortality in India are assumed to be linked with education, health, health care, and mortality
Note: Community variables are written in capital letters. The possible effects of various socio-economic and cultural background factors on women's autonomy are not central to the analysis, and are therefore not indicated

The review serves two purposes. One is to show that a community education effect is indeed theoretically plausible, for a number of reasons. Another is to provide a basic justification for the specification of the models. The variables actually included in the statistical models, reflecting to a large extent the availability of data, are illustrated in Figure 2.

A general underlying assumption is that the characteristics of the individual mother under consideration have no impact on the community, but that community factors may influence the individual, partly through social learning and social influence (e.g., Bongaarts and Watkins 1996; Montgomery and Casterline 1996; Kohler et al. 2001). Social learning means that knowledge and attitudes are transmitted directly from others by communication and observation, whereas social influence refers to a more passive imitation of behaviour, driven by a desire to gain other people's approval or avoid sanctions. In addition, individual behaviour may be influenced by social institutions and other societal factors, which to some extent are shaped by the ideas, resources, and behaviour of people in the community.

Selective migration constitutes another link between the individual and the community. Rather than being partly a *result* of community factors, some individual characteristics may have led the individual under consideration to move to that particular community. For example, people with high intellectual capabilities, perhaps beyond what is captured by the available data, may have moved to a place with a high general educational level for a variety of reasons. For simplicity, this mechanism is ignored in the review below.

The general picture

Determinants of education. In addition to being a key determinant of mortality, education is itself a result of many different factors at the community level and individual level that may also have a bearing on mortality. It is of course necessary to take these factors into account to obtain a good assessment of how changes in education might influence mortality (whereas factors that education may operate through should be left out if the focus is on total effects, and included only if the goal is to identify causal pathways).

For example, educational institutions are more likely to have been established if the community is relatively rich. The degree of urbanization may also be an important determinant. Having a large population in a small area facilitates educational expansion and typically produces a labour market in which education is more of an asset than it would be otherwise. Moreover, political and religious attitudes may be important determinants of the willingness to

invest in schools. (Conversely, educational expansion may feed back on some of these factors; see below.)

The existence of schools, parents' wealth (e.g., Filmer and Pritchett 1999), parents' attitudes (influenced partly by other people's attitudes), and the mere fact that many other children go to school are central factors behind the decision to send an individual girl to school. Another determinant of her education and that of others in the community is women's autonomy, which may be loosely defined as their responsibilities, rights, and freedom to act as they choose compared with men (see below for further definition and a review of possible effects on mortality). Poor parents typically see little need to educate their daughters if community norms about women's position do not allow them to make use of the education for paid work anyway, and if their in-laws perhaps will appropriate any income they might earn.

Women's autonomy. There are many dimensions of women's autonomy that are relevant from a mortality perspective. Using Jejeebhoy's (1995) terminology, women's 'decision-making autonomy' (opportunity to take part and be heard in discussions with parents, husbands, or in-laws) and 'physical autonomy' (freedom of movement) are probably particularly important. These forms of autonomy may operate through such factors as the use of preventive health services, as shown by Bloom et al. (2001), the child's nutrition, as suggested by Miles-Doan and Bisharat (1990), or the treatment of sick children, as suggested by, e.g., Caldwell (1986) and Das Gupta (1990).

'Economic autonomy' has been considered another aspect of women's autonomy, and refers to their ability to fend for themselves economically. It encompasses, for example, women's rights to land and inheritance, their access to credit, and whether they are allowed to keep the money they earn. Some authors have argued that economic autonomy may be important for fertility (e.g., Mason 1987, 1997), through which it might also have an impact on mortality. The possibility that it also has a more direct effect should not be rejected.

These three aspects of women's autonomy are, of course, difficult to separate. They affect each other mutually and definitions will necessarily be blurred. In addition, Jejeebhoy (1995) has suggested another closely related dimension, 'emotional autonomy', which refers to the closeness between husband and wife, and which may also have a bearing on child mortality (Jejeebhoy 1998).

Consequences of education. If other people in the community have some education, they may have more knowledge about good health behaviour than they would otherwise have and be generally better informed and less fatalistic. Their better knowledge and their attitudes may be passed on to the individual mother and add to any similar effects of her own education. The consequences may include, for example, better nutrition of children, higher prevalence of vaccination, a more hygienic environment, more appropriate home care in case of disease, and perhaps an improvement in a woman's ability to communicate with health workers.

In addition, it might be expected that a generally higher level of education among women will gradually strengthen their position, and that there might be similar changes at the individual level (i.e., reversing the direction of causality envisaged above). However, there is little evidence for an unambiguously positive effect of women's education on their autonomy (e.g., Basu 1996). For example, some studies have shown that better educated women may have no more freedom of movement than others, and perhaps even less (e.g., Balk 1997). (It has also been argued that the influence of education and other individual characteristics on women's autonomy is highly dependent on context. For example, Jejeebhoy and Sathar (2001) found that education mattered little in the north of India, where women's freedom is generally very restricted, but that it had a significant impact in the south.)

