Corresponding author:

Øystein Kravdal
Department of Economics
University of Oslo, P.O. Box 1095 Blindern
0317 Oslo, Norway
Phone (47)22855158; fax (47)22855035
E-mail: okravdal@econ.uio.no

Child Mortality in India: The Community-level Effect of Education

Øystein Kravdal

Department of Economics
University of Oslo

SHORT TITLE: Child Mortality and Community Education in India

When assessing health benefits of increased education in developing countries, many researchers have been concerned about the omission of important determinants of education from the models. This study illustrates that one should also be concerned about the limitations of the individual-level perspective. According to a multilevel discrete-time hazard model based on NFHS II data, the average education of women in the census enumeration area has a strong impact on child mortality, in addition to that of the mother's own education. The lower child mortality associated with women's autonomy is taken into account in this estimation. Similar models for various health and health care variables suggest that the effect of community education, just as that of individual education, operates through the use of maternity 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

A large number of studies from many developing countries have shown a strong negative association between mother's educational level and child mortality. Nevertheless, there is still considerable uncertainty about how strong the total impact of education actually is, let alone the underlying mechanisms and the variations 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. Perhaps there is 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 enter into an educational category associated with lower mortality, but also because everyone, including those who themselves remain uneducated, take advantage of 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), while a similar literacy effect was shown for India by McNay, Cassen and Arokiasamy (2003). It has also been reported in studies of health and mortality in developed countries that education and other socioeconomic resources in the community are influential (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 developing countries.

The otherwise excellent paper by Desai and Alva (1998) may serve as an interesting illustration of the lack of attention to the community education effect. 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 also a number of unobserved factors at the community level might be linked with both education and mortality, their next step was to include village fixed-effects instead of the rural/urban indicator, which further 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, it is essentially swept out with all other community factors (but it was implicitly touched in the concluding discussion).

The objective of this study is to find out whether the education of other women in the community is of substantial importance for child mortality in India, where there is still as many as 95 per 1000 who die before they reach age 5, as a national average for 1994-1999 (International Institute for Population Sciences and OCR Macro 2000). The analysis is based on a large, clustered sample of about 90000 women interviewed in the National Family Health Survey of 1998-1999. 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. The data that are used include more questions on women's position relative to men than most other Demographic and Health Surveys, so given also the fairly meagre statistical evidence for the claim that women's subordinate position is an important reason for high child mortality in Southern Asia (for early contributions, see e.g. Caldwell 1986; Dyson and Moore

1983; Mason 1984), the estimates of autonomy effects are an important by-product of the analysis.

Similar models are estimated for some health and health care variables that are presumably important for mortality. This provides 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 only available 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. This must not be considered an exhaustive account, however. Other factors may also play a role, there may be additional effects of the variables that are mentioned, and one may argue for alternative directions of causality.

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

(Figure 1 about here)

A general underlying assumption is that the characteristics of the individual mother under consideration has 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; Kohler, Behrman and Watkins 2001; Montgomery and Casterline 1996). 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 among 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 and individual level, which may also have a bearing on mortality. Of course, these need to be taken 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 only included in an attempt to identify causal pathways).

For example, educational institutions are more likely to have been established if the community is relatively rich. Besides, the degree of urbanization may be an important determinant. Having a large population in a small area facilitates educational expansion and typically produces a labour market where education is more of an asset. Moreover, political and religious attitudes may be important for 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 give an individual girl education. Another determinant of her education, as well as that among others in the community, is women's autonomy, loosely defined as their responsibilities, rights and freedom to act as they choose relative to those of 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 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 factors may, for example, operate through such factors as the use of preventive health services, as shown by Bloom, Wypij and Das Gupta (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).

The 'economic autonomy' has been considered another aspect of women's autonomy, and refers to their ability to fend for themselves economically. It involves, 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. Besides, the possibility of 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. Other people's education may enhance their knowledge about good health behaviour and make them generally more well-informed and less fatalistic. Such consequences of community education may be passed on to the mother under consideration and add to any similar effects of her own education. This may further lead to, for example, better nutrition of the children, higher prevalence of vaccination, a more hygienic environment, and more appropriate home care in case of disease, and it may make it easier to communicate with health workers.

