

# Education, Health, and Development

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The separate roles of education and health in promoting human development have been extensively studied and discussed. As the impressive social and economic performance of East Asian tigers seems to show, strong education and health systems are vital to economic growth and prosperity (Asian Development Bank, 1997; World Bank, 1993). Moreover, the Millennium Development Goals adopted by member states of the United Nations in September 2000 are evidence of an international consensus regarding human development: five of the eight goals relate to education or health. Recent research that links education and health suggests novel ways to enhance development policy by taking advantage of the ways in which the two interact.

Development is a complex process involving multiple interactions among different components. In addition to health and education, the most important drivers of development include governance and other political factors, geography and climate, cultural and historical legacies, a careful openness to trade and foreign investment, labor policies that promote productive employment, good macroeconomic management, some protection against the effects of environmental shocks, overall economic orientation, and the actions of other countries and international organizations.

The interactions among these factors carry important implications for our understanding of the development process as well as for policy. It is now clear that increased access to education, although of great importance, is by itself no magic bullet. Its positive effects on development may be limited by a lack of job opportunities that require high-level skills and therefore enable people to use education to their economic advantage. And, as healthy but poor Cuba and the state of Kerala in India show, the impacts of good health on development are limited without concomitant advances in other areas.

The connections between education and health and their impacts on development have received relatively little attention.<sup>1</sup> This paper discusses

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1. One of the more useful and extensive studies to date is United Nations (2005). *World Population Monitoring 2003: Population, Education and Development*. This work reviews some relevant studies and provides data on education, health, and development. The report asserts that education has been found to be closely associated with better overall health, and that this association is supported consistently, using a range of indicators. In general, the report considers education to be a lever for improving health, although the exact relationships that underlie this connection are acknowledged to be unclear. For children's health, the education of their mothers is particularly important.

these connections and briefly outlines some central issues. The first part of the paper discusses why interactions between health and education are important. The second part describes how the links might work, looking at conceptual channels between them. Part three reviews the literature to establish whether there is evidence for these channels and concludes that there is.

## WHY DO INTERACTIONS MATTER?

Better education and better health are important goals in themselves. Each can improve an individual's quality of life and his or her impact on others. There is an extensive literature on the importance of education and health as indicators and as instruments of human development (See Sen, 1999).

### *Education*

Educational indicators are of various types, and those that are monitored relate primarily to inputs—that is, investments in education in terms of resources and time. UNESCO, for example, collects data on numerous inputs such as enrollment numbers and rates, repetition rates, and pupil/teacher ratios (Bloom, 2006). On outputs—the direct results of the education process—UNESCO measures literacy rates and education stocks. The Organization for Economic Co-operation and Development (OECD) and the International Association for the Evaluation of Educational Achievement collect other output data on average years of schooling and test scores in mathematics, science, and reading.

Education is recognized as a basic human right, and better education improves people's welfare. As an instrument of development, education fosters and enhances work skills and life skills such as confidence and sociability. These skills in individuals promote economic growth on a societal level via increased productivity and, potentially, better governance (Hannum and Buchmann, 2006).

### *Health*

The World Health Organization defines health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.”<sup>2</sup> Health indicators produced by the World Health Organization and other UN bodies include infant and child mortality rates, life expectancy, morbidity data, burden of disease, and disability-adjusted life years (DALYs). Improvements in these measures reflect improvements in quality of life.

Good health not only promotes human development. It also allows people to attend work regularly, to be productive at work, and to work for more years. Healthy individuals also contribute to the good health of those around

2. Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19–22 June, 1946; signed on 22 July 1946 by the representatives of 61 states (Official Records of the World Health Organization, no. 2, p. 100) and entered into force on 7 April 1948.

them because they do not spread infection, and they have the physical and mental strength to look after others. Robust health can often serve as a platform for progress in other areas, given a suitable policy environment.

Good health can also alter the population growth rate in ways that promote development. Health improvements often have the greatest effect on those who are most vulnerable, children in particular. Advances in medicine and nutrition increase the likelihood that a child will survive into adulthood, and parents therefore need to bear fewer children to attain their ideal family size. High fertility, still prevalent in much of the developing world, tends to decline when child survival improves (Stark and Rosenzweig, 2006).

Reduced fertility means parents can concentrate investments of time and money on a few children rather than spreading these resources across many, thus enhancing their children's prospects of leading healthier and better-educated lives. Reduced infant and child mortality lessens emotional stress on families, potentially increasing family cohesion, and gives parents more time to devote to productive activities as the need to care for sick infants decreases. Lower fertility also improves mothers' health, as early and frequent childbirth, particularly in developing countries where health systems are weak and often unsafe, poses serious health risks. Maternal mortality is a major problem in the developing world; in some parts of Africa, 2 percent of live births result in the mother's death (UN Statistics Division, 2004).