Moreover, broader economic transformations may take place as a result of educational expansion, at least in the long run. In particular, the community may become wealthier and thus have better opportunities to establish, for example, good sanitation systems and health-care facilities. Also a change in political attitudes may follow from a higher general level of education in the community and foster a growth in such public services. Such factors will, of course, be important for the individual family's possibility of preventing and treating child diseases. In addition, the family's own wealth is likely to have an effect on such factors, operating in part through their own sanitation facilities and standard of housing. However, the existence and quality of health institutions also reflect social and economic levels further back in time: to some extent, it must be relevant to consider health institutions and the general educational level as a joint outcome of economic wealth and political and ideational factors some years earlier.

While a child's nutrition may be affected positively both by the mother's education and that of other

women, through mechanisms such as those just mentioned, it is also possible that education may have harmful effects. Many investigations have shown that educated women tend to breastfeed for a shorter period than others (e.g., United Nations 1995), which may have serious implications for the child's health. Community education may have a similar effect. When many women in the community are educated, attitudes toward women's work may be more liberal and jobs may be created in the modern sector that are attractive to and suitable for women, and to which they cannot take their children. This may have consequences both for breastfeeding and childcare more generally (see, e.g., Basu and Basu 1991; Tulasidhar 1993 for discussions of the importance of women's labour force participation). In addition, a generally high educational level may produce negative attitudes to breastfeeding regardless of any transformations in the labour market.

Fertility is another channel through which education may operate. Women who live in areas where the average educational level is relatively high may have lower fertility than they would otherwise, for reasons discussed by Kravdal (2002) and Moursund and Kravdal (2003). This may be favourable from the perspective of child health. In particular, short spacing has repeatedly been shown to increase mortality, by weakening intrauterine growth and making mothers less able to care for and nurture their children (e.g., Hobcraft 1992; Muhuri and Menken 1997; Whitworth and Stephenson 2002). However, the quantitative importance of reproductive factors in the education–mortality relationship has been reported to be modest (e.g., Cleland and van Ginneken 1988; Bicego and Boerma 1993).

Another plausible, but somewhat different, effect of community education is that it may lead to a beneficial imitation of behaviour. If many women in the community are educated, there may also be a large proportion who make good efforts to prevent and treat child diseases—efforts that may be imitated by others. (Such imitation effects are notoriously difficult to grasp in a statistical analysis (e.g., Palloni 2001; Kravdal 2003b)).

Finally, if a generally high education leads to fewer diseases among *other* children (and adults), there will be a lower chance of any particular child getting a contagious disease.

For the sake of simplicity, men have been ignored so far. But *their* knowledge and attitudes, partly channelled through similar factors in their wives and other women, may also be important for child health and mortality, and their contribution to the family income is usually the dominant one (facts not indicated in the figure). Because of the possible effects of men's general educational level and its close correlation with that of women, it should be included in statistical models intended to shed light on the implications of specific efforts to stimulate girls' schooling. It is particularly important to include men's education if it is not a *result* of women's education. At the individual level, where a competition aspect is involved, a woman's education may have such a causal effect by improving her opportunities in the marriage market. However, an apparent relationship may also be spurious. For example, the choice of a partner and the woman's education may be jointly determined by the resources and attitudes of her family. A spurious relationship seems the kind most likely to be observed at the community level: a high average education among women is partly a result of community wealth or other factors that also lead to a high education among men.

Implementation issues

In this study, the 'community' is taken to be the village in which the woman lives or a rural or urban area of a similar size (see below). 'Community education' is the average length of education among the female survey respondents, who are supposedly representative of all women of reproductive age in the area. While each woman certainly does not interact directly with all these women, the sub-group she interacts with may participate in interaction chains that in total include much of the population of females in the area. In addition, there are more indirect mechanisms involved. In fact, there is a good case for using an even wider group of influential 'others', stretching far beyond the village.

Unfortunately, indicators of preventive childcare, nutrition, morbidity, and treatment cannot be included in the mortality models, because most of the required data are available only for the children surviving until interview. However, one can get an idea of their importance as causally intermediate factors by estimating separate models for each of these factors, in addition to the mortality models.

In order to obtain assessments of education effects that are as conservative as possible, the models include not only variables that are particularly likely to be determinants of education, but also some that have a less clear causal position and that make the education effects weaker (see Figure 2).

One of the most obvious determinants of education among those available in the data is religious affiliation (not available are data on the details of

religious beliefs, which may be more readily influenced by schooling). Two other determinants are social background, as measured by caste/tribe membership, and whether the place of residence is urban or rural (although education may fuel urbanization in the long run). Indicators of individual and community wealth (definitions below) are also included in the models. Household wealth at the time of interview cannot itself be a determinant of the mother's education, of course, but it can be a signal of the living standards of her family of origin, which is likely to have been a key determinant. Because there is particular doubt about the causal position of the wealth variables, estimates using models from which these variables have been excluded are also provided.