Besides, one might expect that a generally higher level of education among women will gradually strengthen women's position, and that there may be similar effects at the individual level (i.e. a reverse causality compared to that mentioned 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 context-dependent. 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 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 and for the infection risk. In addition, their own wealth is likely to have an effect on such factors, operating in part through their own sanitation and housing standard. However, the existence and quality of health institutions also reflects the economic standard further back in time. To some extent, it must be relevant to consider health institutions and the general educational level a joint outcome of economic wealth and political and ideational factors some years earlier.

While a child's nutrition may be positively affected 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. There may be a similar effect of community education. When many other women in the community are educated, attitudes toward women's work may be more liberal and jobs in the modern sector that are attractive to and suitable for women, and where they cannot bring their children with them, may be created. This may have consequences both for breastfeeding and child care more generally (see e.g. Tulasidhar (1993) and Basu and Basu (1991) for discussion 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 labour market transformations.

Also fertility is a potential channel that education may operate through. Women who live in areas where the average educational level is relatively high may have lower fertility than others, for reasons discussed by Kravdal (2002) and Moursund and Kravdal (2003). This may be favorable from a child health perspective. 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. Bicego and Boerma 1993; Cleland and van Ginneken 1988).

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

Finally, if a generally high education leads to less diseases among *other* children (and adults), there will be a lower chance of seeing the child under consideration getting a contagious disease.

Men have, for simplicity, been ignored so far. However, also *their* knowledge and attitudes, partly channeled through similar factors in their wives and other women, may be important for child health and mortality, and their contribution to the family income is usually the dominant one (not indicated in the figure). Because of the possible effect 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. That would be particularly important if men's education 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, the relationship may also be spurious, for example because the choice of a partner and the woman's education are jointly determined by the resources and attitudes of her family. At the community level, a spurious relationship seems most plausible. Put differently, it is possible that a high average education among women is a result of community wealth or other factors that also lead to a high education among men, and that it is the latter that is important for mortality. This can be checked by including men's or husbands' education in the models.

Implementation of the ideas in the present analysis

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, supposedly representative of all women of reproductive age in the area. Each woman certainly does not interact directly with all these women. However, the sub-group she interacts with may itself be part of interaction chains that in total include much of the female population in the area. Besides, there are more indirect mechanisms involved. In fact, there would be good reasons for using an even wider group of influential 'others', stretching far beyond the village.

Unfortunately, indicators of preventive child care, nutrition, morbidity and treatment cannot be included in the mortality models, because most of this information is 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 get as 'conservative' assessments of the education effects as possible, the models include not only variables that are particularly likely to be determinants of education, but also some with a less clear causal position (see Figure

2). If the latter are positively associated with education and negatively associated with mortality, so that their inclusion reduces the education effect, it is a possibility that some of the total effect of education is tapped out.

One of the most obvious determinants of education among those available in the data is religious affiliation (as opposed to the more detailed character of the 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 is urban or rural (although education may fuel urbanization in the long run). Besides, indicators of individual and community wealth (definitions below) are 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 economic standard in 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 from models where they are excluded are also referred.

Primary health care centres or sub-centres have delivered most of the maternal and child health services in India (e.g. International Institute for Population Sciences 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.

(Figure 2 about here)

The distance to a health centre is relevant and available only for the rural areas. This can be handled easily by combining it with the rural/urban dummy variable. Also other such characteristics of the rural areas can be included, but it turned out to be substantially unimportant. 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. There were significant effects of the distances to an all-weather road, a post office, a bank, or a city, but they were weaker than that of the health centre variable, and inclusion of these factors had almost no impact on the education effect estimates.

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

Afterwards, 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 described by many authors (e.g. Dyson and Moore, 1983), 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).

Also specific indicators of the woman's *own* autonomy are included. It seems reasonable to consider them as causally intermediate to 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, these effects are particularly interesting. No other mediating variables are included, however.