Fertility declines also change population structure, with positive effects on development. In the time lag between increased child survival and parents' subsequent decision to bear fewer children, a "boom" generation is created, which is larger than both the preceding and the succeeding generations. As this generation reaches working age, it can strongly boost an economy if economic policies encourage job creation. This "demographic dividend" accounted for as much as one-third of East Asia's "economic miracle," and has also had strong effects in Ireland (Bloom et al., 2002; Bloom and Canning, 2003).

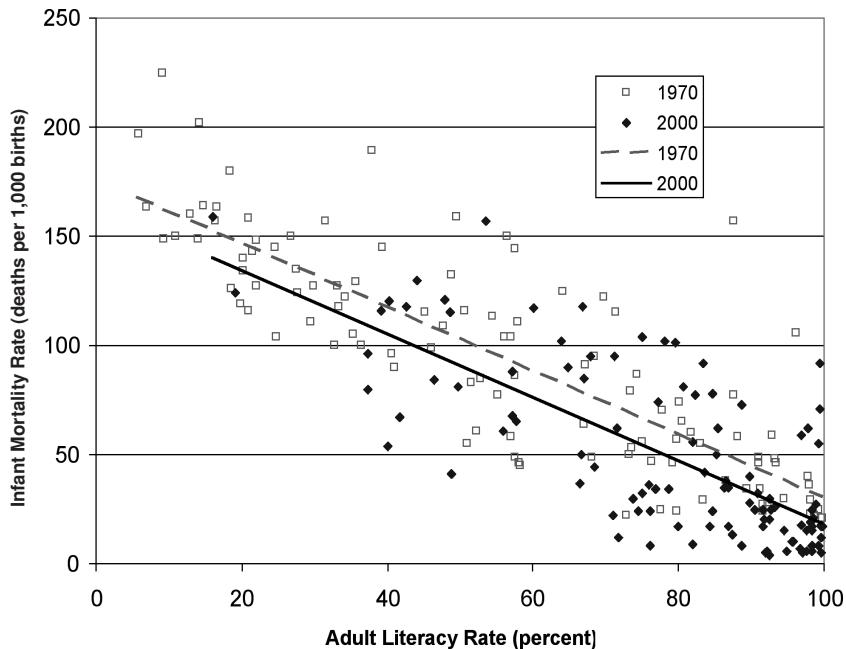
### *Health and Education*

Certain effects of health and education on development are well established. There may also be synergies between these two, in which case we are likely underestimating their impacts. Understanding the links between health and education is important for social policy as well as academic knowledge.

The recent success stories of East and Southeast Asia and Ireland suggest that development requires a combination of factors, such as those listed earlier (Bloom and Canning, 2003). Interactions among the many relevant factors have the potential to set off virtuous development spirals and to halt vicious spirals (Agosín et al., 2006). Understanding how different drivers of development affect one another can translate into better policy. A description of the interactions between education and health may provide a useful model for these other factors.

Most governments treat health and education separately, via separate ministries for health and education. Collaboration between these ministries is

**Figure 1:** Infant Mortality and Adult Literacy, 1970 and 2000



often patchy, with spending decisions on education rarely taking account of impacts on health, and vice versa. In all settings, but particularly in developing countries where funds are especially scarce, maximizing the return on investments is critical. An intervention that improves health will have some impact on human development, but one that improves health and education simultaneously may be a more effective use of resources. In contexts where trade-offs are inevitable, the knowledge that an intervention in one area is likely to spark improvement in other areas could have a major influence on policy.

Ignoring these interactions in policy making is wasteful. It may also be damaging. If they are to succeed, policy interventions intended to spur development must adequately address the range of factors that can impede a country's progress. Funds invested in teacher training, for example, may be squandered if teachers receive no advice or assistance with HIV prevention. AIDS has decimated the education workforce in parts of Sub-Saharan Africa, triggering a vicious spiral whereby poor health in teachers hinders the education of children. This leaves children, through their lack of knowledge, more vulnerable to HIV infection themselves.

Figure 1 suggests that health and education are linked. The figure plots infant mortality against adult literacy for all countries for which data are available, and shows the resulting linear regression lines for both 1970 and 2000. Countries with low infant mortality tend to have high literacy levels, although the range of adult literacy is wide at all levels of infant mortality. Both health status and educational indicators have improved somewhat since 1970, but the relationship between them has remained relatively stable (and this is true for indicators beyond those shown here). However, as we discuss

in more detail below, we cannot infer causality from these data: education could affect health, or vice versa, or both could be affected by other factors.

