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Earnings and the Elusive Dividends of Health

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Abstract

This paper looks at the relationship between health and income. After discussing the general context of health improvements in Latin America during the last few decades, the study elaborates on the interrelationships between the physical and social determinants of health, the complexities that arise in attributing earnings differentials to variations in health status, and the difficulties of accurately measuring health status. The paper presents a methodology for estimating the impact of health on earnings that addresses problems of measurement error and endogeneity, then summarizes the main findings of related studies undertaken as part of a larger project. These studies show that health status does have a significant, although modest, impact on earnings in four Latin American countries. Furthermore, environmental conditions (such as housing and sanitation) appear to have significant impacts on health status, compared to health services and public health facilities, which show little influence. The universally strong relationship between education and earnings is only modestly reduced by the inclusion of health status despite a general expectation that estimated returns to education were, in part, capturing the frequently unmeasured effects of health. By analyzing these relationships together–health determinants and the impact of health on earnings–we can assess the magnitude and importance of the "human capital" component of health status, validate and compare a range of health indicators, and identify promising areas for public policy to invest in health improvements

Introduction

Common sense tells us that healthier people are more productive and that wealthier people can obtain goods and services and shape their environments in ways that make them healthier. The magnitude of these causal relationships, however, is largely unknown. Quantifying how health affects productivity and how wealth affects health is a starting point for understanding the role of health as a form of "human capital"–that is, as a characteristic of individuals, like education, that can be increased and improved through investing time and resources. In turn, understanding this aspect of human capital is critical for evaluating the role public policy plays in encouraging households, private firms, and public sector institutions to make efficient investments in health.

Developing this understanding means grappling with several difficult questions. What constitutes an "investment" in health? How is "health" to be measured? How does health affect productivity and, in turn, yield higher earnings? Is health a statistically significant and relatively substantial factor in determining the earnings capacity? Or is health largely a "consumption" good for which demand increases as incomes rise?

Answering these questions entails examining health investments, health outcomes, and labor productivity. This paper surveys a recent group of studies, based on household surveys in Latin America, which use a common framework to analyze these factors in several countries, and shows how improvements in data and analysis might advance our understanding of their interrelationships and lead to improved policy choices. These papers examine health indicators obtained from household surveys in Latin America.

Taken together, they shed light on which indicators of personal health are most informative, how health varies across populations by differences in age, sex, education, and region of residence, and how these health indicators are meaningfully related to wages or labor earnings per hour worked.

This research agenda involves complex quantitative and qualitative issues. On the one hand, statistical inference must be used to interpret individual indicators of health that are measured with considerable error and that are possibly associated with other unobserved factors that affect wages, such as biological, psychological, and economic endowments and motivations. On the other hand, there are fundamental questions about the nature and purposes of health that economists may feel uncomfortable in answering. Should health be improved only to increase personal market incomes? Surely not. But to the extent that measurements of health can be linked with higher wages, then a statistically valid way will have been found to connect health policy choices to improved health, increased income, and perhaps reduced poverty and economic inequality. Increasing income opportunities is one way to generate sustainable advances in well-being, but other benefits of improved health should also be assessed and included in any global evaluation of policy options.

Good Health Despite Relatively Slow Growth

A population's health is arguably one of the best indicators of its level of "development." This premise is a basic element in efforts to find measures of development other than those based on per capita income–whether it be the UNDP's Human Development Indicator (which includes life expectancy) or the call by Sen (1998) for measuring human "capabilities" that include health status.

For Latin America, the use of income to measure progress leads to the conclusion that the region has developed relatively slowly. Latin America has lagged behind world performance in income growth during the last few decades–and performed poorly compared to the rapidly growing nations of East Asia. Even when the yardstick shifts to measuring progress through human capital investments in educational attainments, Latin America performs well below the international pattern. In fact, the gap in educational progress between Latin America and other regions appears to be growing.

By contrast, using health as a measure of progress would suggest that Latin America has developed quite fast. In fact, Latin America's health status has improved remarkably during recent decades. The process of increasing life expectancy that took as much as 150 years to accomplish in many European countries has swept much of Latin America in less than fifty years. Average Life Expectancy in Latin America was only 58 years in 1962 and stands at just over 70 years in the mid-1990s. Life expectancy increased largely due to reduced mortality rates among children and those over 45. Infant mortality declined from almost 100 per 1,000 live births in the early 1960s to less than 30 in 1995. Currently 11 out of 22 Latin American countries report Infant Mortality rates below 30 per 1,000 live births. Life expectancy in Latin America is almost 10 percent below the rates enjoyed by the more developed OECD countries, but, after controlling for differences in income, the gap disappears.[1]

It is important to qualify these gains in several ways. Most importantly, these rates are national averages and do not necessarily reflect comparable gains in all population groups–whether by sex, region, or ethnic group. In general, health outcomes are significantly worse in rural areas and appear to be worse among lower income groups as well.[2] The infant mortality rate in Peru is almost five times higher in the poorest than the uppermost quintile. Inequalities have also been documented in Guatemala, where neonatal mortality per 1,000 live births is only 18 in urban areas, compared to 29 in rural areas and 32 among the indigenous population.[3]

Despite these qualifications, great strides have been made and this progress can be attributed to many different factors. Some people credit *public health policy*–particularly the provision of

[1] These are the findings by Piras and Savedoff (1999), based on a cross-country sample of 151 countries and using control variables that include income, availability of doctors, nurses, and hospital beds, sanitation and potable water, geographic variables, and average caloric intake. A variety of specifications were used, and as long as income was included, the regression would explain most of Latin America's "advantage" in life expectancy.
[2] See *Health Systems Inequalities and Poverty in Latin America and the Caribbean*, PAHO/UNDP/World Bank Equilac/IHEP Project, forthcoming.
[3] For data on Peru and Guatemala, see *Health Systems Inequalities and Poverty in Latin America and the Caribbean*, PAHO/UNDP/World Bank Equilac/IHEP Project, forthcoming.

sanitary infrastructure, potable water, and immunization campaigns against infectious diseases such as smallpox. Others point to *rising income levels* that allow individuals and families to raise dietary intake and quality and obtain adequate shelter and clothing. Another line of reasoning emphasizes the expansion of *personal medical services*, particularly publicly financed social security and publicly dispensed medical care targeted at the middle classes and the poor. Finally there are those who focus on other *social and cultural transformations* associated with changes in work, urbanization, status inequality, mobility, education, and the environment.

All of these factors do appear to contribute to improvements in health conditions, but the relationships are not always strong. Much of the worldwide decline in mortality rates preceded the introduction of public health initiatives–and many of these were inadequately applied in Latin America. Although income is closely related to rising health status, the region has experienced entire decades of economic crisis (like the 1980s) without seeing a reversal in trend, or even a clear slowdown in the decline of mortality rates. By some measures, notably child and infant mortality, the region may not fare quite as well once adjustments are made for its income level (Piras and Savedoff, 1999). Indeed, some studies claim that income is itself the key factor in explaining the differences in health conditions among countries–which, in some ways, would reinstate income as a valid cross-country measure of welfare and a proxy for health (Pritchett and Summers, 1996).

