THE IMPACT OF HEALTH AND NUTRITION ON EDUCATION

Jere R. Behrman

Child health and nutrition are strongly associated with educational achievement. But associations do not necessarily indicate causality; estimates generally are likely to be biased in one direction or the other. As a result analysts and policymakers should have much less confidence in findings about the effect of health on schooling success than has been claimed in previous surveys. The evidence is more nuanced and qualified than is often recognized but may still support the conclusion that health may have considerable effects on postschooling productivity. Policy implications point toward providing public subsidies for the collection, analysis, and dissemination of information about the links between health and education; and toward providing services to improve the health of poor children.

Better health and nutrition are positively associated with gains in schooling in many areas: enrollment at younger ages, less grade repetition, less absenteeism, more grades completed, and better performance on test scores. Recent surveys conclude that empirical studies constitute strong evidence showing that health and nutrition influence children's success in school (Leslie and Jamison 1990; Levinger 1992; Myers 1992; Pollitt 1990).[1] Leslie and Jamison, for example, write that "the strongest case can be made for a negative effect of nutritional deficiencies on school outcomes. Research has consistently found protein-energy malnutrition and iron-deficiency anemia to have significant negative effects on tests of cognitive function in both pre-school and school-age children, and on attendance and achievement among the latter" (p. 197). These studies, together with more casual observations, have been used to win support for programs that lead to better child health and nutrition on the grounds that one very important payoff is a better-educated population, which will lead to subsequent increases in productivity.

Most of these studies are based on socioeconomic survey data that provide information about the associations between health and nutrition on the one hand and education on the other. But such *associations* do not necessarily imply *causality*, although they are so interpreted. Knowing the empirical magnitude of

The World Bank Research Observer, vol. 11, no. 1 (February 1996), pp. 23–37

such associations may be useful for predicting which students are more likely to be successful in school or for targeting policies on particular groups of individuals when policymakers do not have reliable information on which to base their decisions. For example, if the association between good health and education is positive in many data sets, and policymakers want to target programs to serve those in poor health, using low education as a proxy to identify program recipients might be effective.

The problem is that health, nutrition, and education are not randomly determined but rather are based, at least in part, on the choices made by individuals and their families. These choices are made in response to possibly important predetermined characteristics that policymakers and analysts cannot observe, such as innate ability, motivation, genetic robustness, and the environment. Because these characteristics are not included in most socioeconomic data sets, they are not captured by social scientists analyzing these data. Families make choices, too, that typically are not observed, such as the amount of time that parents spend educating children at home. Our grandparents knew through casual observations that family background and individual characteristics might be critical in school success: Elizabeth had a lot of schooling because she was smart and diligent, but Juan had little because he was lazy and more interested in playing than studying; Pranee was always healthy because she was inherently robust, but Kwame was constantly sick; Lee Ying's family connections assured that she attended the best schools and got a good job, but Bhavani's family held her back.

But most of the time academics from Cambridge to Bangkok and policy analysts from Washington to Santiago do not control for behavioral responses and unobserved characteristics; they simply interpret associations to imply causality. Because associations in cross-sectional data may substantially over- or understate true causal effects, however, much less is known about the subject than is presumed. Although the surveys noted above take into account some measurement issues (such as the failure to control for intensity of schistosomiasis infections), they pay very little, or no, attention to the problems of drawing inferences from data that do not include relevant unobserved variables. Thus the true underlying causal relations may be very different—either larger or smaller—than those presented in the research.

In this article I survey what is known about the magnitude of the effect of health and nutrition on schooling, sketching out a simple framework for estimating the impact of health and nutrition on schooling. After summarizing several empirical studies based on experimental and socioeconomic survey data, the article concludes with three major points. First, most studies do not attempt to deal with the estimation problems discussed in this analysis, which makes it difficult to interpret their results. Moreover, studies based on past data cannot provide much insight into what the effect might be if the incentives change a great deal, say, as a result of market developments or educational reforms. Second, the evidence suggests that good health and nutrition have more nuanced and qualified effects on schooling success than is often recognized but that these effects may still translate into a considerable improvement in postschooling productivity. And third, policy implications point to public subsidies to improve the health of poor children and finance the collection, analysis, and dissemination of information about the links among health, nutrition, and education.