Understanding causality is a key to unlocking the potential for improvement in infant health suggested by Figure 1. Examination (via case studies) of the countries that do not conform to the general trend may also be instructive. The Maldives, for example, had a high literacy rate (88 percent) but also a high infant mortality rate (157 per thousand live births) in 1970. By 2000, its infant mortality rate had improved greatly (to 59 per thousand). Did education have a delayed effect on health or was education in 1970 not of the right type or quality to have an effect on health knowledge or behaviors? Alternatively, did non-educational factors, such as a lack of access to technology or medicine, hinder health improvement? An assessment of why health lagged education and how the Maldives made such huge strides in cutting infant mortality could provide lessons for policy makers facing similar challenges.

#### CONCEPTUAL CHANNELS: HOW EDUCATION AND HEALTH COULD BE LINKED

In this section, I look first at the reasons to expect that better health leads to better or more education, and then at the reasons to expect effects in the reverse direction. Although there are numerous possible channels, not all occur as described below, particularly because government policy and actions influence these potential interactions between education and health.

##### *Health to Education*

Different theoretical channels from improved health to better education occur over the course of an individual's life. Good health as an infant enhances cognitive development, allowing healthy children to derive greater benefit from schooling. At school age, good health means that children can attend school more frequently and pay better attention in class. Good attendance, enabled by good health, is more likely to lead to higher attainment through secondary and post-secondary education and, in adulthood, to increase the mental agility needed for lifelong learning. The health of other family members also affects educational enrollment, as healthy siblings and parents alleviate the pressure on older children to care for others at home. Maternal health, closely connected with child health, is likely to be linked to children's educational outcomes.

Good health also makes investment in education more likely. Healthy parents are likely to be economically better off, and thus better able to afford education (or better education). Parents of healthy children, moreover, receive a greater return on the investment in their children's education than do parents of sick children who may not survive to adulthood.<sup>3</sup> The same is

3. This argument, of course, is based on the idea that parents will act in their children's long-term interests. This assumption, generally reasonable, underlies much thinking about development. However, there is a possibility for this assumption to be off the mark in some cases, as parents' interests are not identical to those of their children, and they may choose, or be forced, to make decisions based on their own shorter-term interests, which could diminish the effect of good health on education.

true for governments considering investments in schools: in countries with relatively healthy populations, government investment in education will yield a higher return in economic growth and other social benefits. Health improvements thus make it more likely that children will attend school for long periods and that the schools they attend will have the resources to teach them well.

Just as good health can strengthen education, bad health can weaken it. At a national level, major health shocks divert public funds from schooling (among other government investments). They also damage the human capital needed to run education systems and teach in schools, as in the case of HIV/AIDS in southern Africa. At the family level, health shocks may divert assets from education. Sick children need medicine and care, both of which consume a family's time and financial resources. Sick parents cannot work to fund their children's schooling, and they may require children to withdraw from school to look after them or to earn income for the family.

### *Education to Health*

There are numerous conceptual links from education to improved health. Direct effects occur if schools provide health services such as vaccines or treatment for illness, or if they supply nutritious meals that students would not receive at home. A negative direct effect of school attendance may be increased exposure to illness; however, if short-term sicknesses are overcome, children can build up immunity against diseases that may be dangerous, or at least time-consuming, if caught in adulthood.

Many less-direct links also exist. Educated individuals have readier access to health information than those without education. The skills gained through schooling can help children absorb health information and adopt health-seeking behavior, although it is unclear whether health is most improved by health-specific education or general education. Many schools provide lessons on hygiene, nutrition, and sex education, and also encourage health-seeking behaviors such as washing hands before meals (families, of course, also provide much of this information to children). Good education nurtures inquisitiveness and teaches the links between cause and effect, with possible positive consequences for health outcomes as evidenced by the impact of maternal education on child health (LeVine, 1987; Buor, 2003; Caldwell, 1979). Educated children may have a more concrete understanding of how various behaviors affect health outcomes. A better understanding of symptoms may also make interactions with physicians more effective.