Personal medical services have clearly expanded since the 1950s, but they account for little, if any, of the health improvement detected. Even social trends such as status inequality, mobility, and urbanization would appear to put Latin America at a significant disadvantage compared with the rest of the world, yet the region performs close to the international average.[4] Some have noted that the one exception among these trends is that Latin America has invested relatively more in girls' schooling than have other developing regions. Since women's educational attainment is strongly correlated with reduced child and adult mortality rates, this may be a powerful factor in accounting for the continued health improvement in Latin America despite income growth stagnation and a slowing pace of average educational improvements during the 1980s (Schultz, 1995a).

Understanding Latin America's performance in health status is very difficult because the determinants of health are not well documented. This is partly due to problems in collecting data on health conditions and partly due to lack of agreement about which health indicators are most accurate and useful for analytical purposes. One rarely used way to evaluate health indicators is to test them against other observable effects of health status. The studies surveyed in this paper take advantage of extensive data on individual earnings to see if it is possible to document relationships between health status (measured imperfectly by several different indicators) and earnings. Because we believe that healthier people are likely to be more productive and therefore, on average, better remunerated in their employment, it should be possible to validate or qualify the various yardsticks for health.

Additionally, this approach may offer insight into the indirect benefits of health. In a sense, it tells us how much health is "worth" in the market. Although this does not change our fundamental interest in improving health conditions, regardless of market valuation, it does provide more knowledge about health's impact on other aspects of individual and social life.

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4 For a recent discussion of Latin America's high levels of inequality, see Inter-American Development Bank (1998).

Understanding Health as a Form of "Human Capital"

The notion of "human capital" emerged in the economic literature in the 1960s as recognition grew that many improvements in human capacities are due to investments of time and resources. This concept led to the development of theories and testable hypotheses to better understand choices made by individuals and their families regarding education, labor force participation, health, fertility, and many other aspects of behavior. The concept of human capital does not imply that genetic, cultural, ethnic, or social factors do not influence behaviors. Rather, it introduces a way of understanding an additional dimension of human capacities by drawing attention to those elements of our capacities that we, as individuals, can influence through our choices and behavior. The key aspects of human capital are that the investments involved affect human capacities over a reasonably long time frame and that people make choices regarding these investments in relation to the expected future returns of those "investments," among other things.

In the specific case of health, two questions arise. First, what is the effect of a change in health status on the productive capabilities of an individual? Second, what individual, family, and community characteristics effect changes in health status? Answering the latter question, in particular, requires focusing primarily on characteristics that are malleable. This focus has two sources: the need to know which policies can improve health, and awareness that it is impossible to properly measure the impact of health on earnings without recognizing that individuals make choices about health investments based on their expectations of how health affects their life opportunities. With answers to these two questions, it becomes possible to assess the resource costs of modifying those conditions that will improve health, and to calculate the internal rate of return on those outlays as a human capital investment.

To evaluate the returns to health human capital involves many of the same problems that have occupied economists for some time in estimating the returns to schooling. There are, however, a few added complications. First, there is no immediately obvious metric for individual health status. By contrast, there is some agreement that "years of schooling completed by a worker" is a reasonable first approximation for the physical units of education, although the equivalence may be further refined to include various qualitative dimensions of the education being measured (Becker, 1964; Mincer, 1974). There is no comparable consensus about how one can measure the stock of health as human capital. For an aggregate population for which age-specific mortality can be estimated, "life expectancy at birth" (or from some other age) has the appeal of a demographic summary measure of expected survival. Such a measure can also be refined by other qualitative aspects of life that people value, such as the timespan that is disability-free. However, there is no comparable summary measure at the individual level for attributing to a given person an "expected lifetime."

The second complication, measurement error, is shared with schooling, but it may be more serious in the case of health. If there is little consensus on how to measure individual health status, and most measures considered involve self-reporting by a survey respondent, it seems likely that the range of error in recording a truly latent variable will be more substantial for health status than for completed years of schooling.

The third complication is the difficulty of assigning weights to the inherited, environmental, and behavioral factors that affect health outcomes. Health human capital (H) can be considered as an outcome of an individual's genetic endowment (Hg), and his or her behaviorally and environmentally determined accumulation of health (Hb). Difficulties arise because the two sources of variation are not only determined by different factors, they may also exert different effects on labor productivity. The productive benefit of the socially accumulated Hb is usually the more relevant variable in evaluating policy interventions to improve health.[5] If the stock of educational capital were measured not by school years completed but by achievement tests, then the same dichotomy between genetic potential and acquired abilities would arise and make it necessary to decompose the effects. The fact that years of education has become a commonly accepted measure of human capital is due to the regularly observed correlation it has with earnings, although educators continue to grapple with finding measurements to differentiate the effectiveness of various forms of pedagogy in terms of their "learning outcomes."

In sum, health presents serious problems for measurement at the individual level through surveys. It presents more serious problems for analysis because of measurement error. Finally, for the purposes of both policy and analysis, it needs to be decomposed explicitly into two functionally different components of health capital: a genetic endowment and a socially acquired set of assets and liabilities.

What insights can be gleaned from the literature on health economics? First, it has been emphasized that the health heterogeneity of individuals can bias direct estimation of health production functions (*h*) that seek to characterize the technological relationship between health inputs (*I*) and health outcomes (*H*) and residual variation (e_1) (Rosenzweig and Schultz, 1983). It is reasonable to expect that individuals, their families, and perhaps their medical advisors will know more about the severity of illness or the frailty of the individual (*g*) than does the social analyst trying to account for health outcomes. The health production function can thus be described, where *g* and e_1 are unobserved:

$$H = h\,(I, g, e_1\,). \qquad [1]$$

Consequently, the demand for medical care and other health-related inputs (*I*) may be modified through a function (d) that has the following elements: the private knowledge of the individual, family, and medical system (*g*); other demand-limiting factors (*X*), such as health input prices, household income, etc.; and another error, or residual, variation (e_2):

$$I = d\,(X, g, e_2\,). \qquad [2]$$

For example, individuals who are ill will seek out medical care, introducing a negative partial correlation in function (h) between demand for curative health inputs (I) and good health (H), rather than the positive correlation that is expected because people who receive preventive care are less likely to be ill. If the unobserved part of an individual's initial health heterogeneity is subsumed in the

[5] We set aside here the question of technologies that may be available to modify genetic potential. Nor do we consider public policies that promote eugenics, or selective reproduction–most notoriously in nationalistic programs that seek so-called "racial purity."

error in the health production function, this error is likely to be correlated with the observed use of health inputs, imparting an omitted variable (or simultaneous equation) bias to the health production function when the latter is estimated by single-equation methods such as Ordinary Least Squares (OLS).

A solution to this health heterogeneity problem is to treat the health inputs as endogenous, or behaviorally controlled, and employ instrumental variables (*X*), such as the local variation in prices or access to health inputs, as natural instrumental variables to predict health input demands. One can then estimate without bias the health production function by two-stage methods (Rosenzweig and Schultz, 1983). Assuming that the input prices and access are not correlated with individual health heterogeneity, and that the price and access variables explain a statistically significant share of the variation in input demand, these instrumental variable estimates of the health production technology are consistent and have desirable properties (Bound *et al*., 1995).

