# Women's education, child welfare and child survival: a review of the evidence

**John Hobcraft**

*Department of Population Studies and Centre for the study of Global Governance (CsGG), London School of Economics, Houghton Street, London WC2A 2AE, UK*

## Abstract

**This paper reviews recent evidence concerning the relative importance of women's education for child health, especially child survival in the Third World. Important regional patterns are uncovered, and particular attention is paid to discussion of the weaker associations observed in sub-Saharan Africa.**

## Introduction

This paper is concerned with the consequences of maternal education for the health of children, where health is interpreted in its broadest sense as complete physical, social, emotional, developmental and environmental well-being.

The importance of mothers' education for child survival through pathways other than enhanced socioeconomic status, was brought into focus by Caldwell's (1979) seminal paper on Nigeria. This paper argued that education of women played an important role in determining child survival even after control for a number of other factors, including such socioeconomic characteristics of the husband, as his educational level and occupation. Caldwell (1979) suggested several pathways whereby mother's education might enhance child survival. In increasing probable order of importance (according to Caldwell) these were: a shift from 'fatalistic' acceptance of health outcomes towards implementation of simple health knowledge; an increased capability to manipulate the modern world, including interaction with medical personnel; and a shift in the familial power structures, permitting the educated woman to exert greater control over health choices for her children.

During the 1980s our factual knowledge concerning the associations between maternal education and child survival at the micro-level expanded considerably as a result of the World Fertility Survey (WFS) program (for example, Hobcraft, McDonald and Rutstein 1984) and from a United Nations study which used both survey and census data (Mensch, Lentzner and Preston 1985). Both of these major studies showed that increased levels of mother's education were associated with improved chances of child survival in a wide range of developing countries: Hobcraft et al. (1984) covered 28 WFS surveys and Mensch et al. (1985) covered 15 countries; and there was some overlap in coverage. This association usually survived controls for a number of other socioeconomic variables, including the husband's education and occupation. The Hobcraft et al. (1984) study demonstrated that socioeconomic differentials in child survival widened with increasing age of the child and found the greatest consistency in fitted models for mortality between ages one and five, where there were strong suggestions that a model that included terms for both mother's and father's levels of education and the father's occupation had widespread applicability. Mensch et al. (1985) explored a wider range of covariates and found that on average about half of the gross effect of maternal education survived as a net effect after controls. They also found that the association of maternal education and child survival

was approximately the same in rural and urban areas, which was seen as consistent with Caldwell's hypothesized pathways, whereas the husband's educational level was associated with greater child-survival advantage in urban areas. Both studies suggested that the associations between mother's education and child survival were weaker in sub-Saharan Africa than in Asia or particularly Latin America, where socioeconomic differentials were generally larger. Hobcraft et al. (1984) also suggested that the husband's socioeconomic characteristics, especially education, were slightly more strongly associated with improved child survival in the sub-Saharan African countries. Both studies also suggested that there was no threshold level of maternal education that needed to be reached before advantages in child survival began to accrue; even a small amount of education was usually associated with improved chances of child survival, and the gains generally increased with increasing levels of education.[1] There is also overwhelming evidence that the strong and persistent associations of infant and child mortality with birth spacing are barely mediated by maternal education.

During the 1980s there were also a number of small-scale studies that tried to elucidate the pathways involved in lowering the mortality of children born to more educated mothers. Findings from these studies often appear contradictory, although it is possible that what we are beginning to accumulate is evidence that different pathways are important in different cultures.

Lindenbaum (1990) has stressed the apparent role of greater cleanliness among educated women in explaining differentials in child mortality in Bangladesh. Cleland (1990) reviews the very mixed international evidence on reported incidence of diarrhoeal episodes by levels of maternal education, including some further studies on Bangladesh; this review suggests that greater cleanliness, if it exists, often fails to be translated into lower frequency of diarrhoeal episodes.

A second pathway to receive considerable attention is the role of education in ensuring that the mother utilizes health services for her children. Again, Cleland (1990) concludes that

> education may have a modest effect on health knowledge and beliefs, but a pronounced effect on the propensity to use modern medical facilities, and adopt modern health practices, because of a closer social identification with the modern world, greater confidence at handling bureaucracies or a more innovative attitude to life among women who have some experience of school (Cleland 1990:412).

A third pathway is that maternal education may be associated with greater emphasis on child quality, perhaps ensuring that fewer children are more likely to survive, have greater food and human capital investments and thus end up as higher quality citizens, being healthier, better educated, more affluent, and emotionally better developed. Evidence for this thesis is scant, although Levine et al. (1991), in a small study in Mexico, suggest that better educated mothers expect earlier intellectual and emotional development of their children. Moreover, Chavez, Martinez and Yaschine (1975) suggest that nutrition can play a critical role in making children more active, demanding and independent, thereby gaining more attention from the mother. However, there are also possible indications that educated mothers may become more effective at discriminating against little valued children. For example, Das Gupta (1990) found that the relative excess mortality of second and later daughters was greater for the children of the more educated mothers.

A final pathway to receive attention is perhaps best referred to as the empowerment of women through education. Cleland (1990) identifies three components to this empowerment, which he terms

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[1] There were some exceptions where children of the uneducated appeared to have better survival chances than those born to women with one-to-three years of education; Hobcraft et al. (1984), suggested that this might result from data deficiencies.

instrumentality, social identification, and confidence. Instrumentality is the ability to manipulate and feel control over the outside world. Social identification is concerned with engagement with modern institutions and bureaucracies. Greater confidence permits the interaction with such officials and bureaucracies. Caldwell's original concerns with women's education altering power structures within the family should also be considered here. Most evidence for this pathway is indirect and can be summarized thus: educated women make greater use of health services for themselves and their children; hence they are empowered.