A Simple Framework for Estimating the Effect of Health and Nutrition on Education

Often the frameworks that analysts and observers use are implicit. An explicit framework, however, has the advantage of clarifying which conditions reflect the effect of health and nutrition on education, and which conditions over- or understate their true causal effect on schooling success. To illustrate these possibilities, consider an explicit example of an important indicator of schooling success—cognitive achievement. Cognitive achievement is influenced by several individual, family, and community variables. Some of these variables can be observed by social scientists and policy analysts; others cannot ("unobserved" in this article). Table 1 shows how these variables might be classified. An explicit framework indicating how such variables affect a child's success in school is important for an accurate analysis of the causal effects of health and nutrition on education.

The simple association between the effects of good health and educational achievement holds if, first, it can be shown that health status affects cognitive achievement and not that children with higher achievement take better care of their health; and second, if the observed indicators (test scores, say) are not

Table 1. *Classification of Variables Influencing Cognitive Achievement*

Variables	*Observed by analysts*	*Unobserved by analysts*
Individual	Health indicators (anthropometric measures, reported illness) Age, gender School attainment	Innate ability Motivation Genetic endowment Capacity to concentrate
Family	Parental education Parental occupation Income	Household intellectual atmosphere Parental time devoted to cognitive development of child Amount of food given to child
Community	Population size, density Pupil-teacher ratio Public health programs (mosquito control, availability of health clinics)	General intellectual atmosphere Effectiveness of school management Water quality Nature of job market

correlated with unobserved variables (such as parental involvement) that affect achievement (because, if they are so correlated, the association between good health and achievement may represent the effect of the unobserved variables).

But, because many studies (see Strauss and Thomas 1995) show that households do make choices that affect their children's health and education, the two conditions noted in the previous paragraph are not likely to be satisfied in behavioral data and may not be satisfied in many experimental studies. If a factor is unobserved (by the analyst) and both affects the child's cognitive achievement directly and is correlated with the child's health, the estimated effect is biased. Moreover, the effect may be overstated (biased upward) or understated (biased downward).

The effect may be overstated if the dominant unobserved factor is, say, a robust constitution that increases the child's learning capacity as well as his or her health status relative to that of other children. Or if it is the amount of time parents devote to the child's intellectual and physical development, or the effect of more perceptive or more effective parents who can raise better educated and healthier children. Similarly, community-specific features, such as lower school or health service fees or higher expected returns to education that encourage and reward school attainment, may bias estimates upward.

On the other hand, the effect may be understated if the dominant factor is an unobserved individual, family, or community variable that favors intellectual development over child health in certain children. For instance, some children are innately smart and others are innately healthy; some parents care about or are good at developing their children's intellectual capabilities and other parents care about or are good at raising healthy children. In some communities the costs of cognitive development are low and the expected returns are high, and in other communities the costs of good health are low and the expected returns are high. The downward bias results because child health and nutrition are negatively correlated with the factor that is unobserved by the analyst and that directly affects the child's cognitive achievement. (A more extensive discussion of these possible biases is contained in Behrman and Lavy 1994.)

Estimating the Effect of Health and Nutrition on Schooling Success

How can we learn what effect health and nutrition have on school achievement?[2] One approach is to analyze data from appropriately designed experiments. In an ideal experiment, children are randomly assigned to either a treatment group or a control group. The assignments are double-blind so that neither the children nor the administrators know which children are in which group. The group in treatment receives better health care than the control group, which receives an identical-appearing placebo. Changes in cognitive achievement are carefully measured. Such data would allow analysts to measure the impact of the treatment on cognitive achievement. But experiments are costly, maintaining appropriate experimental procedures is not easy, and some experiments are unethical or impossible—withholding food or vaccines, for example, to estimate the impact of disease or height on school attainment.

A second approach is to analyze behavioral data using statistical procedures that control for unobserved variables by purging the health and nutrition indicators of those components that are associated with unobserved variables. The usual methods for doing so, however, assume a set of observed variables, such as prices, that are not affected by the behavior that is being investigated and are not correlated with the unobserved variables. This assumption may not be valid, particularly if important variables are unobserved—such as the amount of time parents devote to their children. Many researchers in the past decade have attempted to evaluate the effect of health and nutrition on educational outcomes, but their results have been contradictory.