In trying to evaluate how health human capital affects wages or labor productivity, an analogous problem arises. Assume that outcomes of health human capital can be decomposed into two components: *Hb,* which is explained by the technological effect of socially controlled inputs responding to exogenous constraints (*X*), and a remainder (*Hg*) that subsumes genetic heterogeneity, differences in preferences, other unexplained factors, and specification and stochastic errors from both the production and input demand equations (Schultz, 1996):

$$H = Hb\ (X) + Hg\ (g, e_1 , e_2). \qquad [3]$$

Only the first component can be viewed as a form of reproducible human capital, derived from predicting the health outcome from the fitted reduced form for health that embodies both the health production function and the health input demand equations. If the goal is to evaluate how this overall health human capital affects productivity, it is necessary to predict from the reduced-form health function, and use only this predicted health component in the wage equation as a human capital variable that is uncorrelated with health heterogeneity. Following the health production function literature, the appropriate instruments for predicting the human capital component in the health outcome would include variables such as the local price of health inputs and access to health care for individuals, and the presence of community institutions/investments that affect exposure to disease and adequacy of treatment when ill. It is also arguable that household or family wealth will increase the individual's receipt of health inputs and care, and thus contribute to health human capital (Schultz and Tansel, 1997).

The studies surveyed in this paper extract from available data sources certain instruments on which to base prediction of the behaviorally controlled variation in health human capital. Just as social scientists perennially struggle to decompose variation in achievement due to nature (genetics) and nurture (human capital), this paper offers no entirely satisfactory method for resolving the riddle. In all the studies, some genetic variation in health will be correlated with household income, price, and community variables and thus be embedded in the predicted health outcome. Thus the instrumental variable estimates of the effect of health capital on wages will contain some unavoidable portion of the genetic health effect, in addition to the socially induced variation in health related to the individual and community instrumental variables.[6]

Labor productivity, approximated by the hourly wage rate, is then fitted to variation in individual human capital stocks, where health human capital (*Hb*) is only the variation in health status that is accounted for by the instrumental variable, and hence uncorrelated with e_1 and e_2, which is desirable because these production and demand errors are likely to be correlated with e_3 due to omitted variables in the wage function and other sources of simultaneous equation bias:

$$W = w\,(\,Hb(X), E, Z, e_3\,). \qquad [4]$$

In this equation, *W* is the logarithm of the hourly wage rate; *w* is the wage function; E is education; *Z* represents other observed factors affecting the wage that are not behaviorally determined; and e_3 is the error in the wage equation.

This instrumental variable approach to estimating the effect of health human capital on the wage function has the additional benefit of correcting for the measurement error in the health indicators, a problem that is potentially more serious in the case of health than education.[7] The empirical specification of this model for estimating the effects of health human capital on productivity involves the choice of the health indicator variable (*H*), the specification of the instrumental variables (*X*) that account for the health indicator but are not otherwise related to the wage rate or other household choice variables, and the additional control variables (*Z*) included in the wage equation. Some studies are based on surveys that provide information on community characteristics that are candidates for inclusion in *X* or *Z*. Most household surveys ask respondents their municipality or place of residence. Thus sample clusters can be aggregated from individual responses to other questions so as to draw conclusions about specific community characteristics such as the average distance from a household to the nearest clinic for all observations in the sample, whether they have reported using those services or not. In other instances, government records on the climate, geography, and infrastructure of each sample cluster community can be merged with results from the individual survey respondents who reside there to provide additional contextual information that may be relevant for local health and labor markets. This estimation approach presumes that place of residence is not related to average health heterogeneity, to individual preferences that affect their health, to migration decisions, to the location of health and other service

[6]Hausman (1978) specification tests could be performed to determine whether the health human capital variable appears to be exogenous (or endogenous) in the wage function, which is analogous to testing whether the human capital and residual health components have statistically the same coefficient in the wage equation. Endogeneity of the health human capital variable in the wage equation would be confirmed if the behavioral and genetic/residual components of the health human capital variable received significantly different coefficients in the wage equation. These tests are likely to differ not only as the choice of instruments varies but also as the indicators of health are changed. In some health measures, such as height, the genetic component appears to account for most of the variable's variation, whereas self-reported categorical or disability measures of health are more readily explained by individual/family/community instrumental variables.

[7] However if the measurement error in health is not of the classical form, that is uncorrelated with other explanatory variables in the wage function, then the estimation problem may not be completely resolved by this instrumental variable estimation strategy.

infrastructure, and other relevant individual or community choices and actions (Rosenzweig and Wolpin, 1986; Schultz, 1988).

The sample of wage earners is also interpreted as being representative of all people who could make investments in health, education, etc. In reality, the subsample of wage earners may be selected for characteristics that are related to the unexplained variation in health and wages. Where possible, the studies assess whether standard methods for dealing with sample selection bias shed any light on this potential problem, and it fortunately appears in these cases not to be a serious source of bias. To implement these methods, however, it is generally necessary to specify some exclusion restriction that implies certain variables significantly affect who is selected into the sample of wage earners, but this selection variable should not affect the wages they are offered. This identifying variable, which is excluded from the wage function, presumably affects only the reservation wage or the value of time in activities other than wage employment. It is also generally assumed that the sample selection equation has a specific functional form, such as the standard normally distributed error which can be modeled as a Probit and estimated jointly with the wage equation by maximum likelihood methods.

Study Findings

The main finding of these studies on health and productivity is that healthier people receive higher wages. Though the effect of health on wages varies in magnitude depending on the health measure used in the analysis, it is generally significant when estimated by instrumental variable methods, even after controlling for selected individual and community characteristics and for some job attributes as well. The studies provide evidence that public health services and community conditions, as well as private health inputs and reduced exposure to disease, are associated positively with the health of adults and also with greater individual income-generating capacity. It demonstrates that, as elusive as it may appear, we do have measures that can represent the human capital dimension of health.

Distinguishing Ways to Measure Health

What does "good health" mean? The term is decidedly relative, depending on the era in which the question is asked and the society that frames the question. Sometimes the definition is so nebulous it is little more than a dimly defined perception of potential fitness. Often it seems best to fit health into that singular category of abstract concepts that are impossible to measure but about which one can say, "I know it when I see it." Unfortunately our poor understanding of what determines health and its effects is, in large part, a direct consequence of difficulties in measuring both. As previously discussed, no consensus singles out one variable that best aggregates the diverse dimensions of health in a feasible indicator at the individual level. There is nothing that could function for health in the same way "completed years of schooling" serves as a proxy for a range of educational outcomes in the fields of labor and education studies.

Measures of health status can be broadly divided into four categories: relative assessment of health status, self-reported morbidity, functional limitations, and health and nutritional outcomes. These indicators can be derived from surveys in which respondents are asked to rank themselves relative to some ideal sense of "good health" or relative to others in their community, or asked about specific symptoms, the number of days ill in some reference period, functional limitations, height, or weight. Observed measures range from the official registration of mortality and formal epidemiological surveillance data, to surveys in which individuals are tested for vital signs, symptoms, functional limitations, or size (height and body mass).[8] Tables 1 and 2 provide an overview of the case studies that follow and summarize the health indicators that they use.