Despite a decade of attention to pathways, the evidence is still not clear about which pathways are important where, and even leaves room for doubt as to whether the strong associations of child survival and access to health care with levels of women's education are causal. For example, the study by DaVanzo and Habicht (1986) strongly suggests that little of the overall change in infant mortality in Malaysia from 1946 to 1975 could be attributed to changes in maternal education at the micro-level, even though a strong cross-sectional relationship was apparent at different points in time. Ewbank and Preston (1990) and Woods, Watterson and Woodward (1989) have both extended findings on links between child mortality and maternal education to around 1900 in the developed world and suggested that the weaker associations observed were due to the lack of access to facilities and modern medical knowledge which were simply unavailable at that time. However, studies which have tried to examine the links between maternal education and service accessibility in determining health outcomes in the Third World have had very mixed success in elaborating such links.

## Life events of the mother with consequences for children

There are a number of associations with education of women that are not widely considered in the demographic literature on child survival (and child welfare, such as it exists).

Firstly, educated women tend to marry later and to have their first births later. If this delay moves the first birth beyond the teenage years, especially beyond age 18, the women themselves are more likely to survive the hazardous first birth and the first born child is also more likely to survive. Hobcraft (forthcoming) summarizes the excess risk for first born children to teenage mothers as being about 40 per cent, when averaged across 25 Demographic and Health Surveys.

Educated women generally experience lower rates of maternal mortality, both on a per birth basis and as a result of having fewer children. Loss of a mother can be potentially disastrous for her children's survival chances and for their future welfare, although elaborate fostering mechanisms exist in parts of sub-Saharan Africa. Regrettably, our information on the differentials in maternal mortality by educational level is scant, as is evidence on the consequences for the children. Part of the reason for such limited information is that retrospective surveys and population censuses, which are our main source of national-level information on survival, only include surviving women. Nevertheless, there is the possibility of exploiting census reports on children ever born and surviving to men, rather than women, cross-tabulated by responses on spousal survival to address this issue.

Graham (1991) gives estimated lifetime risks of maternal death. In a typical sub-Saharan African country the overall level of maternal mortality is about 650 per 100,000 live births. With a total fertility of about six births per woman, this translates into a lifetime risk of maternal mortality of about one in 20. If an educated woman experiences maternal mortality at about 300 per 100,000 live births and has an average of four children, her lifetime chance of death would be only one in 70. Put another way, 50,000 out of every million families where the mother was uneducated would be motherless; for educated mothers, some 14,000 families would be motherless. If we assume, for simplicity, that mothers who die average 3.5 and 2.5 children at the time of their deaths, there would be 175,000 motherless children in the million families with uneducated mothers and 35,000 motherless children in the million families with educated mothers. If maternal mortality were lowered to a still rather high and

unacceptable level of 100 per 100,000 live births, with each surviving mother averaging three births, the lifetime risk for the woman is reduced to about one in 330, and there might only be 6,000 maternal orphans in 3,000 motherless families among a million families. While these figures are illustrative, they do show that very large differences can arise in levels of orphanhood. For this illustration, risks of maternal death are assumed to be unvarying with age or parity, which leads to an understatement of probable true differentials; women are assumed to have 1.2 times as many pregnancies as births.

Since uneducated mothers tend to have larger families when they do survive and to begin childbearing earlier, their children are more likely to suffer the excess-mortality risks associated with childbearing too early or too late.

An element in determining the survival of the mother and the birth outcome is likely to be the extent to which the mother receives prenatal care, tetanus toxoid vaccination, and the quality of assistance at delivery. New evidence is beginning to accumulate fast on differentials in such care before and around the time of delivery from the Demographic and Health Surveys (DHS), although much analysis remains to be done. Stewart and Sommerfelt (1991) provide summary information on these variables for 25 DHS surveys, but their multivariate analysis only covers three countries, Bolivia, Egypt, and Kenya. Overall levels of prenatal care vary substantially from 25 per cent of births in Morocco to over 90 per cent in Zimbabwe, Botswana, Sri Lanka, Dominican Republic, and Trinidad and Tobago; for Bolivia, Egypt and Kenya these levels are 45, 53, and 77 per cent respectively. The percentages of deliveries attended by a trained person are also highly variable, from fewer than 33 per cent in Burundi, Morocco, Guatemala, and Mali up to 90 per cent or more in Dominican Republic and Trinidad, with the three study countries being at 42, 35, and 50 per cent respectively. Women had received tetanus toxoid during fewer than 20 per cent of their pregnancies in Egypt, Guatemala, Peru, and Mali; and in more than three-quarters of their pregnancies in Kenya, Botswana, Zimbabwe, Sri Lanka, and Dominican Republic; in Bolivia, Egypt, and Kenya the percentages were 20, 12, and 89 respectively.

Stewart and Sommerfelt (1991) show large differences according to the woman's level of education for prenatal care in Bolivia and Egypt, but much smaller ones in Kenya. After control for several other variables, urban-rural residence, a possessions index, husband's education, parity, age at delivery, multiplicity of births, and prior family-planning use, the woman's own educational level emerged as the most powerful predictor of prenatal care for Bolivia and Egypt, and weakly significant for Kenya, where only urban/rural residence proved a significant predictor. The association of prenatal care with the woman's education was more powerful in urban areas than in rural areas for both Bolivia and Egypt. A more elaborate comparative analysis by Bicego and Boerma (1991) found huge, but immensely variable, differentials in the extent of failure to receive prenatal care by level of education. After controls for an index of economic status and a range of biodemographic variables, the risk of receiving no prenatal care was from 55 to 1,300 per cent higher among uneducated women than those with some education. Since prenatal care did little to account for mortality differentials, it is by no means clear what to make of these vast differences in access.

In all three countries studied by Stewart and Sommerfelt (1991), educated women were much more likely to be attended by a trained person at delivery. Once again, these associations remained powerful after control for the same set of other factors, being strongest in Bolivia. For both Bolivia and Egypt, the net association with the woman's level of education was the largest source of difference, whereas urban-rural differences were again marginally stronger in Kenya. Once again, the association with the woman's education was more powerful in urban areas for Bolivia and Egypt.