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

Many of the possible effects of community education that were discussed above may depend on the child's sex or age. In support of this, the mother's own education or literacy have often been found to be less important for infants than older children (e.g. Bicego and Boerma 1993; Cleland and van Ginneken 1988; Pandey et al. 1998). It can also be argued that effects of community education may depend on individual education, or vice versa. However, all such interactions are ignored, for simplicity.

Data and methods

Data

The analysis is based on data from the National Family Health Survey of 1998-1999 (NFHS II), in which about 90000 ever-married women aged 15-49 were interviewed. The restriction to ever-married women is unproblematic because of the low pre-marital fertility in India. The analysis is further confined to the children whose mother was married at interview. This is because of the intention to include husband's characteristics, and because the questions on women's autonomy are relevant primarily for this group. Excluding the 1-2% of the children with formerly married mothers has no effect on the estimates.

There is supposed to be little underreporting of deaths (International Institute for Population Sciences and OCR Macro 2000). Besides, the moderate age heaping at multiples of six months should be of no concern in this study that is focused on educational differentials and mortality over a five-year period.

The survey has a clustered sample. Within each state, a number of census enumeration areas ('primary sampling units'; PSUs) were selected on the basis of certain criteria. In total, there were 3215 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 these approximately 30 women 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 so 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 about each village within the rural PSUs, from which the information on distance to a health centre is taken.

Models

Discrete-time hazard models for mortality of children born within the five years before interview are estimated in the aML software (Lillard and Panis 2000). Each child contributes a series of six-month observation intervals up to a maximum of five

years. Tests showed this to be sufficiently short intervals. Twins are excluded. The sample includes 3909 child deaths.

Besides, logistic models for 12 health and health care indicators are estimated for children who were less than three years old and still alive at interview and who had no more than one younger sibling. The women were only interviewed about the health and health care of the two youngest children below about age three (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. Besides, 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 the 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 six months starting at the age of nine months)
- whether the child had suffered from diarrhoea the last two weeks before interview
- whether the child had suffered from cough accompanied by fast breathing (symptoms of acute respiratory infection) the last two weeks
- 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 four months received only breast milk, i.e. no solid food, no plain water, and no other liquid (in accordance with recommendations, which have been criticized by Anandaiah and Choe (2000))
- whether a child aged 6-11 months was given both breastmilk 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, which indicates chronic undernutrition)
- whether the child was wasted (weight less than two standard deviations below the reference median for that height, which indicates acute undernutrition)

Individuals in the same PSU may share some unobserved characteristics. Generally, failure to account for such factors gives too small standard errors of the community-effect estimates. In this study, a random term at the PSU level (assumed to be normally distributed with a mean of 0 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 substantially, 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 five-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. The child mortality at a point of time earlier in the five-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, one would definitely have wanted an additional measurement at an earlier time. A particular problem is that many women have not even lived in the area throughout the five-year period, but, fortunately, excluding children whose mothers 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 and 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 community in which they live, beyond those picked up by the included variables, with consequences also 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 five-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 perhaps suspect a multicollinearity problem. However, the standard errors in the most complex models are not much larger than in various simple models that were estimated at a preliminary stage. Besides, the estimates in all models are very robust toward exclusion of observations. For example, when 15% of the respondents were taken out at random, either initially or only when calculating averages, very small changes in the estimates were seen. This is also an additional argument for the appropriateness of basing the analysis on averages from such small sub-samples.

Definition of independent variables

The definition of the independent variables should be sufficiently clear from the short labels in the tables, but a few words about the wealth and autonomy indicators may be

needed. A wealth index is constructed by summing ownership of the following consumer goods: radio, television, bicycle, motorcycle, and car. According to Bollen, Glanville and Stecklov (2002), this 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 or vague, but few other surveys provide a better opportunity to quantify the 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 formed on the basis of 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 construction 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 the 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 some individual-level variables that may lie causally prior to education or signal such background factors: religion, caste/tribe membership, consumer item index and electricity. Education effects are weaker in this model.