In studies that use self-assessment indicators, respondents are asked to compare their health to others in society or in their age group. This measure has two main problems. First, there is no clear benchmark of similar health for others or for the respondent's age group. Thus the respondent may rely on knowledge of the health status of other persons in his/her neighborhood or socioeconomic class, rather than apply a common standard embracing the entire survey population. Second, any self-reported health status could reflect experiential conditioning and perceptions that are potentially correlated with socioeconomic behaviors and outcomes, rather than quantify only the individual's actual condition. Nonetheless these general indicators of health status have been shown to be significantly related to subsequent morbidity and mortality of the individual, and have been used in evaluating the National Health Experiment in the United States (Manning, 1982).

[8] For discussion of alternative measures see Murray, *et al*. (1992) regarding adult mortality in developing countries.

Table 1 **Summary of Case Studies**					
Author	Country	Year	Survey	Sample Coverage	Health Variable(s)
Knaul	Mexico	1995	ENPF	Women Age 15–54	Age at Menarche
Parker	Mexico	1994	ENMV	Age 60–79	Disabled, Disabled Days, Self-Reported Relative Health Status, Functional Limitations
Ribero and Nuñez	Colombia	1993	CASEN	Age 18–70	Disabled, Days Disabled
Ribero and Nuñez	Colombia	1991	ENH	Urban Age 18–60	Adult Height
Murrugarra and Valdivia	Peru	1994	PLSMS	Urban Age 16–60	Ill and Days Ill
Cortez	Peru	1995	ENAHO	Age 18–70	Ill and Days Ill
Espinosa and Fernandez	Nicaragua	1993	ENV	Age 18–65	Ill and Days Ill

Table 2 **Summary of the Main Health Status Variables Used in the Case Studies**		
Country (Year)	Variable	Definition
Mexico (1995)	Age at Menarche	Age (year and month) of first menstruation
Mexico (1994)	ADL	The sum (from 0 to 4) of being able to carry out basic activities (walking up stairs, walking more than 30 m, carrying a heavy object, and doing light domestic tasks)
Mexico (1994)	Disability	A binary variable distinguishing people who reported being sick, injured, or hospitalized in the previous 180 days
Mexico (1994)	Self-Reported Health Status	Ordinal indicators (on scale of 1 to 5) in response to questions regarding the respondent's own health, and own health compared to others of a similar age
Colombia (1991)	Height	Adult height in measured in centimeters
Colombia (1993)	Disability	Individuals who due to illness or injury were unable to work at some time during the month before the survey
Peru (1994)	Days Ill	Number of days of reported illness or injury (including those not necessarily severe enough to miss a workday) during the four weeks prior to the survey
Peru (1995)	Days Ill	Number of days of reported illness (including those not necessarily severe enough to miss a workday) during the 15 days prior to the survey
Nicaragua (1993)	Days Ill	Number of days of reported illness or injury (including those not necessarily severe enough to miss a workday) in the month prior to the survey.

Note: For more details, see the specific study cited.

The second group of indicators is based on asking respondents about illnesses or disability in some retrospective period (which can range from 14 days to 180 days, depending on the survey). These questions sometimes simply ask whether or not the respondent was ill or injured. Sometimes the survey probes further, asking about the number of days ill or whether the person was sufficiently ill to be disabled (i.e., unable to engage in his/her regular activity) during the reference period. Questions of this nature are included in many labor force and household general surveys and have not been subjected to much analysis as an indicator of acute or chronic health status, perhaps because they are viewed as subjective. It has been hypothesized that reports of days lost to disability among wage earners may be a more reliable indicator of health because the illness must be sufficiently severe to forego wage-earning activities, setting a threshold from which to infer the severity of the illness (Schultz and Tansel, 1997).

This kind of self-reported statement regarding whether or not the respondent was ill in recent weeks was the most common indicator used in the case studies. This includes the living standard measurement surveys in Peru for 1994 (Murrugarra and Valdivia, 1999) and Nicaragua for 1993 (Espinosa and Fernandez, 1999), the 1993 CASEN survey in Colombia (Ribero and Nuñez, 1999), and the 1995 National Household Survey (ENAHO) in Peru (Cortez, 1999). In Mexico (Parker, 1999), using the 1994 National Mexican Aging Survey**,** these questions were also asked, but only the dichotomous part of the question was used and the recall period was significantly longer (180 days). By contrast, the ENAHO survey in Peru uses a recall period of only two weeks. The Colombian study focused on days disabled (i.e., that the individual was unable to go to work). In Ghana and Cote D=Ivoire, similar studies have used comparable indicators of Days Ill or Days Disabled (Schultz, 1996; Schultz and Tansel, 1997). As discussed in detail below, the number of people who respond that they were unable to work due to illness is generally one-half to one-third as many as those who report having been ill.

This indicator is not perfect. It is subject to recall error, and the definition of what it means to be ill may vary culturally and according to personal disposition. But it is no accident that this indicator is favored by studies investigating the relationship between health and income. The evidence necessary to link health and income is difficult to find because health surveys, rich in health indicators, rarely collect data on income or wealth; while labor and household surveys rarely collect more than a few health-related indicators. Self-reported days of illness are fairly easy to incorporate in the labor and household surveys, and so these have become the *de facto* choice of health indicator for these kinds of studies.[9]

The number of days ill appears to be a reasonable measure of poor health. It varies systematically with age, gender, income, and education. Individuals who were older, less educated, and poorer generally reported more incidents and days of illness in these studies (see Tables 3, 4, and 5). In general, more women reported being ill in the four weeks prior to the survey than did men; but of those who reported illnesses, women tended to report fewer days of illness than did men. Most of the studies noted how skewed this measure was—large shares of the population report no illness

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[9] When researchers want to use data sets that are richer in health indicators to look at socioeconomic interrelationships, they are reduced to using imperfect proxies such as occupations (e.g., Davey Smith, *et al*., 1990) or place of residence (Phillimore, *et al*., 1994), or to constructing wealth indicators from other variables using DHS (Bonilla-Chacin and Hammer, 1999; and Montgomery, *et al*., 1997).

at all, making it difficult to distinguish degrees of health status among them. For illnesses lasting more than three or four days, there is a "lumping" of answers around discrete numbers of weeks. And finally, there is a truncation at 30 days, which in some cases is quite significant. Cortez deals with these problems by using a transformation of the Days Ill variable ($H=1/(1+D)$) that varies from 1 for those who report no days of illness, and approaches 0 as D approaches infinity.[10] Murrugarra and Valdivia address the problem of truncation by using a two-limit Tobit model to extract the predicted latent health variable. Schultz and Tansel (1997) fit a quadratic approximation to the number of days disabled.

Table 3
Morbidity Indicators by Sex and Age
(percentage ill at any time during reference period)

	Colombia (1993)	Peru (1995)	Peru (1994)	Nicaragua (1993)
Period	Prior month	Prior 15 days	Prior 4 weeks	Prior month
Disability	Unable to Work	Ill	Ill or Accident	Ill or Accident
Age groups				
Men				
18–24	5.0	17.7	17.0	12.8
25–34	5.2	20.1	22.0	18.6
35–44	5.9	22.7	26.0	20.9
45–59	7.0	28.4	30.0	28.3
60–70	12.1	37.9	35.0	36.7
Total	6.2	23.2	29.0	20.2
Women				
18–24	6.2	21.5	22.0	14.7
25–34	6.1	27.3	26.0	20.6
35–44	7.6	32.3	31.0	27.4
45–59	7.9	38.8	41.0	33.9
60–70	9.8	47.7	42.0	43.1
Total	7.0	30.8	32.0	24.1

[10] Of course, since the question asks only about the last 30 days, the minimum value for H is 0.034. The transformation is only an approximation to the problem of truncation bias since the respondent does not indicate when the illness started (it could have been earlier) nor whether the illness is continuing at the time of the survey.