Differentials in tetanus-toxoid immunization by level of woman's education were small for both Egypt and Kenya, but quite substantial for Bolivia. No multivariate analysis was pursued by Stewart

and Sommerfelt (1991) on this outcome. However, Bicego and Boerma (1991) showed remarkable differences between urban and rural strata in the relationship between female education and non-use of tetanus toxoid during pregnancy. The educational advantage seems much greater in rural areas than in towns. Bicego and Boerma speculate that immunization is (correctly) perceived as unnecessary by the educated urban elite, but that female education provides the knowledge and the means to gain access to such health interventions in rural areas.

## Maternal education and child survival: new evidence

Much fresh evidence on associations between maternal education and child survival is appearing from the analysis of data from the Demographic and Health Surveys. Results from some substantial comparative studies are summarized here.

### Multivariate analysis

Hobcraft (forthcoming) discusses results from several multivariate analyses for 25 DHS surveys, which incorporate mother's education as one of the covariates of child mortality, taken here as survival to age two. The general conclusions concerning the associations between maternal education and survival to age two do not differ substantially among the various models considered. The gross effects of mother's education are altered very little by controls for the timing and spacing of births, which is the major concern of Hobcraft's study. This serves to confirm earlier conclusions from WFS data. The greatest attenuation

**Table 1**
**Average odds ratios for continental groups; socioeconomic model**

| **Gross** | **Mother's education (yrs)** | | | **Father's education (yrs)** | | | **Father's occupation** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1–3** | **4–6** | **7+** | **1–3** | **4–6** | **7+** | **Manual** | **Sale/ Serv.** | **Profess Cleric.** |
| Americas (9) | 0.75 | 0.52 | 0.31 | 0.88 | 0.75 | 0.52 | 0.84 | 0.71 | 0.53 |
| North Africa (3) | 0.79 | 0.66 | 0.34 | 0.85 | 0.81 | 0.47 | 0.87 | 0.80 | 0.60 |
| SS. Africa (10) | 0.92 | 0.77 | 0.56 | 0.95 | 0.80 | 0.65 | 0.84 | 0.79 | 0.61 |
| Asia (3) | 0.98 | 0.66 | 0.41 | 1.14 | 0.78 | 0.49 | 0.77 | 0.91 | 0.51 |
| Overall (25) | 0.85 | 0.65 | 0.42 | 0.94 | 0.78 | 0.57 | 0.83 | 0.78 | 0.56 |
| **Net** (including control of region) | | | | | | | | | |
| Americas | 0.79 | 0.60 | 0.38 | 0.90 | 0.91 | 0.85 | 1.09 | 0.92 | 0.85 |
| North Africa | 0.88 | 0.83 | 0.49 | 0.95 | 0.91 | 0.71 | 0.87 | 0.88 | 0.86 |
| SS. Africa | 0.99 | 0.83 | 0.68 | 0.94 | 0.82 | 0.77 | 0.94 | 0.90 | 0.80 |
| Asia | 1.02 | 0.72 | 0.54 | 1.14 | 0.86 | 0.72 | 0.97 | 0.92 | 0.86 |
| Overall | 0.90 | 0.73 | 0.52 | 0.95 | 0.86 | 0.78 | 0.99 | 0.91 | 0.84 |
| **Ratio** (Net/Gross) | | | | | | | | | |
| Americas | 1.05 | 1.15 | 1.26 | 1.02 | 1.20 | 1.62 | 1.30 | 1.29 | 1.61 |
| North Africa | 1.11 | 1.27 | 1.43 | 1.12 | 1.13 | 1.52 | 1.00 | 1.10 | 1.43 |
| SS. Africa | 1.08 | 1.08 | 1.21 | 0.99 | 1.03 | 1.19 | 1.11 | 1.13 | 1.32 |
| Asia | 1.04 | 1.09 | 1.33 | 1.00 | 1.10 | 1.46 | 1.25 | 1.02 | 1.70 |
| Overall | 1.06 | 1.11 | 1.22 | 1.01 | 1.10 | 1.38 | 1.19 | 1.17 | 1.48 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Number of countries** | | | | | | | | | |
| **Statistical significance** | | | | | | | | | |
| One per cent | 2 | 8 | 14 | 0 | 2 | 6 | 1 | 0 | 1 |
| Five per cent | 5 | 10 | 19 | 2 | 4 | 7 | 2 | 4 | 5 |
| | | (of 25) | | | (of 24) | | | (of 21) | |
| **Values of odds ratios** | | | | | | | | | |
| < 1.0 | 20 | 23 | 25 | 16 | 20 | 23 | 13 | 19 | 19 |
| < 0.6 | 0 | 6 | 18 | 1 | 1 | 2 | 0 | 0 | 2 |
| | | (of 25) | | | (of 24) | | | (of 21) | |

**Countries included:**

Americas: Bolivia, Brazil, Colombia, Dominican Republic, Ecuador, Guatemala, Mexico, Peru, Trinidad and Tobago.
North Africa: Egypt, Morocco, Tunisia.
Sub-Saharan Africa: Botswana, Burundi, Ghana, Kenya, Liberia, Mali, Senegal, Togo, Uganda, Zimbabwe.
Asia: Indonesia, Sri Lanka, Thailand.

Source: Hobcraft (forthcoming)

of the gross effects occurs for his 'socioeconomic' model, which incorporates mother's education, father's education, father's occupation, and region of residence as the covariates of survival to age two. Information on women's occupation or work status is not easily used in these comparative analyses (see Hobcraft et al. 1984), because the information available is often extremely limited, some women do not work, and definitions of women's work status apparently differ in unpredictable ways across WFS and probably DHS surveys. The results from the 'socioeconomic' model are considered briefly here.

Table 1 shows average odds ratios for groups of countries resulting from fitting logistic models to predict the chance of survival to age two for each country in turn. The first panel shows the average gross odds ratios, that is without control for the other socioeconomic variables. In gross terms, the overall average odds of dying before age two for a child born to a mother with seven or more years of education are only 42.5 per cent compared with the children of uneducated mothers. The extreme contrasts for the other socioeconomic factors are smaller, with the odds ratio being 56.6 per cent for the children of fathers with seven or more years of education compared with those whose fathers are uneducated, and 56.3 per cent for the contrast between children of professional and clerical worker fathers and those whose fathers are in agriculture and fishing. Thus, there is apparently greater differentiation by maternal education than by the other factors.