Primary health-care centres or sub-centres deliver most of the maternal and child health services in India (e.g., IIPS and OCR Macro 2000), and may therefore have been especially important for child mortality. Because the distance to such centres is also related to education, perhaps spuriously, it is included in the models. Unfortunately, there is no relevant information about the quality of these health centres.

The distance to a health centre is relevant and available for the rural areas only, a fact that can be easily accommodated by combining the distance with the rural/urban dummy variable. It was not necessary to include other such characteristics of the rural areas. The distances to doctors and hospitals, which one would expect to be most directly related to mortality, were included in additional models, but had no effect. The distances to an all-weather road, a post office, a bank, or a city, had significant effects, but they were weaker than the effect of the health-centre variable, and inclusion of these factors had almost no impact on the estimates of the effect of education.

In the next step, specific indicators of autonomy at the community level (see definitions below) are included. They are all positively correlated with community education (details not shown), and can obviously be considered both determinants and consequences of that variable.

Subsequently, a regional variable (North, Central, East, North-East, West, South) is entered into the model. This may pick up more of the effects of women's autonomy. As many authors (e.g., Dyson and Moore 1983) explain, there are large differences in women's position between the Indian regions. However, the regional variable may also capture aspects of people's economic situation, religious beliefs, or other cultural factors that are not adequately picked up by the other variables (and that should probably be considered determinants rather than results of education).

Specific indicators of the woman's *own* autonomy are also included. It seems reasonable to consider them as causally intermediate between individual education and mortality (although they are probably linked with her mother's autonomy, which may have had a bearing on her education). Because of the wide political and scholarly attention given to the importance of women's position, it is particularly interesting to investigate these effects. However, no other mediating variables are included.

Finally, husband's education and the average education of husbands in the community are entered into the model to produce a better assessment of the implications of a change in women's education.

The mother's own education or literacy has often been found to be less important for infants than for older children (e.g., Cleland and van Ginneken 1988; Pandey et al. 1998), and it may well be that some of the possible effects of community education suggested above also depend on the child's age or its sex. Further, it can be argued that the effects of community education depend on individual education, or vice versa. However, all such interactions are ignored, for the sake of simplicity.

Data and methods

Data

The analysis uses data from the National Family Health Survey of 1998–99 (NFHS-2), in which about 90,000 ever-married women aged 15–49 were interviewed. The restriction to ever-married women poses no problem owing to the low pre-marital fertility in India. The analysis is further confined to children whose mother was married at interview, because of the intention to include husband's characteristics, and because it is primarily for this group that the questions on women's autonomy are relevant. Excluding the 1–2 per cent of the children with formerly married mothers has no effect on the estimates.

There is said to be little underreporting of deaths (IIPS and OCR Macro 2000). Further, the moderate age heaping at multiples of 6 months should be of no concern in this study given that it is focused on educational differentials and mortality over a 5-year period.

The survey has a clustered sample. Within each state, a number of census enumeration areas

('primary sampling units' (PSUs)) were selected according to certain criteria. In total, there were 3,215 such areas in the survey, each typically spanning one or a few villages or part of a town or city. On average, about 30 households in each area were randomly chosen, and all women of reproductive age in these households were selected for interview. Weights specific to a small group of PSUs were defined to make the survey nationally representative.

In this study, averages of educational level and some other variables are calculated for those of the approximately 30 women in each area who were married at interview. These averages can be considered proxies for the corresponding PSU averages. For education, the measurement error introduced by using such a proxy was shown in a simulation experiment by Kravdal (2002) to be unimportant. Further evidence of the appropriateness of basing the community-level variables on such small sub-samples is provided below. Exclusion of the mother under consideration before calculating the averages does not influence the effect estimates.

In addition to the individual data, the survey includes a module on each village within the rural PSUs, which is the source of the information on distance to a health centre.

Models

Discrete-time hazard models for the mortality of children born within the 5 years before interview are estimated in the aML software (Lillard and Panis 2000). Each child contributes a series of 6-month observation intervals up to a maximum of 5 years. Tests showed these to be sufficiently short intervals. Twins are excluded. The sample includes 3,909 child deaths.

Further, logistic models for 12 health and healthcare indicators are estimated for children who were less than 3 years old and still alive at interview and who had no more than one younger sibling. The women were interviewed about the health and health care of only the two youngest children below about age 3 (born after 1 January 1995 in states where the fieldwork started in 1998 and after 1 January 1996 in states where it started in 1999), and most of the questions were further restricted to the survivors. Some children are left out of this analysis because of missing information on the dependent variable in focus.