Table 4 Morbidity Indicators by Sex and Education (percentage ill at any time during reference period)			
	Colombia (1993)	Peru (1994)	Nicaragua (1993)
Period	Prior month	Prior 4 weeks	Prior month
Disability	Unable to Work	Ill or Accident	Ill or Accident
Education			
Men			
0 years	8.0	37.0	n.a.
1–6 years	6.5	32.0	38.8
7–12 years	6.1	20.0	19.6
+ 13 years	2.4	20.0	17.7
Total	6.2	24.0	33.3
Women			
0 years	9.1	42.0	-
1–6 years	7.6	36.0	43.1
7–12 years	6.2	24.0	22.6
+ 13 years	6.6	25.0	19.1
Total	7.0	30.0	35.8

Table 5 Morbidity by Quintiles of Individual Hourly Earnings (percentage ill at any time during reference period)		
	Colombia (1993)	Peru (1995)
Period	Prior month	Prior 15 days
Disability	Unable to Work	Ill
Income Quintile		
Men		
1	4.6	29.0
2	5.2	21.4
3	4.9	20.4
4	5.6	21.4
5	4.7	19.3
Women		
1	6.4	35.1
2	8.4	29.5
3	7.7	28.0
4	5.6	25.7
5	6.8	28.3

Note: Quintiles are arranged from the poorest (1) to the richest (5).

The days-ill variable tended to be correlated with other health measures. In general, the higher threshold implied by whether the respondent was able to work reduces the number of reported events to between one-half and one-third of those reporting any illness. Murrugarra and Valdivia in Peru found that approximately 28 percent of the sample reported being ill, but only 10 percent reported being disabled. Ribero and Nuñez in Colombia found that about 15 percent reported being ill, but only a little more than 6 percent reported being disabled. It is interesting to note that, in this latter case, men reported being ill less than women (13 percent versus 18 percent), but a higher portion of men than women who reported being ill were unable to work (47 percent versus 37 percent). Schultz and Tansel (1997) also find that disability was reported about half as much as illness in two West African countries. Ribero and Nuñez also estimated the effect of both Days Ill and Days Disabled on earnings and found that they yield similar results. For elderly Mexicans, Parker calculates that disabled days are significantly correlated with the number of functional limitations, and inversely correlated with questions about the respondent's health status relative to others their own age.

A third group of health indicators is related to functional limitations that the individual experiences in Activities of Daily Living (ADLs). These indicators can be tabulated by observation, or through self-reported answers to specific questions. In contrast to self-reported general health status, or incidences of illness or days disabled, the number of functional limitations appears to be more concrete and less subjective, and the focused form of the questions even permits the interviewer to validate partially the response. It is argued, therefore, that health indicators based on functional limitations in performing daily tasks tend to be less correlated with socioeconomic endowments, conditioning factors, and perceptions, and are thus less likely to be biased by subjective factors (Strauss *et al*., 1995). ADLs appear to represent an adequate continuum of health states among the elderly, for whom physical limitations on everyday activities are commonplace, and have been shown to replicate clinical health status reliably in high-income populations (Stewart and Ware, 1992). How well indicators of functional limitations differentiate health status among the nonelderly is more uncertain because of infrequent incidence in most younger populations. Yet ADLs remain promising health status indicators because they can be readily collected in surveys while reducing the subjective bias that dilutes other measures of adult health status.

In the study by Parker, the number of ADLs that can be performed with difficulty or cannot be performed at all was derived from responses to questions related to the respondent's ability to walk upstairs, walk 300 meters, carry a heavy object, and engage in light domestic tasks. Parker validates this measure against self-assessed health measures and demonstrates that it is a significant determinant of earnings after controlling for other factors.

The final category of indicators includes measures of health and nutrition outcomes. Such outcomes as "height" and "age at menarche" result from a complex accumulation of nutritional inputs and health care, offset by exposure to infectious disease, and modified by the burden of work activities that combine to influence human physical growth (Faulkner and Tanner, 1986; Fogel, 1994). Nutrition and a healthy environment appear to be critical in the rate of uterine and early childhood development, while conditions in adolescence may further modify the outcome when physical growth briefly accelerates during puberty. Adult height is an indicator that is commonly used to measure those aspects of childhood nutritional and health status that have lifetime consequences on an individual's health and physical and mental capacities (Fogel, 1994; Thomas and Strauss, 1997). Age at menarche is another indicator of physical growth that is affected by improvements in nutrition and health, but it has never been studied previously as an indicator of health human capital. Although these health outcome indicators are thought to reflect childhood conditions, they have also been linked to acute and chronic health problems among adults and to levels of physical functioning among the elderly (Costa, 1996).

In their study of Colombia, Ribero and Nuñez analyze data for height among urban adults and confirm findings in other countries that height is increasing systematically over time and that it is consistently correlated with higher earnings. Furthermore, by analyzing "height" and "disabled days," this report suggests that the former is a more robust indicator of health since it is more consistently and strongly associated with earnings.

Knaul has broken new ground by utilizing an unusual measure of health: women's age at menarche, or the onset of first menstruation. Historical evidence shows that menarche has been declining steadily in most high-income countries, and studies have related this decline to improved nutrition and health in childhood. It appears that this measure, like height, is a useful marker for the level of health attained in childhood, a "stock" that could possibly affect later risk of morbidity and mortality as well as productivity.

Health Affects Income

Using these varied measures of health status and morbidity, all of the studies find some association between health and wages. This impact varies in magnitude and reliability depending on the health measure used for analysis, the particular sample, and the range of instrumental and control variables that are employed (see Tables 6 and 7).

Table 6
Ill or Disabled and Days Ill as Indicators of Health Impact on Hourly Earnings (with and without instrumental variables)

	Ill or Disabled		Days Ill		Ill or Disabled		Days Ill	
	with	w/out	with	w/out	with	w/out	With	w/out
	Urban Men				**Rural Men**			
Peru (1995)			-0.93*** (4.7%)	-0.09***			-3.46*** (14.2%)	-0.09*
Peru (1994)			-1.21** (1.2%)	n.s.				
Colombia (1993)	-0.28*** (28%)	n.s.	n.s.	n.s.	-0.41*** (41%)	n.s.	-32.9*** (32%)	n.s.
Mexico (1994)	-3.29*** (96%)	n.s.			-3.29*** (96%)	n.s.		
Nicaragua (1993)			0.16* (16%)	n.s.			n.s.	n.s.
	Urban Women				**Rural Women**			
Peru (1995)			-1.06*** (3.4%)	-0.07***			-2.25*** (6.2%)	-0.15*
Peru (1994)			-2.41** (2.4%)	n.s.				
Colombia (1993)	-0.14* (14%)	n.s.	n.s.	n.s.	-0.19* (19%)	n.s.	-13.5*** (13%)	n.s.
Mexico (1994)	n.s.	n.s.			n.s.	n.s.		
Nicaragua (1993)			n.s.	-0.02* (2%)			n.s.	n.s.