Examining the overall average values for the net odds ratios, shows that all are attenuated somewhat by the control for the other factors shown and for region within country. However, the attenuation is mild for mother's education, with the most advantaged group of children having odds of death which average only half of those for the most disadvantaged group on this dimension. The attenuation is much greater for the father's education and his occupation, with the odds of death for the most advantaged group only being about 80 per cent of that for the least advantaged. These findings strongly suggest that maternal education exerts the most powerful influence on child survival among the few socioeconomic variables considered here.

This conclusion is confirmed by a more detailed examination of the results for individual countries, which is summarized in Table 1. The parameters associated with the effects of maternal education are far more likely to be statistically significant, with 19 reaching a five per cent level and 14 of these being significant at the one per cent level for the contrast between the most and least educated group. Five of the six countries for which this contrast is not significant are in sub-Saharan Africa: Botswana, Ghana, Mali, Uganda, and Zimbabwe; the other exception is Trinidad and Tobago, which

has the smallest sample size. Moreover, the odds ratios for the children whose mothers have had only four to six years of education reach statistical significance more frequently than do those associated with any of the father's characteristics. Similar conclusions can be drawn from the magnitude of the odds ratios associated with the variables considered. In the majority of countries the odds ratios associated with parents having higher socioeconomic status are below one, but this occurs more frequently for all categories of mother's education. Even more importantly, very few odds ratios are below 0.6 for the father's characteristics, only one or two in each category, suggesting chance occurrences; yet fully 18 of the 25 countries have net odds ratios below this level for the contrast between the children with the most and least educated mothers. The net odds ratios for this contrast are always below 0.5 in the countries of the Americas; and always below 0.6 in the few North African and Asian countries included here.

**Weak effects in sub-Saharan Africa**

However, only three of the sub-Saharan African countries have odds ratios for the extreme maternal education contrast which are below 0.6 (Burundi, Senegal, and Togo); the remaining seven include Kenya and Liberia at just over 0.6, Mali, Zimbabwe, Botswana, and Uganda at around 0.75 to 0.8, and Ghana at 0.95. Earlier studies (e.g. Hobcraft et al. 1984; Mensch, et al. 1985) had indicated that the association of child survival with maternal education was weaker in sub-Saharan African countries than elsewhere, but the findings here are more powerful than hitherto. We can only speculate as to why this substantial difference arises.

The apparently weaker effect of maternal education on child survival does not arise simply because of lower penetration of education in African countries, since several of the countries considered here have quite advanced educational systems. Over a third of births in Botswana, Ghana, Kenya, and Zimbabwe occur to mothers with seven or more years of education during the period of two to fifteen years preceding the DHS surveys used in the analysis. Only Sri Lanka and Trinidad and Tobago exceed these proportions who are relatively highly educated. Of course, several of the sub-Saharan African countries included in the analysis have very low levels of education: fewer than seven per cent of births occurred to women with seven or more years of education in Burundi, Mali, Senegal, and Togo. But this is also the case for Morocco and Guatemala. So the low differentiation in child survival by maternal education in sub-Saharan Africa cannot be ascribed to fundamental structural differences.

Caldwell (1990) draws attention to the much greater autonomy of women in sub-Saharan Africa than in many Asian and Muslim societies. He might thus go on to argue that the effects of maternal education for child survival are weaker in sub-Saharan Africa because the key empowerment aspects within the family are less relevant. But this ignores the even greater differentiation in Latin America, where women also have considerable autonomy.

Several of the sub-Saharan African countries considered here have significant levels of child fostering or of labour migration. Perhaps these aspects of child-care practice, including the level of surrogate care, interact with mother's education in a way that means that a few years of education leads to higher risks of child death than for the children of uneducated mothers, for example by disrupting traditional practices.

Perhaps health infrastructures are weaker in sub-Saharan Africa, thereby inhibiting the ability of more educated women to take advantage of their human capital in the health environment. But once again this argument can hardly be applied throughout the diverse range of sub-Saharan African societies considered here. Botswana, Kenya, and Zimbabwe have fairly low levels of child mortality by Third World standards, with fewer than 100 children per thousand dying by age five (see Hobcraft 1991); these countries have achieved mortality levels which are comparable to those achieved in the other continental groupings considered here. Undoubtedly, many of the sub-Saharan countries considered do

have very high levels of child mortality; among the 25 DHS countries considered, the only ones with estimated levels of mortality before age five of above 150 per thousand for the 15 years preceding the surveys come from this region: Mali (295), Liberia (232), Senegal (223), Burundi (192), Uganda (184), Togo (160), and Ghana (153). But Burundi, Senegal, and Togo are the only three countries of the region which do exhibit low odds ratios of death (<0.6) for the children of the most educated group of mothers compared with those born to uneducated mothers; and Liberia is only just above this level.

Ghana and Uganda in particular experienced periods of unusually extreme hardship during the fifteen or so years covered by this analysis. Perhaps the very weak association of child mortality with mother's educational level in these two countries is in part a reflection of these experiences? The next section looks at recent evidence on differentials in health-service utilization and nutritional status: perhaps sub-Saharan African countries achieve a greater homogeneity of provision of whatever health services they have, possibly associated with outreach programs of immunization overcoming the traditional advantage associated with having an educated mother?

One further possibility which must be mentioned is the issue of data quality. The weak associations with levels of maternal education do not simply occur for the poorest and least educated sub-Saharan African societies. Is there any reason to suppose that reporting of child mortality is worse in Botswana and Zimbabwe, relatively advanced societies in this context, than in Senegal or Togo? This also seems an implausible explanation.

Thus, despite a clearly weaker association between levels of maternal education and child survival in sub-Saharan Africa, we have only been able to speculate as to the reasons for this. A number of plausible explanations have been raised here, but none found convincing. This issue will be a focus of further research.