Studies Based on Experimental Data

Experimental studies in India and Indonesia assessing the effect of iron deficiency on children's cognitive development and school performance found that iron supplements had significant positive effects on children who were initially anemic (Soemantri, Pollitt, and Kim 1985; Soemantri 1989; Soewondo, Husaini, and Pollitt 1989; Seshadri and Gopaldas 1989). The extent to which these results are generalizable is qualified, however, because the results obtained from similar studies in Thailand and analyzed by Pollitt and others (1989) were considerably different, although the analysts point out that the studies appear to have been conducted with at least as much care as those in India and Indonesia. In the Thai studies, which included about twice as many children as the total in the seven studies on India and Indonesia, researchers found significant positive associations between iron status and both ability and cognitive achievement.[3] But they found no significant association between iron treatment and changes in ability or achievement during the study. Pollitt and his colleagues speculate that the true effect may have been obscured and identify two reasons for the apparent discrepancy. First, the control group benefited from a significant increase in iron status during the study (judging from the clinical examinations) that was about half as large as that of the treatment group. Second, even if iron supplementation helps to correct some attention disorders immediately, it does not remedy accumulated deficits in information. This sort of problem illustrates some of the difficulties of evaluating experimental research. In this case, the Thai study brings into question the results of the studies in India and Indonesia.

In two studies investigating the impact of parasitic and whipworm (*Trichuris trichiura*) infections on cognitive achievement in Natal, South Africa, Kvalsvig, Cooppan, and Connolly (1991) report their findings for 210 children (those most infected in the group of children for whom parental consent had been obtained). The first study's results were consistent with the hypothesis that parasitic infections combine with nutritional deficits to impair cognitive processes.

But in determining parasitic loads, not all the relations were significant, and the studies did not control for the age of the child. The second study attempted to overcome this problem and also used a more comprehensive drug treatment program. This study found no association between treatment and educational attainment or memory function but indicated that a poor attention span was significantly associated with parasitic infection. The authors conclude that the results are suggestive, although "not conclusive," and note problems in selecting subjects, finding culturally appropriate tests, and measuring infection. Nokes and others (1992a, b) report on another double-blind placebo-controlled clinical trial of 103 Jamaican children with moderate-to-heavy infestations of whipworm. The children were randomly assigned to treatment and control groups. On three of eight cognitive tests (related to attentiveness and memory), children in the treatment group improved significantly more than those who had received the placebo and no longer differed significantly from uninfected children in the control group. No significant difference was detected in "the more global cognitive processes resembling classroom tasks (measured by the arithmetic and listening comprehension tests)" (Nokes and others 1992b, p. 545). The investigators concluded that moderate-to-heavy whipworm infection has a detrimental and rapidly reversible effect on certain aspects of cognitive development.

Finally, researchers have gathered information on food supplementation using experimental procedures but appear to have been even less successful than researchers studying parasitic infection in following such procedures satisfactorily. Among thirty-four rural Mexican children who were followed from birth through age nine, the half who received supplementary food generally performed significantly better on school tests, were more active in the classroom, and interacted more positively with their classmates than did the control group (Chavez and Martinez 1986). This study is consistent with a positive effect of child nutrition on school performance. But no information is provided on how to evaluate the rate of return of this intervention compared with using the resources in other ways, such as providing more textbooks. Nor did researchers control for the effect of increased income that families who participated in the program received in the form of food.

In another study, food supplements were provided to a much larger group of children in four Guatemalan villages during 1969–77, and the 72 percent of that sample who could be located were checked in a 1987–88 follow-up study by the Institute for Nutrition in Central America and Panama (Martorell 1993; Pollitt and others 1993). The results indicate that those who received the nutritious supplements averaged 0.6 standard deviations higher on tests for adolescent intelligence, a result that is consistent with the evidence that early childhood nutrition has important long-run effects on cognitive achievement. But because the group receiving the supplement was not randomly selected, the results may have been compromised. For example, those parents who enrolled their children in the program may have been different from the population at large. Even without the program, they might have elected to provide a more nutritious diet for their children and to invest more in them in other ways as well. If so, the estimated associations indicate that food supplementation has a stronger effect on intelligence than it may have in actuality.

Other experimental studies included educational and social interventions in addition to dietary supplements and health care. Pollitt (1990, p. 181) summarizes these studies as having observed "robust beneficial developmental effects . . . in tests of cognitive function during the preschool period and later on school performance." Because these studies involved massive multidimensional interventions, however, it is difficult to identify the contribution of the health and nutrition components alone.

Thus these experimental studies of the impact of health and nutrition on schooling provide much less support for such effects than often is asserted. Because the results frequently are contradictory and afflicted with methodological problems, their conclusions must be qualified.