Notes: * = significant at 10% level; ** = significant at 5% level; and *** = significant at 1% level.
n.s. = not statistically significant; blanks indicate that the dependent variable or particular sample was not used.

For definitions of variables, see Table 2.

Mexico (1994) is a combined rural and urban sample.
Nicaragua (1993) had significant coefficients in combined samples, but not when the sample was disaggregated by sex and area.
Peru (1995) coefficients are listed as negative here for comparability even though the estimates given in the study itself are positive, due to the reciprocal transformation of the dependent variable.

Table 7 **Height, Menarche, and ADLs as Indicators of Health Impact on Hourly Earnings (with and without instrumental variables)**				
	Men		**Women**	
	with	w/out	with	w/out
Height in Colombia (1991)	7.9*** (7.9%)	0.72***	6.8*** (6.8%)	0.48***
Age at Menarche in Mexico (1995)			-0.26*** (26%)	n.s.
ADLs in Mexico (1994)	-0.86*** (58%)	n.s.	n.s.	n.s.

Note: * = significant at 10% level; ** = significant at 5% level; and *** = significant at 1% level.
n.s. = not statistically significant; blanks and shading indicate that the dependent variable or particular sample was not used.

For definitions of variables, see Table 2.

Numbers in parentheses represent the percentage effect calculated from the coefficient in the log-linear specification.

Despite the problems of endogeneity and measurement discussed previously, there are some variables that appear to be significantly related to wages, even in a simple regression without using instrumental variable techniques. An individual's height was a statistically significant predictor of earnings in the Colombian study, even after controlling for education and other personal characteristics and even without using instrumental variables. When elderly Mexicans ranked their health relative to others their own age, this measure was also significant in a simple wage equation. The rest of the health variables were not significant at the 10 percent level, with the exception of Days Ill in the Peruvian ENAHO survey. Either health has little impact on productivity, or the endogeneity and measurement problems associated with these health indicators are generally quite serious.

The results of applying a two-stage analysis to these problems demonstrate that health *does* have an impact on earnings after all. For the most part, health indicators that were not significant in single-stage regression were significant after endogeneity and measurement errors were corrected through the use of instrumental variable techniques. Furthermore, the magnitude of impacts estimated for most health indicators increased with the two-stage estimation procedure.

Earnings are lower for people who are predicted to be ill, and are systematically lower for those who are expected to be ill longer. The magnitudes, however, vary widely–between 1 percent and 58 percent. For the most part, an additional day ill was associated with a decline of between 1 percent and 4 percent in hourly earnings. This was found to be the case in both Peruvian studies and in Colombia. The largest impact was found for elderly Mexicans, men over 65 years old, for whom an additional day ill was associated with a 58 percent decline in earnings. Although this may be overestimated, it plausibly suggests that health status may have a stronger effect on productivity and earnings potential as individuals age, a conclusion supported by Murrugara and Valdivia in Peru.

The studies that looked at whether or not an individual reported any illness also showed an impact on productivity. Ribero and Nuñez found that having been sick in the last month decreases the earnings of men by 28 percent and women by 14 percent in urban areas, while the effect was larger in rural areas–41 percent and 19 percent, respectively. Parker provides evidence that being ill reduces the wages of elderly men by at least 40 percent.

For the two physical growth measures of health "stock," the instrumental estimates were also quite significant. Knaul presents evidence that a one-month increase in a woman's age at menarche is associated with a wage decline of 2.3 percent; while Ribero shows that each additional centimeter of height increases urban male earnings by 8 percent and urban female earnings by about 7 percent.

Health and Education: Is There Synergy?

It has long been suspected that the returns associated with education, documented in virtually every household survey, may be overestimated as a result of being positively correlated with other socioeconomic factors that might raise earnings. Among the omitted variables that can lead to bias is health.

Although the studies surveyed in this paper do confirm that educational returns may be somewhat inflated when there is a failure to control for health status, the magnitude of this effect appears to be modest. According to Knaul, Parker, and Espinosa and Hernández, respectively, an individual's schooling is widely observed to be associated with improved health indicators, and most of the studies surveyed find that wage returns to schooling are smaller when health variables are included in the estimated wage function (see Table 8). In general, a year of additional completed schooling was associated with 5 percent to 20 percent higher wages when health was ignored, and this estimated private return to schooling declined by less than a tenth when controls were included for health human capital. Thus, although all the studies suggest improvements in health have contributed to the substantial gains in labor productivity in Latin America, controlling for health indicators does not markedly weaken the estimated role in the region of schooling as a stimulant to growth.

In addition to potentially misattributing the measures of returns to education, there is evidence that health and education may interact in important ways, making a joint impact greater than the sum of their separate contributions. For example, specific studies have argued that healthier children benefit more from schooling, are more likely to remain in school, and are more likely to reach higher levels of schooling than those who are less healthy.[11] A few of the studies surveyed in this paper sought evidence for this complementarity by introducing interaction terms between health and education, but the results were not always significant or conclusive. The strongest results appear in the study by Cortez, in which he found positive and significant effects on wages from an interaction of health and education in his sample of male workers. However in the female sample, the interaction term was not significant. In Knaul, the interaction of the health indicator and education also had a positive impact on wages, although this result was statistically weak. Nonetheless, these studies yielded more support for the positive interactions (complementarity) between health and schooling

[11] See for example Moock and Leslie (1986) and Glewwe and Jacoby (1992).

than did Schultz (1995b) in West Africa.

Table 8
Returns to Education with and without Controls for Health

Study	Health Variable	No Health Variable	With Health Variable	With Instrumented Health Variable
Men				
Colombia (1993)	Days Disabled	8.5%	8.5%	8.4%
Colombia (1991)	Height	9.8%	9.5%	9.1%
Mexico (1994)	Days Ill		11.7%	6.8%
Mexico (1994)	ADLs		11.9%	10.2%
Nicaragua (1993)	Days Ill	8.6%	8.6%	8.5%
Peru (1994)	Days Ill	8.0%	8.0%	7.5%
Peru (1995)	Days Ill	8.3%	8.2%	7.0%
Women				
Colombia (1993)	Days Disabled	10.4%	10.4%	8.8%
Colombia (1991)	Height	9.6%	9.5%	9.0%
Mexico (1994)	Days Ill		18.7%	19.6%
Mexico (1994)	ADLs		19.6%	18.6%
Mexico(1995)	Age at Menarche		13.5%	13.1%
Nicaragua (1993)	Days Ill	7.3%	7.3%	7.0%
Peru (1994)	Days Ill	8.6%	8.5%	6.9%
Peru (1995)	Days Ill	6.9%	6.8%	6.0%

Note: Returns to education are estimated at the sample mean, using coefficients reported in the case studies. All include both urban and rural populations except Colombia (1991) and Peru (1994). Where necessary, population-weighted averages were calculated, and splined or dichotomous specifications were converted to average annual returns to schooling. The Mexican studies did not report earnings equations that excluded the health variable.

Subpopulation Comparisons: Are the Differences Real or Imagined?