**Further multivariate analysis**

We now turn to a brief examination of the results of the comparative analysis by Bicego and Boerma (1991), which covers experience from up to 17 DHS surveys. This study fitted logistic-regression models to neonatal mortality and hazards models to mortality from ages one to 24 months. Only births during the five to six years preceding the surveys were included in the analyses, mainly because they go on to examine health-service utilization information which was only covered for recent births. The main focus of the analysis was upon maternal education and child survival. Countries were divided into two groups: those with sufficient numbers of births occurring to women with secondary or higher levels of education (Bolivia, Colombia, Dominican Republic, Guatemala, Egypt, Thailand, Sri Lanka, Ghana, Kenya, Uganda, and Zimbabwe), where three education groups were maintained, no education, primary, and secondary; and those with lower levels of education (Morocco, Tunisia, Burundi, Mali, Senegal, and Togo), where only the contrast between mothers with no education and those with some was maintained. The analyses consisted of the estimation of a series of models, which progressively introduced 'blocks' of control variables. Only the coefficients for maternal education are presented. The first model simply includes maternal education as an explanatory variable, giving the 'gross' effects. The second model controls further for whether the household has piped water, whether it has some kind of latrine, and for an index of household economic status, derived from information on possession of a radio or television, of motorized transport, and a non-dirt floor in the dwelling unit. The third model introduced controls for birth order, preceding birth-interval length, and age of the mother at the birth; 'bio-demographic' or 'family formation' controls. Their fourth model includes indicators as to whether or not the mother received prenatal care and tetanus toxoid during the relevant pregnancy. A final model introduces an interaction between the maternal education effect and rural-urban residence in order to assess whether the relationship is different.

Bicego and Boerma (1991) confirm once again that neonatal mortality is generally less sensitive to maternal education than mortality in the next 23 months of life. But they also note that Bolivia, Colombia, Mali, and Burundi provide exceptions to this generalization. In contrast to Mensch et al. (1985) they find a stronger relationship of maternal education with child survival in towns than in rural areas. Whether this contrast in findings is related to Bicego and Boerma (1991) not controlling for paternal education or to their only interacting maternal education with urban-rural residence remains open to question. Mensch et al. (1985) found no difference between urban and rural areas in the relationship of child mortality to maternal education, but did find stronger effects for father's education in urban areas; they also fitted separate models to the rural and urban strata, thereby interacting all variables with urban-rural residence. Bicego and Boerma (1991) see education as being more important in towns partly because of the greater complexity of bureaucracy and social structure and partly since urban dwellers may more easily escape traditional family power structures, enabling them to make more effective use of educational advantage. Somewhat curiously, they see their finding as indicating that education is not important for overcoming problems of physical access to services, since the advantage is not greater in low-access rural areas; but a certain density of service provision may be essential for any access and this may occur more easily in towns.

The gross effects of maternal education on child survival were reduced by 30 to 50 per cent by controls for the economic index and prior use of health services. This finding suggests that a sizeable fraction of the gross effect of maternal education on child survival is operating to capture more general socioeconomic advantage, although more than half of the effect is not attributable to these indicators.

Controls for family-formation patterns generally increased slightly the advantages of higher maternal education for child survival, although there were exceptions. Only Kenya showed a large increase in the education effects, suggesting that the less educated have the most favourable patterns of family formation there. In general, though, the association of these family-formation variables with maternal education proves weak, as in many other studies.

Addition of the health-service use indicators reduced the net maternal education effect in most countries, but only substantially so in Zimbabwe, Bolivia, and Dominican Republic (and, perhaps, Morocco). Of course, this prior health-service utilization is at least partly attributable to the mother's education, so that the indirect effect of maternal education through these indicator variables should still be properly accounted as part of the total effect of maternal education on child survival. What is being captured here is thus one of the pathways through which higher education leads to better child survival.

## The health and well-being of children

The DHS has also provided us with a considerable body of new information on differentials in health status of children. Information is collected on use of prenatal care, tetanus-toxoid immunization during pregnancy, and type of care at time of delivery for all births during a five-to-six year period preceding the surveys. For surviving children only, further information is collected concerning height and weight, extent of immunization, and childhood morbidity and treatment patterns. Once again, this rich mine of information is only partly used to date.

### Growth faltering

Bicego and Boerma (1991) continue their comparative analysis referred to in the previous section to provide useful information on maternal education and growth faltering for children aged 3-23 months at the time of the surveys. Low height for age ('stunting') is widely regarded as indicative of adaptation to routine and chronic malnutrition, but not a key indicator of being at risk of death. Thus, the study of stunting is likely to provide important indicators of the likely longer-term health of children into adulthood and perhaps indicate probable future small stature with potential higher risk of low birth-

weight babies and consequent higher risks of child mortality. Bicego and Boerma (1991) find that stunting in early life is strongly related to maternal education, but not as strongly as mortality risks between one and 24 months. Control for the index of economic status reduces the excess risks for the children of the less-educated mothers by about 50 per cent, suggesting that economic status is important in determining long-term nutrition. However, even after controlling for economic status, children of women with no education are at least twice as likely to be stunted in Colombia, Dominican Republic, and Thailand as children of secondary-educated women. It would be interesting to have these analyses further controlled for the socioeconomic characteristics of the father, for example education and occupation.

Low weight for age is usually more closely associated with likely future mortality, reflecting short-term nutritional crises to a greater extent than stunting. Bicego and Boerma (1991) find that the gross relationship of being underweight is of the same order of magnitude as that for mortality between one and 24 months. But control for the index of economic status reduces these effects more substantially (by close to 60 per cent on average), such that the net effects of maternal education on low weight for age are a little weaker than the net effects on stunting.

Control for prior use of health services only accounts for about ten per cent of the excess risk of being underweight and about 20 per cent of the effect for stunting. These findings suggest that the greater propensity to use health services among the educated mothers, whether as a result of education *per se* or other related factors, does not play a critical role in determining or reducing growth faltering, although perhaps playing a small part.