Education also indirectly affects health through education's effect on incomes. Educated children tend to earn higher incomes in adulthood and, therefore, are more likely to have the money and time to visit medical practitioners. Children in school—and their parents—have more to lose financially in taking health risks (such as smoking, having unprotected sex, making poor dietary choices, and failing to exercise) than those who are unenrolled. These factors may encourage health-seeking behavior. In adulthood, higher incomes allow people to eat better food (although in some cases wealth can

also lead to their eating too much food), live in more secure dwellings, protect themselves against environmental shocks, and purchase better health care. The educated may, as a consequence, be more resilient to health setbacks and better able to respond to them.

Higher income also affects mental health. People with higher incomes have more effective support networks than the poor, and they are less likely to feel and to be socially excluded. Wealth enables greater control of one's circumstances than poverty, and stress levels are therefore likely to be lower. The combination of social exclusion and stress could make the less educated more vulnerable to mental illness and its physical effects.

Through its positive effects on wage rates, education can also contribute to fertility decline. Higher wages increase the opportunity cost for women of raising children full-time, and in most countries increased wages have been associated with falls in fertility. As discussed above, fertility declines allow parents to concentrate resources in fewer children, increasing the likelihood that children will be healthy.

Perhaps most important, the broader context matters in facilitating the links between education and health. If, for example, large numbers of people are unemployed, then increasing education levels will not raise incomes and the health benefits that would otherwise follow from raised incomes are foregone. In this circumstance, there is no consequent health improvement to feed back to better or more education.

## THE EVIDENCE

### *The Big Questions*

Despite a growing body of academic work<sup>4</sup> on the links between health and education, many key questions about their interaction remain unanswered. A search of the Rockefeller University library's Evidence-Based Medicine database uncovers over 1,000 items discussing both health and education. However, few of these studies are based on randomized trials, and many overlook the effect of external variables on education and health improvements. Although associations are often found between advances in health and education, causality is more often implied than proved, with ad hoc studies prevailing over more robust longitudinal data and data from randomized controlled trials.

To deepen academic understanding of the links and to strengthen policy decisions, a core set of questions should be addressed. Regarding channels leading from health to education, we might first ask, "Whose health, if anyone's, is important to a child's educational outcomes?" The health of many parties may be important. The nutritional status and overall health of a young child may affect his or her ability to learn. Maternal physical and mental

4. See, for example, "Education and Public Health: Mutual Challenges Worldwide," Special Issue of *Comparative Education Review* 49 (4) (November 2005), and the works cited therein.

health before, during, and after pregnancy plays an important role. If a child's father is the breadwinner, the father's health could be crucial to the child's education. If a child has siblings, their illness can divert resources away from a child's education. The health of teachers, too, may be relevant to children's educational outcomes.

We also need to investigate what types of health interventions improve schooling outcomes. Such interventions might include dietary improvements (e.g., school lunches and micronutrient and vitamin supplements), immunization programs, and school-based clinics. They might also include public health information campaigns that target children or their family members.

Regarding channels from education to health, we need to ask, "Whose education benefits whose health?" In particular, we need to better understand what role mothers' education plays in maternal, infant, spousal, and child health. Similarly, what are the effects of a father's education? Other questions in this area include: Do educated children bring health benefits to uneducated parents or siblings? Do the effects of education on male health and female health differ? Do impacts vary by country or region? To what extent are policy lessons transferable from one location to another?

We have some knowledge about how education improves health, but we do not know enough about exactly how this works. With a dearth of randomized experiments, our understanding has room to develop. It is plausible that attending school promotes health-seeking behaviors such as exercise, good hygiene, avoidance of alcohol and smoking, and delay of sexual initiation/pregnancy, but we do not know enough about these interactions. For example, some have suggested that education is like a "social vaccine" for HIV/AIDS prevention.<sup>5</sup> To what extent is this true, and do particular levels of education have different effects? Are some health problems—say, infectious diseases or mental health issues—more responsive to education than others? We also need to know when education might pose a threat to health, for example, by increasing exposure to disease.

We need to understand how different types of education counter risks and maximize health benefits. For example, primary schooling may be a key for some disease prevention efforts but not others. Health education per se has been the subject of numerous studies, but more work is needed to understand the means and extent of any impact.

### *The Evidence—Research Methods*

Empirical research on the links between health and education takes various forms, including randomized studies, retrospective studies, ethnographic work, and case studies.

5. "Ministries of education increasingly recognise that education is an effective 'social vaccine' against HIV/AIDS, but that the impact of the epidemic is compromising their ability to deliver this vaccine" (Donald Bundy, of the World Bank, quoted in [http://siteresources.worldbank.org/CSO/Resources/Learning\\_to\\_Survive\\_by\\_Oxfam.pdf](http://siteresources.worldbank.org/CSO/Resources/Learning_to_Survive_by_Oxfam.pdf)).