More specifically, models for the following probabilities are estimated:

- whether the mother had received antenatal care from a health worker (physician, nurse, midwife, other health professional, or home health worker);
- whether the mother had received at least one tetanus injection before birth;
- whether the child had been fully vaccinated (restricted to children who were 12–23 months old at interview, because children should be fully vaccinated at the time of their first birthday, according to international and Indian guidelines);
- whether the child had ever received vitamin A supplementation (restricted to children older than 12 months, because the current Programme on Prevention of Blindness prescribes doses every 6 months starting at the age of 9 months);
- whether the child had suffered from diarrhoea during the 2 weeks before interview;
- whether the child had suffered from a cough accompanied by fast breathing (symptoms of acute respiratory infection) during the 2 weeks before interview;
- whether a child with diarrhoea had been taken to a health facility or provider for advice or treatment;
- whether a child with diarrhoea had been given oral rehydration;
- whether a child younger than 4 months received only breast milk, i.e., no solid food, no plain water, and no other liquid (in accordance with recommendations, though these have been criticized by Anandaiah and Choe 2000);
- whether a child aged 6–11 months was given both breast milk and solid or semi-solid food, as recommended;
- whether the child was stunted (height less than two standard deviations below the median for the international reference population at that age, an indicator of chronic undernutrition);
- whether the child was wasted (weight less than two standard deviations below the reference median for that height, an indicator of acute undernutrition).

Individuals in the same PSU may share some unobserved characteristics. Generally, failure to account for such factors yields standard errors of the community-effects estimates that are too small. In this study, a random term at the PSU level (assumed to be normally distributed with a mean of zero and a variance to be estimated) is included in all models, but has no importance for the conclusions. It would also have been relevant, although even less important for the conclusions, to include random terms at lower

levels. Some variables are measured for a household, from which there may be more than one woman in the sample, and many women have had more than one child during the 5-year period.

Various methodological problems

It is not ideal, of course, that all individual variables refer to the situation at interview, and that the community variables refer to the situation at interview in the PSU in which the woman lived at that time. Child mortality at a time earlier in the 5-year period is influenced by the mother's education and various other characteristics at that time, or shortly before, which themselves are a result of factors further back. Presumably, there is much stability in some of the covariates that are included (e.g., religious affiliation), and individual education itself probably changes little after entry into motherhood, but, especially for the variables that have an unclear position in the causal structure, an additional measurement at an earlier time would have been very useful. One issue that seemed likely to pose a problem was that many women had not lived in the area throughout the 5-year period, but, fortunately, excluding women who had moved to the area after the child was born gave very similar results.

More importantly, there may be some unobserved correlates of education that also have a strong bearing on mortality. As an illustration, let us compare an uneducated woman who lives in an area with a generally high educational level with another uneducated woman who lives in an area where the average educational level is much lower, but where other observed community characteristics are the same. These two women may differ in many ways. For example, there may be differences in the general wealth or gender norms in the communities in which they live, beyond those picked up by the variables included in the analysis, with consequences for the corresponding individual-level characteristics. There may also be differences in more 'global' community factors. In addition, there may be unobserved individual differences because of selective migration (not only during the 5-year period, but also earlier). If there had been two or more surveys in the same PSUs, one might have pooled the samples and included fixed effects at the PSU level, which would have captured at least the persistent unobserved community-level factors. However, different PSUs were used in the NFHS-2 and NFHS-1 surveys, so this approach could not be used.

Some of the variables are fairly strongly correlated, so one might suspect a multicollinearity problem. However, the standard errors in the most complex models are not much larger than those in various simple models that were estimated at a preliminary stage. Besides, the estimates in all models are very robust with respect to the exclusion of observations. For example, when 15 per cent of the respondents were taken out at random, either initially or only when calculating averages, very small changes in the estimates occurred. This finding is also an additional argument for the appropriateness of basing the analysis on averages from such small subsamples.

Definition of independent variables

The definition of the independent variables is probably sufficiently clear from the short labels in the tables, but a few words about the wealth and autonomy indicators may be helpful. A wealth index is constructed by summing ownership of the following consumer goods: radio, television, bicycle, motorcycle, and car. According to Bollen et al. (2002), this index should be a fairly good proxy for economic status. Electricity in the household is included as an additional indicator of wealth and modernization.

The survey includes a number of questions about women's rights and opportunities that are meant to capture various dimensions of their autonomy. Many respondents may well have found it difficult to answer these questions, some of which are quite sensitive and others vague, but few other surveys provide a better opportunity to quantify the apparent effects of women's autonomy. A simple index of women's physical autonomy is constructed by summing over the following two 0/1 variables: whether the woman needs permission to go to the market, and whether she needs permission to visit relatives or friends. Similarly, an index of decision-making autonomy is based on information about whether the woman takes decisions herself, or at least jointly with her husband or others, on the following: what to cook, whether to obtain health care for herself, whether to purchase jewellery or other major household items, and whether to stay with her parents or siblings. With respect to economic autonomy, an index is constructed by adding two 0/1 variables: whether the woman is allowed to have some money set aside that she can use as she wishes, and whether she earns cash and participates in decisions on how to use it.

Results

Education effects on child mortality

Model 1 in Table 1 includes only the woman's education and the child's age. Model 2 also includes the following (proxies of) individual-level variables that may lie causally before education: religion, caste/tribe membership, consumer-item index, and electricity. Education effects are weaker in Model 2.