**Immunization**

We now turn to some of the information on differentials in immunization of children (see Boerma et al. 1990). The DHS results serve to reiterate and confirm the huge changes under way in the coverage of immunization. Among children aged 12-23 months at the time of the DHS surveys about 80 per cent were reported to be fully immunized (BCG, three DPT, three or more polio, and measles) in Botswana, Zimbabwe, and Tunisia; around two-thirds in Kenya and Sri Lanka; and over half in Egypt, Morocco, Brazil, and Colombia. Fewer than 20 per cent of such children were fully immunized in Mali, Liberia, Senegal, Bolivia, and Guatemala; about a third in Ghana, Uganda, Thailand, and Peru; and 44 per cent in Burundi. Among children born to mothers with at least secondary schooling, over 90 per cent of those aged 12 to 35 months at the time of the DHS surveys had ever been vaccinated in 20 of the 23 countries considered by Boerma et al. (1990). The only exceptions were Uganda and Liberia, both at 88 per cent, and Mali. But children of women who were uneducated were far less likely to have ever been immunized, although levels still exceeded 90 per cent in nine countries. Fewer than three-quarters of such children had ever been immunized in Ghana, Liberia, Mali, Senegal, Uganda, Thailand, and Bolivia. The difference in immunization coverage between children of the uneducated and those of the educated was below ten percentage points in ten of the 23 countries, and only exceeded 20 percentage points in Ghana, Liberia, Mali, Senegal, Uganda, Thailand, and Bolivia. Increased coverage of immunization of children can only narrow these differentials.

Information on specific immunizations in Boerma et al. (1990) is restricted to children aged 12-35 months with a health card. Fractions of the population covered by health cards vary enormously and there are often large differentials in such coverage by the mother's level of education. In general, the extent of coverage by health cards increases with level of mother's education and often quite substantially. For example, the extent of coverage increases by at least 25 percentage points from children of uneducated mothers to those of secondary-educated mothers in Ghana, Senegal, Thailand, and Dominican Republic. But coverage decreases with increasing education of mother in Botswana and Zimbabwe, and drops away for children born to mothers with secondary schooling in several other

countries. This makes it extremely hazardous to interpret differentials in immunization levels among those with a health card.

As a general rule, over 90 per cent of children with a health card have received their first DPT immunization. This coverage level only drops below 90 per cent in Liberia (62%) and Egypt (86%) for children born to mothers who had primary education; and for children of uneducated mothers in Liberia (68%), Senegal (83%), Egypt (76%), Bolivia (82%), and Brazil (88%). Differentials are thus generally small, with the few exceptions noted here. But coverage among this group with health cards for the third DPT vaccination is much more variable. Even for children born to women with secondary or higher education, fewer than 80 per cent received DPT3 in Burundi, Liberia, Senegal, Bolivia and Guatemala. Among children of uneducated women with health cards 80 per cent or more received DPT3 in Botswana, Kenya, Zimbabwe, Tunisia, Sri Lanka, and Thailand. Differentials in coverage by level of maternal education were thus generally small for these countries. However these differences spanned over 30 percentage points in Ghana, Senegal, Uganda and Brazil; and also exceeded 20 percentage points in Liberia, Egypt, Morocco, Bolivia, Colombia, and Peru.

Measles immunization for children with a health card reached about 90 per cent of those with uneducated mothers in Botswana, Zimbabwe, and Tunisia, but was below 80 per cent in the 17 other countries covered by Boerma et al. (1990). Education differentials in extent of measles vaccination were usually in the 10-to-20 percentage points range; but were lower in Botswana, Burundi, Zimbabwe, Tunisia and reversed in Thailand and Guatemala; and slightly above 20 percentage points in Ghana, Kenya, and Egypt.

In many countries, immunization levels have increased very rapidly over recent years. As these reach saturation levels socioeconomic and other differentials in coverage inevitably become small. It remains an open but intriguing question how far the very high and even coverage by levels of maternal education in Botswana and Zimbabwe play a role in producing the low mortality differentials. The outreach nature of mobile vaccination teams undoubtedly serves to reduce the access advantages normally associated with socioeconomic advantage, including maternal education. Perhaps we are beginning to see the results of a new 'radical egalitarian' form of health provision in parts of Africa which is achieving smaller differentiation by socioeconomic status than in a classic case like Sri Lanka (Caldwell 1986); and perhaps this equality of treatment is being achieved medically, despite the lack of the same political will for equality. Or perhaps this is just reflective of major and rapid development. Answering these questions further is beyond the scope of the current paper.

**Morbidity and treatment**

Differentials in the prevalence of diarrhoea during the two weeks preceding DHS surveys for children aged six-23 months are given by Boerma, Sommerfelt and Rutstein (1991). The differentials in reported incidence of diarrhoea show unexpected features and are often somewhat counter-intuitive. The varied pattern of these differentials no doubt reflects a combination of differing propensities to report, the salience of diarrhoeal episodes for the mother, and real differentials in incidence. In five out of 23 countries studied the prevalence of diarrhoea was considerably higher (at least 20%) among children of uneducated women than among those born to mothers with primary schooling; but prevalence was also ten or more per cent lower for four countries. In 14 out of the 23 countries children of primary school mothers had a prevalence of diarrhoea which was higher by more than 20 per cent than for children of mothers with secondary schooling; in only one country was the difference more than ten per cent in the opposite direction. These differentials by education of the mother, especially the contrast associated with secondary schooling, were among the largest and most consistent of a wider range that were examined, including possession of a radio, piped drinking water, and toilet facility. The greater strength of association of reported incidence of diarrhoea with maternal education than with

these other variables is strongly suggestive that Cleland's (1990) dismissal of Lindenbaum's (1990) hypothesis was both unfounded and premature, since he was using the same DHS evidence.