Few studies on the links between health and education have employed randomized designs (Bettinger, 2006) although these are often the most compelling way of establishing causal connections.<sup>6</sup> Evaluating health and education interventions requires evidence of causality. Studies that look at retrospective data, as valuable and often necessary as they are, do not necessarily construct valid groups for comparison—groups that are statistically similar but for the single difference of interest. The validity of the results may be colored by unexamined differences, making inferences of causality unreliable (Moffitt, 2005). A finding that children who attend school are healthier than those who do not may reflect the inability of unhealthy children to attend school, or it may result from the variety of ways that factors such as family income, parental health knowledge, or diet influence health and education status. Although multivariate analysis can, in principle, eliminate the confounding effects of factors that are included in the analysis, multivariate analysis cannot eliminate the effects of unknown confounding variables. It may be difficult to be confident of the impact of schooling unless confounding factors are reasonably spread across treatment and control groups, and only randomization can ensure such comparability.

In randomized tests, randomly selected treatment and control groups are likely to be similar to each other on average and are therefore valid groups for comparison. Any changes occurring after programs are implemented may be more reliably attributed to the intervention. Because randomized trials can be costly to implement and results can take several years to emerge, especially in areas with long-term effects such as health and education, they tend to be underutilized. Strong skills in research design and implementation are needed for trials to be effective, and these skills are often insufficient in developing countries.<sup>7</sup> However, as the INDEPTH network<sup>8</sup> of demographic surveillance sites in Africa, Asia, and Latin America demonstrates, investing in randomized studies can help build up local research capacity and inform national policy.

In terms of wasted policy opportunities, the cost of *not* conducting randomized trials may be much higher than that incurred by conducting them. As an example, a randomized community health study by the Navrongo Demographic Surveillance Site in northern Ghana found that moving nurses into communities and mobilizing community volunteers to assist the nurses

6. However, such trials can be quite costly to conduct and they sometimes raise difficult ethical issues. Denying a control group of children access to schooling is not politically or morally feasible. Similarly, offering an intervention to only one group of students or one set of schools, when that intervention seems likely to be beneficial, is also very problematic. This ethical problem is mitigated, however, by the consideration that if no students receive the intervention, none of them will be better off, nor will anyone learn whether the intervention is definitely effective or cost-effective. Obviously, such trials must be carefully designed and reviewed before they are initiated. One additional possibility is sequential staging, in random order, of an intervention that cannot be delivered everywhere at once to solve the ethical problem while permitting statistically valid comparisons.

7. Bettinger (2006) offers a detailed discussion of these challenges.

8. <http://www.indepth-network.net/>

reduced overall mortality in treatment areas by 30 percent. The program is now part of Ghana's national health care policy and has sparked international interest.

Novel combinations of research methods will make possible new and stronger findings, as illustrated by two examples. First, the relationship between health and education can be investigated using micro-data, such as those from surveys or randomized trials, or macro-data where the typical unit of observation is a nation, such as those supplied by the World Bank's *World Development Indicators*. Asking the same question via these two very different methods may yield consistent or contradictory results. To the best of my knowledge, this type of comparison has not been carried out very often, if at all, and may be a fruitful direction for research. Second, qualitative research methods may offer another fruitful approach. Randomized studies do not try to explain *why* people act as they do. Focus groups, case studies, and ethnographic techniques are required to generate useful hypotheses about the dynamics of a situation that can sometimes be tested using quantitative research methods. Such qualitative designs are often complementary to quantitative ones.

### *The Evidence – Health to Education*

In this subsection, I summarize some studies covering channels from health to education and the reverse. Although this summary is not an exhaustive review of the literature, most of the studies are prominent or recent. These studies indicate that education and health have mutually reinforcing interactions.

The most persuasive evidence that good health leads to good education has come from randomized studies. These studies examine the effects on school children (absenteeism, test scores) of de-worming programs, iron supplementation, and the provision of school meals in developing countries.

A 2004 study by Miguel and Kremer examines the effect of de-worming programs on primary school children in Kenya. The investigation, which was randomized over 75 schools, finds that de-worming reduced absenteeism from school by one-quarter in the treatment group and also improved health and school participation in students who were not included in the program, both in the treatment school and beyond it (Miguel and Kremer, 2004). The study finds no impact of the de-worming program on academic test scores, however. A similar study by Bobonis, Miguel, and Sharma (n.d.) in the slums of Delhi, India, finds that delivering iron supplementation and de-worming drugs to children attending pre-school reduced absenteeism by one-fifth in the first five months of the program. The authors could not maintain randomized groups for comparison when they extended the study over a further year, as parents who were aware of the program self-selected their children into treatment schools (highlighting a potential problem with randomized trials).