The effects of individual education are further reduced when the corresponding community variables, including average length of education, are also entered into the model along with a combined variable for rural/urban residence and distance to a health centre (Model 3). On the other hand, because the effect of average education is itself very strong, the total impact of education is much larger according to this model. (The same community education effect is estimated when finer categories for individual education are used.)

This enhanced impact of education can be illustrated by calculating overall 5-year child mortality as a weighted average of predicted education-specific mortality probabilities, with different educational distributions as weights. More specifically, the calculation is of how this 5-year mortality would change if the educational distribution among all women of reproductive age were changed from the current Indian national average to that in Kerala, which is the state with the highest average educational level. It is assumed that the educational distribution among mothers of children younger than 5 is the same as that among all women of reproductive age. In other words, the effect of differential fertility is disregarded, thus leaving a 'purer' mortality influence. These predicted changes over time must not be taken too literally, of course, because the estimates of

Table 1 Effects (with standard errors) of education and other variables on mortality among Indian children with a married mother[1]

	Model 1		Model 2		Model 3	
Mother's education						
0–2 years[2]	0		0		0	
3–6 years	–0.50***	(0.05)	–0.39***	(0.05)	–0.31***	(0.05)
7–9 years	–0.67***	(0.06)	–0.51***	(0.06)	–0.36***	(0.06)
10+ years	–1.12***	(0.07)	–0.87***	(0.08)	–0.61***	(0.08)
Average education among women (years)					–0.087***	(0.014)
Caste/tribe membership						
Scheduled caste			0.06	(0.05)	0.09*	(0.05)
Scheduled tribe			0.21***	(0.06)	0.24***	(0.06)
Other backward castes			0.05	(0.04)	0.04	(0.04)
Other[2]			0		0	
Religion						
Hindu[2]			0		0	
Muslim			–0.20***	(0.05)	–0.13**	(0.06)
Sikh			0.02	(0.16)	–0.01	(0.16)
Christian			–0.24*	(0.13)	–0.12	(0.13)
Other			–0.11	(0.17)	–0.06	(0.17)
Consumer items index			–0.08***	(0.02)	–0.09***	(0.02)
Electricity (no = reference)			–0.18***	(0.03)	–0.06	(0.05)
Proportion scheduled caste/tribe					–0.17*	(0.09)
Proportion Muslim					–0.16*	(0.10)
Rural/urban * health care						
Rural, health-care centre within 3 km					–0.12*	(0.05)
Rural, health-care centre in village					–0.12***	(0.05)
Rural, other[2]					0	
Urban					–0.09	(0.06)
Consumer-items index for community					0.10**	(0.05)
Proportion with electricity in the household					–0.16**	(0.08)
Standard deviation of PSU-level random term	0.36***	(0.03)	0.34***	(0.03)	0.32***	(0.04)

[1]Constant term and effects of child's age (six categories) are not shown.
[2]Reference category.
*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.
Source: Second National Family Health Survey of India, 1998–99.

education effect are from a 'static' model and there are many unobserved correlates of education and considerable uncertainty about directions of causality.

Using the estimates from the model with only individual education and the child's age (Model 1), this hypothetical educational expansion to the level of Kerala would reduce 5-year mortality in India by 0.030. The corresponding change calculated from the estimates from Model 2 would be 0.024. According to the more complex Model 3, which includes average education, the change would be 0.040, of which 0.018 would be an individual-level contribution (obtained by using the all-India average educational level in all predictions of education-specific mortality, but changing the weights in accordance with the changes in the educational distribution) and the remaining 0.022 a community-level contribution. Thus Model 2, which includes the woman's own education, but not community education, picks up what appears from the more complex model to be the 'true' individual-level contribution of 0.018 (except that it might have been considerably smaller if more individual correlates of education had been included) and part of (0.006), but far from the entire (0.022, according to Model 3), community-level contribution (as illustrated mathematically for simpler models in Kravdal 2001).

Leaving individual education out of Model 3 would have given a community education effect of –0.135 (details not shown). According to this estimate, an educational expansion to the level in Kerala would have reduced mortality by 0.040, just as found with Model 3. In other words, we would capture the whole effect of education by such an approach (also in accordance with Kravdal 2001), but without being able to identify the individual-level and community-level contributions.

At this stage, it may be instructive to revisit the fixed-effects model estimated by Desai and Alva (1998). As explained in Kravdal (2003a), the individual education effects in Model 3 are almost the same as would have been obtained if community fixed effects had been included (one dummy for each of the PSUs except for the one that is chosen as a reference) instead of the other community variables. In that sense, the two approaches are similar. However, the fixed-effects approach ignores the effect of community education and thus considerably understates the total impact of investments in education.