There are massive variations in the extent of knowledge concerning oral rehydration salt (ORS) packets among mothers of differing educational levels, although some countries provide notable exceptions. In Botswana, Zimbabwe, and Egypt over 90 per cent of all mothers had heard of ORS packets; not surprisingly educational differentials are small in these countries. At the other extreme, fewer than half of the mothers had heard of ORS packets in Burundi, Mali, Togo, and Uganda. In Peru, only 25 per cent of uneducated mothers had heard of ORS, contrasting with 89 per cent of those with secondary schooling: a difference of 64 percentage points. The range was about 50 percentage points in Uganda, Mali and Guatemala, and also over 40 points in Burundi, Ghana, and Bolivia. Thus, differentials in knowledge of ORS by mother's education are among the most dramatic that we have found.

The fraction of diarrhoeal episodes to children aged 1-59 months in the two weeks preceding the DHS surveys which were treated with ORS packets was nevertheless fairly low for all levels of education of the mother. About 40 to 50 per cent of diarrhoeal episodes for children of mothers with secondary schooling were so treated in Botswana, Ghana, Togo, Thailand, Colombia, Dominican Republic and Trinidad and Tobago. Elsewhere, the levels of ORS treatment among secondary schooled mothers were lower still, being below 15 per cent in Liberia, Uganda, Brazil, Mexico and Peru. Educational differences were small in Botswana, where just over 40 per cent of children of all educational groups received ORS treatment. Differentials were absolutely large (over 20 percentage points) in Togo and Dominican Republic and relatively large in a number of other countries.

Information on prevalence of fever in the four weeks preceding the DHS surveys was collected only for ten sub-Saharan African countries and Colombia (Boerma et al. 1991). The differentials in reported prevalence of fever by mother's education are typically small. Overall prevalence levels are low in Botswana, Burundi, and Zimbabwe, being below ten per cent. Elsewhere the reported prevalence of fever is much higher, over 30 per cent, and in Liberia over 50 per cent; the figure for Senegal is also high, at 61 per cent, but reflects a question on incidence of malaria during the previous cold season. The low reported prevalence of fever in Burundi increases with increasing education of the mother. Moderate to significant gradients in the expected direction emerge for Senegal, Togo, and Uganda.

More educated mothers are generally more likely to take children with a fever to a medical facility; some 90 per cent do so in Botswana, where there is little differentiation. Differential use of medical facilities for feverish children is greatest in Ghana (33 percentage points) and in Togo and Colombia (both at 21 percentage points). With the exception of Botswana, a quarter to a half of uneducated mothers took a feverish child to a medical facility, contrasted with half to three-quarters of mothers with secondary schooling.

By and large there is strikingly little variation by levels of mother's education in the prevalence of a cough or rapid or difficult breathing in the four weeks preceding the DHS surveys, although overall reported prevalence levels vary dramatically among societies. Prevalence of a cough etc. in the four-week reference period is reported for over 40 per cent of children in Liberia, Zimbabwe, Egypt, Bolivia and Ecuador; and for fewer than ten per cent of children in Mali and Togo. Prevalence increases with increasing maternal education in Egypt.

Resort to medical facilities for treatment of coughs etc. is high in Botswana (82%) and Kenya (66%) and low in Burundi (36%), Togo (33%) and Bolivia (22%); elsewhere the range is 40-55 per cent. Educational differentials in access to medical treatment for coughs are small in Botswana, Kenya,

and Zimbabwe, being less than 12 percentage points. But differentials are large, over 20 percentage points, in Ghana, Egypt, Bolivia, and Colombia and nearly 40 percentage points in Togo.

## Conclusion

With the striking exceptions of Botswana and Zimbabwe (for which some information is missing), there is fairly clear evidence of differentiation according to the level of the mother's education in the prevalence, but more especially in the treatment of childhood diseases. Educated mothers seem somewhat more successful at reducing the prevalence of diarrhoeal diseases, but their children seem equally at risk of fevers and coughs. Educated mothers are strikingly better informed about ORS packets and generally more likely to make use of these for diarrhoeal episodes. Educated mothers are also generally more likely to use medical facilities for treatment of diarrhoeal episodes, fevers, and coughs. We are not in a position to assess how far these differentials translate into better chances of survival for the children, since this information is only obtained for surviving children. Equally we can at the moment only speculate as to how far these differences, especially in treatment, translate into the improved nutritional status of children of educated women.

Similarly, more educated women are more likely to have initiated immunization and even more likely to have ensured that their children are fully vaccinated. Again it is impossible to assess from DHS data how far these differences translate into a mortality advantage, since this information is only collected for surviving children, although DHS II extends coverage. More educated women are also more likely to have received prenatal care, to have been immunized with tetanus toxoid during pregnancy, and to have their deliveries attended by trained personnel. Evidence suggests that some of the survival advantage accruing to the children of more-educated mothers is mediated through better prenatal care and tetanus-toxoid vaccination.

More-educated women also marry and enter motherhood later and have fewer children. As a consequence of their greater likelihood of using health services, of avoiding high-risk pregnancies and of experiencing fewer pregnancies, they are considerably less likely to die in childbirth and thereby orphan their children with deleterious consequences.

More-educated women also have fewer stunted children, who will be disadvantaged in later life through their adaptation to low-nutritional inputs, for example through producing lower-birthweight children of their own.

The evidence of improved survival chances of children with increasing education of the mother has been shown to be very strong across time and culture, although there are some exceptions which ought to be the focus of greater scrutiny. We have discussed, but failed to resolve, the apparently weaker association in several sub-Saharan African countries. The literature which tries to disentangle the pathways through which survival and health advantage accrues to children born to more educated mothers remains inconclusive.

As has been stressed throughout this paper, we can still not be sure that the associations of all of these key factors in child health with maternal education are causal. Associations are often attenuated by control for a limited range of other factors. Control for key unmeasured factors might reduce these associations with mother's education to negligible levels. However we must beware of accepting such findings without careful thought, because the additional factors may simply be capturing the pathways through which maternal education operates to produce differing health outcomes.