In addition to increasing attendance, treatment of health problems may also improve cognition and learning abilities. Nokes and others (1992) test the impact of whipworm infection on the cognitive abilities of 9–12 year-old

children in Jamaica. The study includes a treatment group, a group that received a placebo, and a control group of uninfected children. It finds that curing whipworm led to significantly improved scores in short-term and long-term memory tests, and that treated children caught up with uninfected children in these tests after nine weeks. A similar study by Bhargava et al. in Kenya provides further evidence of the effect of health on cognitive development, finding that both height and hemoglobin concentration are significant predictors of scores on achievement tests (Bhargava et al., 2005).

School meals provide a strong incentive for students to attend school. A randomized test in Kenya finds that school meals improved school attendance and test scores. School attendance by the treatment group was 36 percent, while in the control group it was 27 percent. Test scores improved only in schools where teachers were more experienced. According to the authors, “what seems crucial is that the children who had better scores attended school more often and had a teacher with more experience” (Vermeersch and Kremer, 2004). A non-randomized study in Pakistan by Alderman and others finds that health and nutrition had significant positive effects on school enrollment and that these effects were stronger for girls than boys (Alderman et al., 2001). As noted above, however, the results of non-randomized studies may be less conclusive due to biases in the data.

Several non-randomized studies consider the effect of HIV/AIDS on students and teachers. An analysis of case studies of 49 families infected with HIV/AIDS in Zambia finds that among 215 children, over one-quarter had had to withdraw from school (Haworth et al., 1991). A further Zambian study finds that the number of AIDS-related teacher deaths in the first ten months of 1998 was equivalent to two-thirds of the country’s newly qualified teaching pool each year (UNICEF, 2000). Kobiané and others (2005) investigate the effect of adult deaths on the education of young children by studying the educational participation of orphans. This issue is particularly salient in the face of the HIV/AIDS crisis in Africa. The study finds that orphans are less likely to enter school than their non-orphan peers, and this effect is more pronounced in rural areas, among the poor, and for girls.

Not all randomized studies supported the health-to-education link. A study by Dickson et al. (2000) reviews 30 earlier studies covering 15,000 children to determine whether treating children infected with worms improved their cognitive performance. This meta-analysis finds no connection, but various problems with the data compromise the study’s ability to do so. Likewise, Madhavan and Thomas (2005) find that although childbearing would seem to be an impediment to a girl’s completion of formal education (and most data support this supposition), it does not necessarily signal the end of schooling. The analysis by Madhavan and Thomas suggests that certain household-level attributes might enable young mothers to complete their education.

In sum, although there is evidence that health affects education, the overall picture is not entirely clear. Many questions remain unanswered, and many health interventions that may affect education have not been tested in

randomized trials. More research is needed before health interventions can be most effectively incorporated into education policy.

### *The Evidence – Education to Health*

It is possible to test educational interventions to improve the health of children using randomized trials, but most work to determine the effect of education on health has been carried out using other research methods.

Studies have investigated the impact of education on broad indicators of health, such as mortality and functional ability. To determine whether the association between education and health is causal, Adriana Lleras-Muney (2005) examines the health of individuals who had grown up with differing compulsory education laws; those who were subject to such laws would have had more education than those who were not, even if other socioeconomic factors were equal across such groups. Her study concludes that education reduces adult mortality and that the effect is larger than previously thought. A study by Scott J. Adams (2002) uses econometric modeling of U.S. Health and Retirement Study data to demonstrate that increased educational attainment promotes improved health among adults. Using functional ability as an indicator for health and controlling for family background, the study finds education to have a significant positive effect on almost all indicators, with a stronger effect for women than for men. Another study in four different U.S. locations finds that education was associated with lower mortality rates in adults in men, but not in women (Bassuk et al., 2002).

Other studies consider more specific health effects. Berger and Leigh (1989) use econometric modeling to eliminate the impact of self-selection bias on findings that education improves health. They find that increased schooling was associated with lower blood pressure and lower likelihood of reporting disabilities or functional impairments, even after accounting for background variables such as age, initial health, and ability. A study based on data from Brazil, Ghana, and the United States finds that parental education influenced children's height, which is often seen as a proxy for health. In particular, a father's educational level had a bigger effect on his son's height than on his daughter's, and a mother's level affected her daughters' height more than her sons' height (Thomas, 1994).<sup>9</sup> Donald Kenkel (1991) uses U.S.