Some of the effects of the other variables in Model 3 are difficult to understand. For example, women from scheduled tribes experience high child mortality, whereas low mortality is indicated for those who live in communities where relatively many are members of scheduled castes or tribes (where mortality was found to be low also by Murthi et al. 1995). Further, the effect of community wealth is positive, whereas the expected negative effect is estimated for the corresponding individual-level variable and the proportion with electricity. The positive wealth effect disappears, however, when region is taken into account (not shown in the table).

The effects of religion are more consistent: Muslims experience lower child mortality than Hindus, as reported also by others (e.g., Pandey et al. 1998), and there are indications of low mortality in areas with many Muslims. According to these models with many other variables, living in an urban area is not particularly advantageous (as observed also by Pandey et al.), but within the rural areas, having a health-care centre or sub-centre in the village reduces mortality significantly. There are also indications that having a centre within a few kilometres is advantageous.

As explained above, the causal position of wealth and economic modernization is particularly unclear. Fortunately, exclusion of the electricity variables and the consumer-item indices would have had a modest impact on individual education effects, which would have become 0.05–0.10 sharper, and hardly any impact on the community education effect. Ignoring distance to a health-care centre, which is also a causally problematic variable, would have made the community education effect only 0.003 sharper.

There is considerable unexplained variation in mortality between the different communities even in the most complex model. The inclusion of some community variables reduces the standard error of the random term by only 0.02, from 0.34 to 0.32 (and to 0.27 when more variables are added; see below).

Among the community-level indices of autonomy, only the measure of physical autonomy has a significant effect, in the expected direction (Model 4, Table 2). When these variables are included, the community education effect is reduced from –0.087 to –0.070.

If the different aspects of women's general autonomy are primarily determinants rather than consequences of women's education, the estimate of –0.070 is a better assessment of the community-level effect of investments in schooling than the estimate of –0.087. However, the total impact of a hypothetical educational expansion up to the level in Kerala would nevertheless be as large as 0.036. This is larger than found with the simplest model (Model 1), and much larger than the prediction of 0.024 based on the individual-level model with some possible

Table 2 Effects (with standard errors) of education and other variables on mortality among Indian children with a married mother[1]

	Model 4		Model 5		Model 6		Model 7	
Mother's education								
0–2 years[2]	0		0		0		0	
3–6 years	–0.30***	(0.05)	–0.28***	(0.05)	–0.28***	(0.05)	–0.23***	(0.05)
7–9 years	–0.34***	(0.06)	–0.32***	(0.06)	–0.31***	(0.06)	–0.22***	(0.06)
10+ years	–0.60***	(0.08)	–0.59***	(0.08)	–0.59***	(0.09)	–0.39***	(0.09)
Average education among women (years)	–0.070***	(0.014)	–0.045***	(0.014)	–0.046***	(0.014)	–0.050***	(0.018)
Community autonomy:								
Decision-making autonomy	–0.05	(0.04)	–0.03	(0.03)	0.02	(0.04)	0.01	(0.04)
Physical autonomy	–0.26***	(0.06)	–0.19***	(0.06)	–0.14**	(0.07)	–0.14**	(0.07)
Economic autonomy	0.01	(0.09)	0.16*	(0.09)	0.13	(0.09)	0.13	(0.09)
Region								
North[2]			0		0		0	
Central			0.11*	(0.06)	0.11*	(0.06)	0.11*	(0.06)
East			–0.26***	(0.07)	–0.27***	(0.07)	–0.27***	(0.07)
North-East			–0.13	(0.11)	–0.13	(0.11)	–0.14	(0.11)
West			–0.23***	(0.08)	–0.24***	(0.08)	–0.25***	(0.08)
South			–0.25***	(0.07)	–0.26***	(0.07)	–0.27***	(0.08)
Individual autonomy:								
Decision-making autonomy					–0.04***	(0.01)	–0.04***	(0.01)
Physical autonomy					–0.05*	(0.03)	–0.05*	(0.03)
Economic autonomy index					0.03	(0.03)	0.04	(0.03)
Husband's education								
0–2 years[2]							0	
3–6 years							–0.04	(0.05)
7–9 years							–0.17***	(0.05)
10–11 years							–0.17***	(0.06)
12–14 years							–0.23***	(0.08)
15+ years							–0.64***	(0.12)
Average education among husbands (years)							0.013	(0.014)
Standard deviation of PSU-level random term	0.31***	(0.04)	0.27****	(0.04)	0.27****	(0.04)	0.27***	(0.04)

[1]In addition, the same variables as those in Model 3 in Table 1 are included.
[2]Reference category.
*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.
Source: As for Table 1.

determinants of education included (Model 2) and the 0.017 that would be obtained if community fixed effects were added.

The inclusion of region, which may capture additional effects of autonomy or other socio-economic factors, leaves a much weaker community education effect of –0.045 (Model 5). According to this model, the impact of a hypothetical educational expansion up to the level in Kerala would be 0.029, of which 0.012 would be the community-level contribution. In other words, the results suggest that the effect of community education is indeed worth attention, but that individual education is even more important.