Most of the studies estimated health effects on earnings among different subpopulations that are expected to have different outcomes for biological, social, or economic reasons. The evidence shows that the individual's gender, age, schooling, rural/urban residence, and household wealth are frequently related to his/her health status indicators. In most studies, health and wage estimates are disaggregated by sex because of the substantial differences in the level and structure of earnings by gender, the higher mortality rates among men within each age cohort, the marked differences in height, and other likely gender differences in morbidity and health status that might arise for biological or behavioral reasons and then be modified by economic development.

Each time that health impacts are estimated separately for subpopulations, the interpretation of findings is complicated by an underlying question: Are the categories exogenous or endogenous? Sex is perhaps the most exogenous of these divisions, but choosing to enter the labor force is not exogenous, so adjustments have to be made for the fact that women in the labor force differ systematically from the population as a whole. The studies often find significant differences in health impacts for men and women, but it is difficult to generalize the results.

It is reasonable to expect that there would be gender differences in the elasticity of wages with respect to health. Other studies have shown that labor force participation decisions and an individual's potential earnings in the labor market, after controlling for other personal characteristics, lead to different patterns of remuneration between men and women. In most of the studies surveyed, health appears to have more impact on wages for men than for women (see Table 9). Male earnings appear to be more sensitive than female earnings to differences in health in Colombia (Ribero and Nuñez), in the Peruvian national survey data (Cortez), and among elderly Mexicans (Parker). Women's earnings were more sensitive to health in the Peruvian study that focused on urban areas using the PLSMS and in the Nicaraguan study. Looking at a wider range of studies does not lead to a clear pattern. The gender differences could be real, but they could also be a consequence of smaller samples for working women than men, increasing the margin for sample selection bias to distort the estimates for women.

Ethnicity may be similar, but place of residence introduces more concerns about endogeneity. People move, and their migrations are often related to selecting places that improve their earnings, and potentially their ability to obtain access to health services. Rural and urban populations differ by health conditions, labor markets, employment opportunities, and welfare. Although disaggregating the samples by this distinction may be informative, it could also introduce some bias because of the substantial migration of individuals, during a lifetime, from one region to another. In Latin America during recent decades, this has taken the predominant form of rural to urban migration. Expectations are that the rural-to-urban migrants will tend to be better educated and possibly more healthy than the rural population they left behind, but possibly have received lower-quality schooling and amassed lower health human capital than the native urban population among whom they settle.

Study comparisons of health or productivity within the rural or urban sectors may thus be affected substantially by the distinctive characteristics of the migrants, interjecting a possible sample selection bias. The health characteristics of the community where migrants currently live may diverge sharply from those of the community in which they grew up and in which many adult health outcomes were shaped. The magnitude of migration suggests that about a fourth of the population may be mismatched (Schultz and Tansel, 1997). Several of the studies presently considered tried to address this bias by using variables in the survey regarding whether or not the respondent was an immigrant. But this information was only available in a few cases. Unfortunately, none of the surveys asked respondents about their place of birth, which would provide an even better identification of immigrants.

The mismatch is crucial because of the temporal lag between childhood investments in human health capital and eventual adult outcomes. The current health conditions and policies of the community of residence may not approximate the conditions when individuals were making critical childhood investments in health. In general, rural areas are associated with poorer health, even after controlling for schooling and other individual, family, and community characteristics (Murrugarra, Knaul, and Parker). And in several of the studies, health appears to have a greater impact on earnings in rural than urban areas. Nevertheless, the health indicator studies reported here, and most others as well, have not corrected rigorously for these matching problems. To estimate the impact on adult health of childhood health investments requires additional data on migration histories and the past evolution of community health programs.

When differences are considered across occupations, formal versus informal employment, and income levels, the questions of bias due to self-selection and sorting make interpretation even more difficult. The studies that enter this territory can be considered suggestive, and they demonstrate the need for more refined models and further analysis.[12] Murrugarra and Valdivia use quintile regressions to demonstrate that earnings are more sensitive to changes in the instrumented health variables for lower-income than for higher-income individuals. It would be important to discover which policy interventions most benefited the health and earnings of low-wage workers, and which policy interventions were on balance more favorable for high-wage workers. Future research could then seek to assess the distributional impact of alternative public health policies and programs.

Instrumental Variables as Policy Guides

All of the studies used an instrumental variable procedure to estimate the impact of health indicators on wages. There were two reasons. First, there is plausible evidence that errors in measurement of health human capital are substantial, and second, the heterogeneity across workers in their reported health is likely to be correlated with the unexplained variation in their wages. To correct for these, the studies exploited a range of variables that are linked to health, such as housing infrastructure, community sanitation, and potable water. To instrument health, Murrugarra and Valdivia used adequate ceilings as a measure of *housing quality*, while Parker used running water and proper floors, and Ribero and Nuñez used crowding (i.e., persons per room). Such variables are likely to reflect household wealth, and more generally the community's wealth, which stimulates demand for investment in health human capital. *Health policy interventions* were also used as instruments, and equated largely with access to various public programs. Murrugarra and Valdivia used distance to health centers, while Parker used the number of hospital beds, Knaul used the number of physicians, and Ribero and Nuñez used the percentage of people enrolled in the social security system. Other aspects of *family wealth* are also used to instrument for the health indicators, such as home ownership (Ribero and Nuñez) and private savings (Parker). Tests of overidentification and other specification tests may help to show that alternative reasonable choices in identifying instrumental variables will lead to similar estimates of the impact from health status indicators on wage productivity.

For guiding public policy, the primary focus centers on community characteristics that can be modified through collective actions. Such characteristics include those that could influence exposure to health risks or disease, including population density, transportation, sanitation, or access to potable water. They might also include local population traits that affect behaviors and generate externalities, such as education. These variables are summarized for urban men and women in Tables 9 and 10.

[12] One study conducted by Vijverberg (1995) explicitly addresses such problems in modeling the selection process between rural and urban areas, and between wage and self-employment categories.

Table 9
Impact of Selected Policy Variables on the Health Status of Urban Men

	Peru (1994)\1	Mexico (1995)	Mexico (1994) 1/	Peru (1995)	Colombia (1991)	Nicaragua (1993)
Individual Characteristics						
Education	-0.72		0.006*	-0.43***		-0.026
Age or Experience	-0.68**		-0.005**	-0.18***	0.43*	-.004
Migrant	-11.54**		-0.24			
Personal Health Services						
Distance to health center	-13.38**					
Food price	-7.27**			-0.98**		
Physicians per capita						
Nurses per capita						0.032
Housing						
Potable water and Sewerage			1.25*	1.54	7.0*	0.083
Floors or Ceiling	2.71**		0.06**	0.28*		-0.078

Notes:
1/ = For urban and rural sample combined with a dummy variable for residing in urban areas.
Significance levels as: * significant at 10% level; ** significant at 5% level; *** significant at 1% level.
Returns to education and age are estimated at the sample mean using coefficients reported in the case studies.
Other policy variables were used as instruments but have not been included here for purposes of presentation. Information about variables that were not included can be found in the respective studies.
Mexico (1994) is based on the analysis of ADLs, and Colombia (1991) on adult height.