(Table 1 about here)

The effects of individual education are further reduced when also the corresponding community variables, including average length of education, are entered into the model along with a combined variable for rural/urban and distance to a health centre (Model 3). On the other hand, the effect of average education is itself very strong (which is not because of too broad categories for individual education; not shown), so the total impact of education is much larger according to this model.

This enhanced impact of education can be illustrated by calculating overall five-year child mortality as a weighted average of predicted education-specific mortality probabilities, with different educational distributions as weights. More specifically, it is calculated how this five-year mortality changes if the educational distribution among all women of reproductive age is 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 five is the same as that among all women of reproductive age. In other words, differential fertility is disregarded, which leaves a 'purer' mortality influence. These predicted changes over time must no be taken too literally, of course, as the education effect estimates 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 Kerala level would reduce five-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 is an individual-level contribution (obtained by using the all-India average educational level in all predictions of education-specific mortality, but change 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 (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- 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 one would get if community fixed-effects were included (one dummy for each of the PSUs except 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 understates the total impact of investments in education considerably.

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, Guio and Dreze 1995). Besides, 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. Living in an urban area is not particularly advantageous according to these models with many other variables (as also seen 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 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 become 0.05-0.10 sharper, and hardly any impact on the community education effect. Ignoring the 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. Inclusion of many individual and community variables reduces the standard error of the random term only from 0.36 to 0.32 (and further to 0.27 when more variables are added; see below).

Among the community-level autonomy indices, only that for physical autonomy has 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.

(Table 2 about here)

If the different aspects of women's general autonomy are primarily determinants of women's education, rather than consequences, 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 determinants of education included (Model 2) and the 0.017 one would get if community fixed-effects were added.

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 the individual education effect estimates. Put differently, individual education apparently operates through other factors than the woman's autonomy.

The education of the woman's own husband (a finer 5-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 than wife's education fits well with conclusions from other studies (see e.g. 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 as in Model 6 are included, with the intention of providing as 'conservative' estimates as possible. Besides, 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.

(Table 3 about here)

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 6-11 month old child both solid food and breast milk. In consistence with this, 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 the two weeks before interview, and have not particularly often been brought to a health worker 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 community education are sharper (not shown). This sharpening may reflect that a high education among men, given women's education, is a result of low autonomy for women, which more than outweighs the 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 (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 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, for example, 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 new-born children. As explained above, one might expect breastfeeding to be undermined by education, and the individual-level effect indeed supports such an idea, but there is no effect of community-level education.

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. This accords well with the patterns reported elsewhere. Especially the reported prevalence of fevers and coughs has been

shown in other studies to be 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 also may 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 developing countries may have been seriously biased because of omitted factors, and one should, of course, continue the 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, one should also be concerned about the limitations of the individual-level 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 five by 0.029, of which 0.012 is 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 one would get 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 about 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, or 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, as 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 one would have estimated a weaker community education effect, i.e. that even the most 'conservative' estimate referred to above is too high. On the other hand, it is also possible that the factors that *are* included actually may *tap out* some of the effect. 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. Anyway, also the individual-level effects may be biased because of unmeasured determinants of education, even in these models with a fairly large

number of variables included, so this uncertainty in the assessment of the community-level contribution should not be a reason for continuing to ignore it.

The results support the idea that women's decision-making and physical autonomy may be 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 indeed has a bearing on 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 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. At least, significant effects of women's average education are estimated in models for various indicators of antenatal care, preventive child care, the use of supplementary nutrition, the child's disease risk (but not consistently), and the mother's care for a sick child (not consistently either). 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.

The bottom line is that 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. Exploration of these mechanisms is left to future studies.

Acknowledgements

This work was largely done 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 the good advice and comments provided by Jiajian Chen, Vinod Mishra, Robert Retherford, Noriko Tsuya, two anonymous referees, and the editor.