In Model 6, individual and community effects of women's autonomy are separated. Significance is attained at both levels. The average physical autonomy in the community is negatively related to mortality, as in the simpler model. At the individual level, such an effect is seen for decision-making autonomy. There is also an indication that the woman's own physical autonomy has a beneficial influence. Economic autonomy is not negatively related to mortality at any level.

While community autonomy explains some of the community education effect, the inclusion of the mother's own autonomy, which is more likely to be a mediating variable, has no impact on estimates of the individual education effect. In other words, individual education apparently operates not through woman's autonomy but through other factors.

The education of the woman's own husband (a finer five-level categorization is more appropriate for men) has a significant effect, while the average education of other husbands in the PSU has no effect

(Model 7). With these variables included, the individual-level effect of a woman's education is reduced, but the community education effect remains essentially unchanged. This generally weaker effect of husband's education (compared with the wife's) fits well with conclusions from other studies (see, e.g., the review by Hobcraft 1993).

Education effects on child health and health care

Estimates from models for various health and health-care indicators are shown in Table 3. The same variables used in Model 6 are included, with the intention of providing estimates that are as conservative as possible. In addition, month of interview is included as a control variable, because the fieldwork took place in different seasons in different states, and because of the seasonal variations in some of the diseases considered.

Apparently, community education operates through many different channels. A high average education increases the mother's use of preventive services during pregnancy, makes it more likely that the child is vaccinated and given vitamin A supplementation, reduces the risk of diarrhoea, makes treatment of children with diarrhoea more appropriate, and makes her more inclined to give a 6- to 11-month-old child both solid food and breast milk. Consistently with these advantages, the child has a lower risk of becoming stunted or wasted. On the other hand, children in areas with a relatively high general educational level have, to a *larger* extent than other children, suffered from symptoms of acute respiratory infection during the 2 weeks before interview, and have not been brought to a health worker particularly often if they have had diarrhoea. These children do not have an advantage with respect to breastfeeding either.

The same pattern appears if husbands' education is included, but a few effects of women's average education are sharper (details not shown). This sharpening may indicate that high education among men, for a given level of women's education, is linked with low autonomy for women, and that the harmful effect of that more than outweighs any advantage stemming from better-educated men's higher level of knowledge and larger economic contributions. (If the difference in average education between the sexes is included in these models instead of husbands' education, which more clearly invites such an interpretation, the effects of women's average education are weaker, but still significant.)

If the indicators of the woman's own autonomy had been taken out of the models, the education effects would have been very similar (details not shown).

The effects of community education are quite similar to those of individual education. One exception is that women who themselves have education tend to bring children with diarrhoea more often to a health worker than do the uneducated, whereas community education has no such effect. However, significant community-level effects show up for vaccination and vitamin A supplementation, so one should not reject the idea that a generally high educational level may increase the individual woman's awareness of the importance of modern medical health services and her willingness to make use of them. Another inconsistency between the effects at the two levels appears in the model for nutrition of newborn children. As explained above, one might expect breastfeeding to be undermined by education, and the individual-level effect indeed supports such an idea, but community-level education has no such effect.

Generally, education effects are less clear for the disease-prevalence variables than for the other health and health-care variables. Individual education has no significant effect on the risk of getting diarrhoea, and a blurred picture appears for the risk of getting an acute respiratory infection. These findings accord well with the patterns reported elsewhere. The reported prevalence of fevers and coughs has been shown in other studies to be especially little influenced by the mother's education (e.g., Hobcraft 1993). The respective community effects, however, are significantly negative and positive in these two models. The latter effect is the only indication in these data that a high average education may also contribute to a *high* mortality. One possible explanation for the generally weak, or even positive, effects may be that educated mothers, or those living in communities where the educational level is relatively high, are more sensitive to illnesses and thus more likely to report them. That would be consistent with findings by, for example, Murray and Chen (1992).

Summary and conclusion

It is widely recognized that education effects in many previous studies of child mortality in less developed countries may have been seriously biased because of omitted factors. We should, of course, continue efforts to establish good indicators of characteristics that are linked with education, with a special eye to those that are likely to be confounders rather than mediators. However, we should also be concerned about the limitations of the individual-level

Table 3 Effects of education on health and health-care factors of relevance for child mortality in India[1]