I have largely neglected issues of the role of maternal education in broader child development and welfare, mainly because my knowledge of a literature on such topics is scant. However Levine et al. (1991) illustrate some of these broader concerns for a small study in Mexico as does the assessment by Myers (1992). My neglect of child welfare and development issues is not because they are taken to be unimportant. On the contrary, this arena of positive health concerns for children in the developing

world should become the next major focus of demographers' attention, following the gradual spread into broader health concerns as evidenced by the recent DHS surveys and a widespread literature on small-scale and anthropological studies not given adequate attention here.

Evidence from the developed world strongly suggests important developmental advantages for children of more educated mothers: the move towards 'quality' children and away from emphasis on basic survival. Educational differentials in survival certainly persist in the developed world (Valkonen 1987) and a massive literature assesses disadvantages and relative welfare of children in relation to mother's education among other explanatory variables (see, for just one example, Robins and Dickinson 1985).

## References

Bicego, G.T. and J.T. Boerma. 1991. Maternal education and child survival: a comparative analysis of DHS data. Pp.177-204 in *Proceedings of the Demographic and Health Surveys World Conference, Washington D.C., 1991, Vol I.* Columbia, Maryland: IRD/Macro International Inc.

Boerma, J.T., A.E. Sommerfelt and S.O. Rutstein. 1991. Childhood morbidity and treatment patterns. *DHS Comparative Studies No.4*. Columbia, Maryland: Institute for Resource Development.

Boerma, J.T., A.E. Sommerfelt, S.O. Rutstein and G.T. Bicego. 1990. *Immunization: Levels, Trends, and Differentials. DHS Comparative Studies No.1.* Columbia, Maryland: Institute for Resource Development.

Caldwell, J.C. 1979. Education as a factor in mortality decline: an examination of Nigerian data. *Population Studies* 33,3:395-413.

Caldwell, J.C. 1986. Routes to low mortality in poor countries. *Population and Development Review* 12,2:171-220.

Caldwell, J.C. 1990. Cultural and social factors influencing mortality levels in developing countries. Pp.44-59 in *World Population: Approaching the Year 2000*, ed. S.H. Preston. *The Annals of the American Academy of Political and Social Science* 510.

Chavez, A., C. Martinez and T. Yaschine. 1975. Nutrition, behavioral development and mother-child interaction in young rural children. *Federation Proceedings* 34,7:1574-1582.

Cleland, J.G. 1990. Maternal education and child survival: further evidence and explanations. Pp.400-419 in *What We Know about the Health Transition: The Cultural, Social and Behavioural Determinants of Health. Vol.I,* eds. J.Caldwell, S.Findley, P.Caldwell, G.Santow, J.Braid and D.Broers-Freeman. Canberra: Health Transition Centre, The Australian National University.

Das Gupta, M. 1990. Death clustering, mother's education and the determinants of child mortality in rural Punjab, India. *Population Studies* 44,3:489-505.

DaVanzo, J. and J.-P. Habicht. 1986. Infant mortality decline in Malaysia, 1946-1975. The roles of changes in variables and changes in the structure of relationships. *Demography* 23:143-160.

Ewbank, D.C. and S.H. Preston. 1990. Personal health behaviour and the decline in infant and child mortality: the United States 1900-1930. Pp.116-149 in *What We Know about the Health Transition: The Cultural, Social and Behavioural Determinants of Health Vol I,* eds. J.Caldwell, S.Findley, P.Caldwell, G.Santow, J.Braid and D.Broers-Freeman. Canberra: Health Transition Centre, The Australian National University.

Graham, W.J. 1991. Maternal mortality: levels, trends, and data deficiencies. Pp. 101–116 in *Disease and Mortality in Sub-Saharan Africa*, eds. R.G. Feachem and D.T. Jamison. Washington DC: Oxford University Press for The World Bank.

Hobcraft, J.N. 1991. Child spacing and child mortality. Pp.1157-1182 in *Proceedings of the Demographic and Health Surveys World Conference, Washington D.C., 1991. Vol II*. Columbia, Maryland: IRD/Macro International Inc.

Hobcraft, J.N. forthcoming. *The Consequences of the Timing of Births for Child Mortality.* United Nations.

Hobcraft, J.N., J.W. McDonald and S.O. Rutstein. 1984. Socioeconomic factors in infant and child mortality: a cross-national comparison. *Population Studies* 38,2:193-223.

LeVine, R.A., S.E. LeVine, A. Richman, F.M.T. Uribe, C.S. Correa and P.M. Miller. 1991. Women's schooling and child care in the demographic transition: a Mexican case study. *Population and Development Review* 17,3:459-496.

Lindenbaum, S. 1990. Maternal education and child care processes in Bangladesh: the health and hygiene of the middle classes. Pp.425-440 in *What We Know about the Health Transition: The Cultural, Social and Behavioural Determinants of Health, Vol.I*, eds. J.Caldwell, S.Findley, P.Caldwell, G.Santow, J.Braid and D.Broers-Freeman. Canberra: Health Transition Centre, The Australian National University.

Mensch, B., H. Lentzner and S.H. Preston. 1985. *Socioeconomic Differentials in Child Mortality in Developing Countries*. New York: Dept. of International Economic and Social Affairs, United Nations (ST/ESA/SER.A/97).

Myers, R. 1992. *The Twelve Who Survive: Strengthening Programmes of Early Childhood Development in the Third World*. London and New York: Routledge/UNESCO.

Robins, P.K. and K.P. Dickinson. 1985. Child support and welfare dependence: a multinomial logit analysis. *Demography* 22,3:367-380.

Stewart, K. and A.E. Sommerfelt. 1991. Utilization of maternity care services: a comparative study using DHS data. Pp.1645-1668 in *Proceedings of the Demographic and Health Surveys World Conference, Washington D.C., 1991, Vol III.* Columbia, Maryland: IRD/Macro International Inc.

Valkonen, T. 1987. Social inequality in the face of death. In *European Population Conference: Issues and Prospects*. Helsinki: Central Statistical Office of Finland.

Woods, R.I., P.A. Watterson and J.H. Woodward. 1989. The causes of rapid infant mortality decline in England and Wales, 1861-1921. Part II. *Population Studies* 43,1:113-132.