Studies Based on Socioeconomic Surveys of Behavioral Data

Using socioeconomic surveys of behavioral data that find strong positive associations between health and school achievement (table 2), the authors of these types of studies conclude that the effects are strong and important. For example, Moock and Leslie (1986, p. 49) state that their results "add to the growing evidence suggesting that efforts to improve child nutritional status may have educational benefits as well as survival and health benefits. If the economic benefits of improving nutritional status can be legitimately calculated to include the higher productivity of a more educated adult population . . . , as well as the treatment savings from a better nourished, less disease-prone child population, it may turn out that an investment in child nutrition is one of the best investments a developing country can make."

These studies indeed indicate that chronic malnutrition is negatively associated with school performance in several developing countries.[4] But without controlling for the effects of unobserved variables, the estimates may be biased, perhaps considerably.[5] Even the direction of bias is unknown. Therefore these studies provide much less persuasive evidence than is claimed by their authors and by previous surveys.

Two recent studies use the 1988–89 Ghanaian Living Standards Measurement Study data collected by the World Bank to evaluate how robust the estimates are to some of the methodological problems with such data. The first, Behrman and Lavy (1994), presents alternative estimates of the relation between health and cognitive achievement in the simple framework discussed earlier. These alternatives suggest that the estimated effect varies considerably depending on the assumptions made about the behavior that determines child development. If it is assumed, first, that child health reflects household behavioral decisions that cannot be observed (that is, genetic endowment or a learning environment), but, second, that there are no unobserved inputs to child cogni-

Table 2. *Studies Based on Socioeconomic Surveys that Report Strong Positive Associations between Child Health and Nutrition and Schooling Success*

Schooling success indicator	*Child health/nutrition indicator*	*Location*	*Source*
Enrollment rates	Height-for-age, weight-for-height[a]	Terai, Nepal	Moock and Leslie (1986)
Age-specific grade attainment	Age-standardized height, weight-for-age	Northeastern Thailand	Chutikul (1986)
Age-specific grade attainment	Height-for-age	Gansu and Jiangsu, China	Jamison (1986)
Intelligence scores	Height-for-age	Guatemala	Johnston and others (1987)
Cognitive achievement scores	Height-for-age[b]	Philippines	Florencio (1988)
Age-specific schooling	Height-for-age[c]	Bukidnon, Philippines	Bouis (1992)
Dropout rates	Visual acuity[d,e]	Cerea, Brazil	Gomes-Neto and others (1992)
On-time promotion	Visual acuity, skinfold thickness-per-age[e]	Cerea, Brazil	Gomes-Neto and others (1992)
Cognitive achievement	Skinfold thickness-per-age[e,f]	Cerea, Brazil	Gomes-Neto and others (1992)

a. But not weight-for-age nor hemoglobin counts.

b. Significant relation in about a third of the cases. Generally no significant relation with hemoglobin.

c. Significant for half of the age groups considered.

d. But no significant association with skinfold thickness-per-age.

e. But no significant associations with height-per-age or an index of vita capacity based on height, weight, and thorax circumference.

f. But no significant association with visual acuity.

tive development reflecting the choices of households (such as the allocation of parental time), the effect of health and nutrition on children's cognitive achievement is actually two to three times greater than standard measures imply. That is, under these assumptions, the usual estimates are biased downward. But if the second assumption is dropped, and procedures adopted that control for unobserved family and community factors, the findings indicate that estimates of the causal impact of health and nutrition on schooling success are substantially overstated. Therefore, what appears to be a positive impact on cognitive achievement based on the procedures used in the studies summarized in table 2 (and that appears even stronger with the usual statistical methods of dealing with behavioral choices) is apparently due to unobserved household and community factors. That is, child health and nutrition may be a fairly good indicator of cognitive achievement, but it does not seem to cause cognitive achievement.

The second study (Glewwe and Jacoby 1995) investigated how health and nutrition affect the age at which children enroll in school, after demonstrating that this decision can have a substantial impact on lifetime wealth. The results, based on a range of estimates, indicate that early childhood malnutrition (as indicated by height, given the child's age) is related to delayed enrollment. This effect is reduced substantially (by almost two-fifths), however, if the study controls for unobserved family and community variables, again suggesting that indicators of health and nutrition may serve in part as proxies for such factors.