References

Anandaiah, R. and M.K. Choe. 2000. Are the WHO guidelines on breastfeeding appropriate for India? National Family Health Survey Subject Reports 16. International Institute for Population Sciences (Mumbai, India) and East-West Center (Honolulu, U.S.A)

Balk, D. 1997. Defying gender norms in Bangladesh: A social and demographic analysis, *Population Studies* 51: 153-72.

Basu, A. 1996. Girls schooling, autonomy and fertility change- what do these word mean in South Asia, in R. Jeffrey and A. Basu (eds.),*Girls Schooling, Autonomy and Fertility Change in South Asia.* New Dehli: Sage Publications.

Basu, A. and K. Basu. 1991.Women's economic roles and child survival: The case of India, *Health Transition Review* 1: 83-103.

Bloom, S.S, D. Wypij, and M. Das Gupta. 2001. Dimensions of women's autonomy and the influence on maternal health care utilization in a North Indian city, *Demography* 38: 67-78.

Bollen, K.A., J.L. Glanville, and G. Stecklov. 2002. Economic status proxies in studies of fertility in developing countries, *Population Studies* 56: 81-96.

Bongaarts, J. and S. C. Watkins. 1996. Social interactions and contemporary fertility transitions, *Population and Development Review* 22: 639-82.

Caldwell, J. 1986. Routes to low mortality in poor countries, *Population and Development Review* 12: 171-220.

Cleland, J.C and J.K van Ginneken. 1988. Maternal education and child survival in developing countries. The search for pathways of influence, *Social Science and Medicine* 27: 1357-68.

Das Gupta, M. 1990. Death clustering, mother's education, and the determinants of child mortality in rural Punjab, India, *Population Studies* 44: 489-505.

Desai, S. and S. Alva. 1998. Maternal education and child health: Is there a strong causal relationship? *Demography* 35: 71-81.

Dyson, T. and M. Moore. 1983. On kinship structure, female autonomy, and demographic behavior in India, *Population and Development Review* 9: 35-60.

Filmer, D. and L. Pritchett. 1999.The effect of household wealth on educational attainment: Evidence from 35 countries, *Population and Development Review* 25:85-120.

Hobcraft, J. 1992. Fertility patterns and child survival: A comparative analysis, *Population Bulletin of the United Nations* 33: 1-31.

Hobcraft, J. 1993. Women's education, child welfare and child survival: A review of the evidence, *Health Transition Review* 3: 159-75.

International Institute for Population Sciences (IIPS) and ORC Macro. 2000. *National Family Health Survey (NFHS-2), 1998-1999: India*. Mumbai:IIPS.

Jejeebhoy, S. 1995. *Women's Education, Autonomy and Reproductive Behavior: Experience From Developing Countries*. Oxford: Clarendon Press.

Jejeebhoy, S. 1998. Associations between wife-beating and fetal and infant death: Impression from a survey in rural India, *Studies in Family Planning* 29: 301-308.

Jejeebhoy, S. and Z. Sathar. 2001. Women's autonomy in India and Pakistan: The influence of religion and region, *Population and Development Review* 27: 687-712.

Kohler H.-P., J. R. Behrman, and S.C. Watkins. 2001. The density of social networks and fertility decisions: Evidence from South Nyanza district, Kenya, *Demography* 38: 43-58.

Kravdal, Ø. 2001. The importance of education for fertility in sub-Saharan Africa is substantially underestimated when community effects are ignored, Memorandum, March. Department of Economics, University of Oslo. Available at http://www.oekonomi.uio.no/memo/memopdf/memo0301.pdf

Kravdal, Ø. 2002. Education and fertility in sub-Saharan Africa: Individual and community effects, *Demography* 39: 233-50.

Kravdal, Ø. 2003a. Child mortality in India: Individual and community effects of women's education and autonomy, East-West Center Working Papers, Population Series, No. 111, available at available at www2.eastwestcenter.org/pop/misc/wp112.pdf

Kravdal, Ø. 2003b. The problematic estimation of 'imitation effects' in multilevel model. *Demographic Research* online at www.demographic-research.org/ Volumes/Vol9/2

Lillard, L.A. and C.W.A. Panis . 2000. aML multilevel multiprocess statistical software, Release 1.0. Econware, Los Angeles, California.