	Antenatal care		Preventive childcare	
	Mother prenatal care by health worker	Tetanus vaccine	Child aged 12–23 months fully vaccinated	Vitamin A by age 12 months
Mother's education				
0–2 years[2]	0	0	0	0
3–6 years	0.76***	0.78***	0.53***	0.47***
7–9 years	1.00***	1.21***	0.59***	0.64***
10+ years	1.46***	1.71***	0.64***	0.63***
Average education among women (years)	0.14***	0.09***	0.08***	0.07***
Sample size:	30,497	30,445	9,680	19,518
	Diseases		Treatment	
	Diarrhoea last 2 weeks	ARI[3] symptoms last 2 weeks	Brought to health worker if diarrhoea	Given ORS[4] if diarrhoea
Mother's education				
0–2 years[2]	0	0	0	0
3–6 years	0.06	0.01	0.02	0.20***
7–9 years	0.06	0.11**	0.49***	0.24***
10+ years	–0.11*	–0.24***	0.55***	0.44***
Average education among women (years)	–0.06***	0.04***	–0.01	0.07***
Sample size:	31,209	31,150	6,002	5,973
	Nutrition		Nutrition and health indicators	
	Only breast milk first 4 months	Breast milk + solid food 6–11 months	Child is stunted	Child is wasted
Mother's education				
0–2 years[2]	0	0	0	0
3–6 years	–0.22**	0.34***	–0.20***	–0.07
7–9 years	–0.34***	0.29***	–0.42***	–0.16***
10+ years	–0.16	0.34***	–0.62***	–0.23***
Average education among women (years)	0.01	0.12***	–0.08***	–0.05***
Sample size:	4,485	5,026	23,955	24,781

[1]In addition, the same variables as those in Model 6 in Table 2 are included, plus month at interview.
[2]Reference category.
[3]Acute respiratory infection.
[4]Oral rehydration solution.
*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.
Source: As for Table 1.

perspective. This analysis has revealed a sharp effect of other women's education, which is not adequately captured in an individual-level model.

According to the most conservative estimates, from Models 5 or 6, a hypothetical expansion of the educational level in India up to that currently found in Kerala would reduce the probability of death before the age of 5 by 0.029, of which 0.012 would be a community-level contribution. This is somewhat higher than the 0.024 calculated from an individual-level model that includes some possible individual-level determinants of education, and much higher

than would be obtained if community-level fixed effects were added to such a model, which would leave only the individual-level contribution of 0.017. Investigators who are not conscious of the importance of community education effects might, as an alternative to including community fixed effects, be inclined to estimate a multilevel model with many variables, such as Model 5, but without community education, and perhaps also without other community variables for which corresponding individual-level variables are included. According to such models (i.e., restricted versions of Model 5; not shown), the hypothetical expansion of education would reduce mortality by only 0.019 or 0.020, respectively.

Unfortunately, the estimated effects of community education may be biased even though a number of potential determinants of education are included in the models. For example, a woman who lives in an area with a relatively high average educational level may be surrounded by people who also score high on some important unobserved socio-economic factors, or benefit from various societal institutions that foster low mortality. There is plenty of room for such factors, given that much community variation is left unexplained by the model.

One cannot know what would have happened if it had been possible to include more determinants of education, but it may well be that a weaker effect of community education would have been estimated, i.e., that even the most 'conservative' estimate referred to above would have been shown to be too high. On the other hand, it is also possible that the factors that *are* included are actually to a large extent causally intermediate, and thus should have been left out to produce a better, and higher, estimate of the total effect of community education. That may, for example, be the case for the autonomy variables at the community level, which pick up a substantial part of the education effect: whereas a subordinate position for women is likely to be a very important reason for their low educational level, a reverse causation is also possible. Further, the individual-level effects also may be biased because of unmeasured determinants of education, even in these models with a fairly large number of variables included. In the light of these considerations, it would be particularly unreasonable to let the uncertainty in the assessment of the community-level contribution make us continue to ignore it.

The results support the idea that women's decision-making and physical autonomy are important, either at the individual or community level, while economic autonomy seems to have no impact. Moreover, the effect of region, which explains much of the community education effect, may be an additional signal that women's autonomy does indeed have a bearing on child mortality. However, whereas the general level of women's autonomy explains some of the community-level effect of education, the mother's own autonomy seems not to be a causally intermediate factor between individual education and child mortality.

Apparently, it is the general educational level among *women* that is important, not that among men. The husband's own education has an impact on child mortality, but there is no beneficial effect of husbands' average educational level.

The effect of community education may operate through many different health and health-care variables. Significant effects of women's average education are estimated in models for various indicators of antenatal care, preventive childcare, the use of supplementary nutrition, the child's disease risk (but not consistently), and the mother's care for a sick child (also not consistently). Such factors are probably important proximate determinants of mortality, but could not be included in the mortality models because of data limitations. Therefore, the analysis provides only fairly weak evidence for the importance of these causal pathways.

Clearly, more attention should be devoted to the possible impact of community education, without downplaying the effect of the mother's own education. It seems that both factors are important, and that they may operate through a wide range of health and health-care variables. The mechanisms that link community education with these variables may involve, for example, the quality of the health-care institutions, the prevalence of potentially fatal contagious diseases, the sanitation systems, imitation of behaviour, or transmission of health knowledge and attitudes. The exploration of these mechanisms will be important subjects of future studies.

Notes

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2 This work was largely completed while the author was at the East–West Center, Honolulu, with support from the Norwegian Research Council. Inspiring talks with and excellent comments from Minja K. Choe are greatly appreciated. The work has also benefited from good advice and comments provided by Jiajian Chen, Vinod Mishra, Robert Retherford, Noriko Tsuya, and two anonymous referees.

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