9. One reviewer asked whether this study had "...[considered] the possibility that parental physical vigor and intelligence were a common causal factor responsible for both high levels of parental education and greater height of their offspring;" and, "Instead of education causing health, it could be that both parental education and child height result from a common antecedent, parental 'fitness.'" In private correspondence related to this point, Duncan Thomas wrote: "First, it may be that parental education is proxying for resource. . . [T]he evidence on parental education being positively associated with child height is robust to controlling parental resources (measured with income, wealth or consumption). Second, it is possible that there are other unmeasured factors that drive parental education and child height. To the extent these do not vary with the gender of the child, and as long as their influence on child height is linear and additive, then models that include household fixed effects will absorb their impact on child height. The evidence you cite is robust to including household fixed effects. This amounts to comparing the influence of father's education on sons, relative to daughters, and doing the same for mother's education."

Health Interview Survey data to show that schooling was associated with increased health-seeking behavior in terms of refraining from smoking, partaking in exercise, and reducing alcohol consumption. The study does not establish causality, however, and does not rule out the possibility that variables other than schooling had a greater effect.

Maternal education is strongly associated with improved health outcomes for children and with reduced fertility. Studies reported by Robert A. LeVine (1987) use survey data and ethnographic observations in Mexico to show that maternal education is negatively associated with fertility and with infant mortality after controlling for socioeconomic factors. Educated mothers were more likely to take sick children to clinics, and their fertility rates were lower even after taking into account the effect of attending school or work on age of marriage. “The pathways from school to reduced fertility,” the author reports, “do not run through postponed marriage and improved job opportunities but through the apparent psychosocial influence of school on a woman and her marriage to a man more likely to share her lower fertility goals” (LeVine 1987).

The findings reported in LeVine’s summary are supported by other research. Janet Currie and Enrico Moretti (2003) construct longitudinal panel data from U.S. Vital Statistics natality files to measure the effect of mothers’ education on child health. They find that schooling in mothers reduces the incidence of low birth weight, premature birth, and fertility. Cynthia Lloyd and others (2000) use Demographic and Health Survey (DHS) data to study the link between primary schooling and fertility in Sub-Saharan Africa. All nine countries that had achieved mass primary schooling began their fertility transitions soon after. As with other studies, however, causality is not addressed.

A particularly intriguing study in Ghana by Benefo (2006) finds that, independent of a woman’s own level of education, her interest in modern methods of contraception and in having fewer children increases when the level of education of other women in her community increases. This result suggests that education may have greater ability to influence reproductive health in rural Africa than has previously been thought.

Other studies suggest the links from education to health are either negligible or negative. A study of the effect of years of schooling on cigarette smoking in the United States analyzes survey data of high-school age students and includes follow-up interviews of a sample of the survey respondents seven years later. The authors find no correlation between additional years of schooling and propensity to smoke (Farrell and Fuchs, 1982). A Tanzanian study comparing children enrolled in primary school with those not enrolled found no consistent difference in levels of parasitic infection. The study, which relied on survey data and blood and urine samples, finds some positive correlation between school enrollment and malnutrition and anemia (Beasley et al., 2000). A review of 27 studies on the effect of education on HIV infection finds that in Africa the more educated had an increased rate of infection (although it appeared that this pattern might be changing),

whereas in Thailand education was associated with a lower risk of HIV (Hargreaves and Glynn, 2002). A 1994 sentinel surveillance study in Zambia supports the Africa finding. A 1997 study finds a positive correlation between education and HIV levels among women aged 25–29 (Flykesnes et al., 1997). Later on in the epidemic, however, the strength of this relationship weakened, and in some African countries it reversed (Vandemoortele and Delamonica, 2000).

Evidence for differences in health effects of general education versus health-specific education is difficult to find. Education by itself, as opposed to health-specific education, may be a key driver of health improvements. A study by Nayga (2001) uses U.S. Diet and Health Knowledge Survey data to examine the effect of schooling on obesity. Among a randomly selected sample of 1,579 survey respondents, education was linked to significantly reduced obesity in women and men, even after controlling for health knowledge, suggesting that schooling's association with lower obesity was not due to health knowledge. The author does not examine other factors that may account for the link, but the study points to a significant benefit of general education for health.

Other studies indicate the importance of maternal education in child health. A regression analysis of survey data in Morocco shows that although the health knowledge mothers obtain as a result of schooling was associated with significantly better health for their children, fathers' schooling had no relationship with child health (Glewwe, 1997). The channels from mothers' education to their children's health appear to work through the acquisition at school of skills in reading and basic mathematics. These skills enabled girls to acquire health knowledge after leaving school, which they used to improve their children's health. Direct health education of girls in schools might have improved their children's health further, but the study does not test this idea.