Mason, K.A. 1984. The status of women: A review of its relationships to fertility and mortality, New York: Rockefeller Foundation.

Mason, K.A. 1987. The impact of women's social position on fertility in developing countries, *Sociological Forum* 2: 718-45.

Mason, K.A. 1997. Gender and demographic change. What do we know?, in R. Jeffrey and A. Basu (eds.),*Girls Schooling, Autonomy and Fertility Change in South Asia.* New Dehli: Sage Publications.

McNay, K., R. Cassen, and P. Arokiasamy. 2003. Why are uneducated women in India using contraception? A multilevel analysis, *Population Studies* 57: 21-40.

Miles-Doan, R. and L. Bisharat. 1990. Female autonomy and child nutritional status: The extended family residential unit in Amman, Jordan, *Social Science and Medicine* 31: 783-89.

Montgomery, M. R. and J. B. Casterline. 1996. Social learning, social influence and new models of fertility, *Population and Development Review* 22 Suppl: 151-75.

Moursund, A. and Ø. Kravdal. 2003. Individual and community effects of women's education and autonomy on contraceptive use in India, *Population Studies* 57: 285-302.

Muhuri, P.K. and J. Menken. 1997. Adverse effects of next birth, gender, and family composition on child survival in rural Bangladesh, *Population Studies* 51: 279-94.

Murray, C.J.L. and L.C. Chen. 1992. Understanding morbidity change, *Population and Development Review* 18: 481-503.

Murthi, M., A.-C. Guio, and J. Dreze. 1995. Mortality, fertility, and gender bias in India: A district-level analysis, *Population and Development Review* 21: 745-82.

Pandey, A., M.K. Choe, N.Y. Luther, D. Sahu, and J. Chand. 1998. Infant and child mortality in India, National Family Health Survey Reports 11. International Institute for Population Sciences (Mumbai, India) and East-West Center (Honolulu, U.S.A)

Pickett, K.E. and M. Pearl. 2001. Multilevel analyses of neighbourhood socioeconomic context and health outcomes: a critical review, *Journal of Epidemiology and Community Health* 55: 111-22.

Sampson R.J., J.D. Morenoff and T. Gannon-Rowley (2002). Assessing "neighborhood effects": Social processes and new directions in research. *Annual Review of Sociology* 28: 443-78.

Tulasidhar, V.B. 1993. Maternal education, female labour force participation and child mortality: Evidence from the Indian census, *Health Transition Review* 3: 177-90.

United Nations.1995. *Women's Education and Fertility Behaviour.* ST/ESA/SER.R/137 Population Division. New York.

Wen, M., Browning, C.R. and K.A. Cagney. 2003. Poverty, affluence, and income inequality: Neighborhood economic structure and its implications for health. *Social Science and Medicin*e 57: 843-860.

Whitworth A. and R. Stephenson. 2002. Birth spacing, sibling rivalry and child mortality in India, *Social Science and Medicine* 55: 2107-19.

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 heterogeneity term	0.36*** (0.03)	0.34*** (0.03)	0.32*** (0.04)

[1] Constant term and effects of child's age (6 categories) are not shown.
[2] Reference category
* p< 0.10; ** p< 0.05; *** p< 0.01
Source: Second National Family Health Survey of India, 1998-1999.

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 heterogeneity term	0.31*** (0.04)	0.27**** (0.04)	0.27**** (0.04)	0.27*** (0.04)

[1] In addition, the same variables as 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

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

	Antenatal care		**Preventive child care**	
	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:	30497	30445	9680	19518

	Diseases		**Treatment**	
	Diarrhoea last two weeks	ARI symptoms last two weeks	Brought to health worker if diarrhoea	Got ORS 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:	31209	31150	6002	5973

	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:	4485	5026	23955	24781

[1] In addition, the same variables as in Model 6 in Table 2 are included, plus month at interview.
[2] Reference category
* p< 0.10; ** p< 0.05; *** p< 0.01
Source: As for Table 1