These results thus raise considerable questions about the use of behavioral data in determining the relations between schooling and child health.[6] Further exploration of whether these results carry over to other countries and other indicators of school success would be valuable.

Conclusion

Undertaking research on the relation of health and nutrition to schooling success is difficult. As noted, the ideal technique is a well-conducted, double-blind, experimental study with random assignment to treatment and control groups. But actual experimental studies often have major limitations that may compromise the results. And although studies using socioeconomic surveys ideally would approximate good experimental practice, in fact they usually cannot control for unobserved variables, which may also bias the estimates. Even the best studies based on data collected in the context of one set of institutions can provide only limited insight into the expected impact if incentives were to change, say, due to market developments and educational reforms.

Such difficulties are pervasive in socioeconomic and policy-related research, however, and must be put in perspective. For example, summaries that point to high rates of return to schooling are plagued by the same problems. Analyses by Colclough (1982), Psacharopoulos (1994), World Bank (1993), and the United Nations Development Programme (1990) are based on studies with a wide range of results, some of which indicate no—or very small—effects. Most of these do not control for problems such as those discussed here, and those that do often report rates of return that are half or less than half those in the standard studies (see the surveys in Behrman 1990a, b, c). Recent studies for the United States, however, suggest that standard estimates may understate the effects of schooling on wages (see Behrman forthcoming for a brief survey and references). Card (1994) shows that the choice of instruments used in these estimates biases upward the estimated returns to schooling because it effectively overweights that part of the curve where the response is greatest, a point elaborated in a more general framework in Angrist, Graddy, and Imbens (1995).

Such difficulties are hardly limited to the analysis of human resource investments. Some of the basic tenets of current conventional wisdom about economic development policy, such as the advantages of uniform tariffs, are based on relatively weak empirical foundations with little control for estimation problems such as those mentioned in this article.

The point is that in most areas the empirical basis for policies is subject to a large number of qualifications. It would be desirable to obtain a firmer foundation by collecting better data (particularly longitudinal data) and subjecting the data to more careful analyses. Meanwhile, policies concerning the effects of health and nutrition on education have to be made. And although the empirical basis for such policies is not as strong as might be desired, policymakers cannot ignore what the better studies suggest, particularly since the information is as good as it is in many other areas.

For example, there seems to be some systematic evidence that iron deficiency and parasitic infections affect cognitive achievement. There also is considerable evidence about strong positive associations between health and educational achievement, although there is much more ambiguity regarding the *effects* on schooling of more general indicators of health and nutritional status.[7]

How might these effects translate into long-run productivity in the labor market? There are, to my knowledge, three studies of the impact of cognitive achievement on wage rates in developing countries that treat cognitive achievement as the outcome of behavioral choice: Boissiere, Knight, and Sabot (1985); Glewwe (1994); and Alderman and others (forthcoming). These studies suggest that health, nutrition, and education enhance cognitive achievement and increase wages—and presumably productivity.[8] The effect may be fairly substantial. For example, if the 10 percent increase in cognitive achievement (after iron supplementation) found by Soemantri, Pollitt, and Kim (1985) and Soemantri (1989) persisted, it would, on the basis of the wage rates referred to above, translate into a 13–22 percent increase in wages. The increase in cognitive achievement attributable to an increase of one standard deviation in height-for-age in the Behrman and Lavy (1994) estimates for Ghana implies a 14–34 percent increase in wages if there is no control for unobserved factors (but this effect disappears when the methodology controls for such factors). Thus, at least for the poor, the effects of improved health and nutrition on schooling success may compare favorably with the effects of many other investments. And many other positive effects have not been considered here, such as releasing resources (including the time of parents and other family members as well as health and nutrition services) that now are devoted to caring for family members in poor health.

The evidence suggests that better health and nutrition may pay off in terms of economic growth as well as equity concerns by improving the educational performance of poor people in the developing world. That productivity and equity concerns probably are in harmony is an important plus. Policymakers, therefore, should seriously consider how various policies affect child health and nutrition and identify those policy changes that would improve it. Productivity and equity concerns naturally raise another question. Who has the comparative advantage in these areas—governments or individuals, families, and other private entities? Just because education or manufacturing or health has positive productivity effects does not mean that the government should provide or subsidize such activities. But from an efficiency point of view, one area in which the government is likely to have a potentially important role is in collecting and disseminating information about the benefits and sources of better nutrition. Private entities are unlikely to collect and disseminate such information because of its "public good" characteristics. (That is, one person's access to information on malaria control, say, does not leave that information less available for others.) And the development of reliable information is difficult and expensive. Much of what previous surveys claim is "known" and "supported" by the literature, upon further examination does *not* distinguish persuasively between association and causality. But careful studies can provide useful information on the possible effects of health and nutrition on education. There also are allegedly important externalities to knowledge acquired in schools. If these externalities in fact are important—a matter on which there is some controversy—the empirical evidence is as strong for subsidizing child health and nutrition among poor populations as for subsidizing teachers' salaries or textbooks.