The proposed pathway from maternal education to child health is supported by the work of Rowe and others (2005) on education's effect on maternal health practices in Nepal. Their work shows that general education enables mothers to benefit from health-specific education. As in some other relatively isolated countries, the dissemination of information about health practices that improve the life chances of children is hampered in Nepal by illiteracy, by within-country geographical barriers, and by longstanding child-raising practices that do not benefit from knowledge gained in other parts of the world. Rowe et al. show that the health-related knowledge and practices of mothers is affected not only by their schooling, but by subsequent use of their literacy skills and also by their exposure to media.

Health education occurring outside of formal schooling may have positive effects on health-seeking behavior. Lee and Mason (2005) find that mothers who used prenatal care had a higher subsequent likelihood of immunizing their children.

The effects of health-specific education on student health are not clear. A UNAIDS literature review assesses the impact of HIV/AIDS and sexual health education on the sexual behavior of young people. The review finds that of 53 studies that evaluate interventions, 27 report no change in recipients' sexual

behavior. Twenty-two studies report reductions in behaviors linked with a higher risk of HIV infection, such as the number of sexual partners, unplanned pregnancy, and sexually transmitted disease. However, the authors admit that “the interpretative value of this research was somewhat compromised . . . because of inadequacies in study design, analytic techniques, outcome indicators, and reporting of statistics”(UNAIDS, 1997). Responding to studies that cast doubt on the efficacy of education initiatives in promoting health, Pridmore and Yates (2005) argue that a different type of education may be more effective in confronting the HIV/AIDS crisis. They advocate that governments embrace open learning systems and new, more flexible means of educating youth, and suggest that young people should be involved in encouraging communities to confront AIDS.

A particularly interesting study by Curtin and Nelson (1999) finds that the benefits of improved health that are expected to result from primary education only come about when children also receive post-primary education. The authors attribute longstanding beliefs in the higher returns (both for income and health improvements) from investments in primary education (as opposed to secondary or tertiary education) as stemming from flawed World Bank methodology.

Although few of the studies described above provide decisive evidence of causality, they do identify the possible impacts of education on health, and these are consistent with the intuitive reasons for their occurrence.

Uncertainties abound, even on basic questions. Mothers' education appears to be particularly strongly associated with better health outcomes for their children, but clarifying the effect of a child's schooling on his or her own health has proved more difficult. Whether health education and general education have different effects is unclear, as is knowledge of what type of health education is most effective under what circumstances and for what purposes. Differences in the specific health impacts of primary, secondary, and tertiary schooling have yet to be determined, although the study by Curtin and Nelson does shed light on a possible important difference between the effects of primary and post-primary education on health. There is also considerable uncertainty about the effects of education on male health versus female health. Nevertheless, with the balance of studies suggesting there are links from education to better health, establishing how these links work is critical for designing policies to take advantage of them.

The effects of education on health could vary from one context to another. For example, in a country that trades extensively with a large neighbor, the effect of education on health might be different from that in a country whose economy is more isolated. Without the opportunities that arise from proximity to a behemoth, an isolated country may have fewer development options, so the need for education to facilitate health improvements may be stronger. Similarly, the effects of education on health can vary over time. In Africa, individuals with more education were at first more likely to become infected with HIV. As those with education became more aware of how HIV spreads, uneducated people became the ones more likely to become infected.

## CONCLUSION

Although the evidence is far from complete, it appears that the interactions between education and health can promote virtuous development spirals. Good health boosts school attendance and improves learning. Good education, particularly of mothers, boosts child health, and the effects can last into adulthood. Policies that take advantage of the interactions between health and education should be developed and implemented. They should also avoid potential pitfalls. A case study in Karnataka, India, finds that a disproportionate share of subsidies for education and health benefited the well-off, and relatively little went to women, people in rural areas, or other individuals with low levels of health and education (Mahal, 2000).

Because key questions remain unanswered, policy-makers have only slim evidence on which to formulate plans. More research is needed. Randomized studies should be an important focus of efforts, but different research designs have different strengths that may be beneficial to research efforts.

Retrospective quantitative studies can draw on large amounts of data and benefit from experiences in a wide array of situations. Qualitative studies can both provide seminal insights and lead to critical, testable hypotheses. Effective policy requires strong evidence, and a robust mix of studies may have the potential to push our understanding forward faster than any single research strategy.

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