Leaving aside information issues and related policies, improving the health and nutrition of poor children can be an efficient way to improve school attendance and enhance economic growth. This is the case not simply because more learning translates into long-run productivity, but because the private incentives, particularly for the poor, are to invest less in child health and nutrition than would be socially desirable from a pure efficiency perspective for human capital investments. The difference in private and social incentives for investing in child health and nutrition is likely to be much larger for the poor both because gains from positive externalities are likely to be concentrated among the poor and because imperfect capital markets that result in weaker private than social incentives for human resource investments are likely to be important constraints primarily for the poor.

Perhaps the commonsense observation that poor health adversely affects children's schooling is right. Perhaps it is sensible to design policies based on that belief even if there is considerable uncertainty about the dimensions of such effects. But policymakers are likely to make better policy decisions if they are sensitive to the possible problems of interpreting results that do not take unobservable characteristics into account. Furthermore, by generating and disseminating information on these interactions, countries will benefit from considerable social gains arising from improved policies.

Notes

Jere R. Behrman is William R. Kenan, Jr., Professor of Economics at the University of Pennsylvania. This article was originally prepared as a paper for the World Bank Workshop on Social Service Delivery, held on May 18, 1994. The author would like to thank Harold Alderman, Nancy Birdsall, Anil Deolalikar, Andrew Foster, Paul Glewwe, Erik Hanushek, Kenneth Hill, Estelle James, Dean Jamison, Elizabeth King, Victor Lavy, Philip Musgrove, John Newman, Mark Pitt, Robert Pollak, Mark Rosenzweig, John Strauss, Duncan Thomas, and Paul Taubman. The author alone, and not the World Bank, is responsible for the contents of this paper.

1. These surveys all are based primarily on a common set of studies.

2. This summary draws in part on Behrman (1993), which also reviews some older studies. There also are studies on industrial economies that fall into similar general patterns as the studies reviewed here (see, for example, Miller and Korenman 1993).

3. In this double-blind clinical trial to assess the impact of iron treatment on the IQ and educational attainment of 1,358 children ages nine to eleven, treatment involved taking either an iron tablet or a placebo tablet in school. Children were randomly assigned to the iron and the placebo groups. Before and after a sixteen-week course of treatment, Raven Progressive Matrices tests were administered to measure ability, and Thai language and mathematic tests were administered to measure achievement.

4. Chronic malnutrition is indicated by low height-for-age and poor visual acuity. Transitory malnutrition is indicated by weight-for-height and weight-for-age.

5. Several of these studies also have other estimation problems that make interpretation difficult. For example, most of them use school samples but do not control for selectivity regarding which children attend school, although Chutikul (1986), Bouis (1992), and Johnston and others (1987) use all the children in a household-based sample rather than school-based samples, so they probably do not have this selectivity problem.

6. Although these studies attempt to ascertain the robustness of their results to alternative assumptions, they, too, have limitations. The controls for unobserved family and community factors that use data on families with multiple children may exacerbate estimation biases toward zero because of measurement error, although the first study attempts to explore this possibility. These methods do not, moreover, control for unobserved individual factors. The second study assumes, further, that how the child is treated before age six affects school readiness through the child's health but not through cognitive development, which seems counter to the beliefs of many researchers.

7. The surveys noted in the introduction, in contrast, do not seem very sensitive to these ambiguities. Note, for example, that Leslie and Jamison (1990, p. 197), writing about anemia, seem to ignore some of the puzzles raised in the studies noted here, including those on Thailand, Nepal, and the Philippines. Their claim about the effects of protein-energy malnutrition completely ignores the problems of using behavioral data to determine the causal effects of health and nutrition on schooling.

8. The cognitive achievement-wage rate studies summarized here are sensitive to estimation issues and have attempted to explore how robust these estimates are and to control for them.

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