Table 10 Impact of Selected Policy Variables on Health Status of Urban Women						
	Peru (1994)	Mexico (1995) 1/	Mexico (1994) 1/	Peru (1995)	Colombia (1991)	Nicaragua (1993)
Individual Characteristics						
Education	0.75	.025**	0.10	-0.17**		0.01
Age or Experience	-0.24**	-0.049	0.09**	-1.83**	0.83*	0.52
Migrant	1.98		0.21			
Personal Health Services						
Distance to health center	9.65*					
Food price	-13.3**			-0.72***		
Physicians per capita		-0.26				
Nurses per capita						-0.013
Housing						
Potable water and Sewerage		0.006***	-0.30	-0.15	0.50	-0.25
Floors or Ceiling	2.86**	0.012***	0.67***	-0.28***		-0.23

Notes:
1/ = for urban and rural sample combined with a dummy variable for residing in urban areas.
Significance levels are indicated as: * significant at 10% level; ** significant at 5% level; *** significant at 1% level.
Returns to education and age are estimated at the sample mean using coefficients reported in the case studies.
Other policy variables were used as instruments but have not been included here for purposes of presentation; Information about those variables can be found in the respective studies.
Mexico (1994) is based on the analysis of ADLs, and Colombia (1991) on adult height.

Access of individuals to community health and educational services is expected to ameliorate the health consequences of exposure to these risks and can be reflected in the general availability and price of health services and health-related goods, such as food, nutritional supplements, and medicines. For example, some studies found that the community's health resources (in Knaul, the number of physicians per capita; in Espinosa, the number of nurses; and in Parker, the number of hospital beds) are associated with increases in residents' health status. Findings also linked health indicators to the local prices of basic food staples such as potatoes (Murrugarra and Valdivia), and to rural community coverage rates under national social security programs that provide health insurance (Ribero and Nuñez). The average distance from community households to a health center and the average waiting time in those centers were used as proxies for the local prices of public health services but were not found consistently to be significantly related to adult health indicators.

The policy variables that most consistently showed an impact on health were those related to housing characteristics and sanitation. For example, at the community level, the household living space (the number of people per room), the proportion of homes with proper floors or ceiling materials, and suitable drainage and sanitation facilities were all associated with increased individual health status in the studies by Knaul, Espinosa and Hernandez, and Ribero and Nuñez.

A Research Agenda for Policy Improvements

All the Latin American studies surveyed in this paper, each based on microanalyses of seven different household surveys, find evidence to support the notion that healthier individuals are more productive and earn more per hour worked. Given the lack of consensus among experts on how to measure adult health and the resulting variation in survey questionnaire designs, the various studies understandably have measured health status or health human capital using widely different criteria. Yet all of them found that using instrumental variable techniques to isolate the impact of the individual, family, and community resources, prices, and environment on the individual's health indicator showed the effect of adult health on productivity to be positive and generally statistically significant. The elasticity of earnings with respect to health at the sample means ranges from 0.09 to more than 0.80, but in general, these estimates indicate that earnings may be quite sensitive to small but consistent improvements in health (see Table 11).

Table 11
Summary of the Estimated Percentage Change in Wages Associated with Changes in Various Indicators of Adult Health

Health Indicator, Country (source)	Females	Males
Height (1 centimeter)		
Colombia (Ribero and Nunez, 1999) – urban areas only	7%	8%
Ghana (Schultz, 1996)	*8%*	*6%*
Brazil (Alves, et al., 1999)	*6%*	*4%*
Age at Menarche in Years (Elasticity with sign reversed)		
Mexico (Knaul, 1999)	0.47	-------
Body Mass Index (Weight kg/Height M^2; 1 unit change)		
Ghana (Schultz, 1996)	*7%*	*9%*
Cote d'Ivoire (Schultz, 1996)	*14%*	*9%*
Illness and/or Inability to Work as Usual (Elasticity with sign reversed)		
Colombia (Ribero and Nunez, 1999) – Days unable to work, pop. wtd. average elasticities for rural and urban samples	0.04	0.07
Colombia (Ribero and Nunez, 1999) – Unable to work, pop. wtd. average elasticities for rural and urban samples	0.010	0.017
Peru (Murrugarra and Valdivia, 1999) – Days sick, urban only, pop. wtd. average elasticity for wage earners and self-employed	0.07	0.04
Peru (Cortez, 1999) – Reciprocal of days sick plus one with sign reversed, average elasticity for rural and urban areas	0.10	0.20
Mexico Elderly (Parker, 1999) – Number of days sick or injured in last 180 days	n.s.	0.81
Nicaragua (Espinosa and Hernandez, 1999) – Days sick	0.16	n.s.
Ghana (Schultz and Tansel, 1997) – Days unable to work	--------	*0.11-0.24*
Cote d'Ivoire (Schultz and Tansel, 1997) – Days unable to work	--------	*0.09-0.28*
Functional Limitations (Elasticity with sign reversed)		
Mexico (Parker, 1999) – Number of ADLs for working individuals over 60 years of age	n.s.	0.38

Note: n.s. indicates not statistically significant at 5 % level; and - - indicates not applicable. Studies not surveyed in this paper are indicated by italics. All elasticities are reported at the sample mean.

The next step is more difficult. These aspects of health are hard to link precisely to the available measures of current community social services that one might associate with investments in public health and development infrastructure. These studies demonstrate that the use of instrumental variable estimation is warranted because it deals reasonably with three problems: measurement error embedded in health indicators, the heterogeneity in individual endowments and compensating behavioral patterns, and the dual nature of health differences (i.e., a genetic foundation modified at the margins by the accumulation of a stock of human capital).

Yet the measures of policy choices that research teams can use as instrumental variables need to be improved. Major improvement in knowledge about the relationships between public policy interventions and adult health could occur if data were assembled on the historical time series variation in regional health programs that could be matched to individual migration histories. The production of health is distinctively a process of long gestation. Tracing an individual's access to health services and exposure to disease during the critical early childhood years is critical for testing definitively the hypotheses of social scientists and physicians that public policies are responsible for the dramatic increases in life expectation and health in the twentieth century. Great strides could then be made to fine-tune estimates of how public policy interventions can be best designed to improve future adult health status and thereby enhance adult productivity and welfare.

Two of the measures of adult health, height and age-at-menarche, are determined during the individual's development lifecycle by physical growth processes and then remain more or less constant. Because these variables are determined by adulthood, say age 20 to 25, the cross-sectional variation in these variables associated with the age of each respondent makes it possible to construct a historical time series. From this, one can infer how these indicators of health have improved within a population over time, assuming there are no systematic errors in reporting associated with age. The two studies under consideration that use these indicators find strong secular improvements in health among their surveyed populations, comparable to that noted in high-income countries since the Industrial Revolution and in a few observed low-income countries (Strauss and Thomas, 1998; Schultz, 1995b and 1999b). More-frequent inclusion in household surveys of these anthropometric indicators of physical health and early nutritional health status could open the door to comparative analyses of the inequality of health in Latin America. Although the surveys used here did not contain information on adult weight-for-height, commonly known as a body-mass index (BMI), this measure is as important as height alone is for future data collection. Collecting data on BMI would allow researchers to go beyond the long-term research that utilizes height data and begin to understand short-term effects, including the impact of current malnutrition and poor health status on earnings.

In sum, gathering migration histories for individuals and assembling better databases on health conditions and policy variations by small regions of residence will lead to stronger analyses and to greater reliability in their findings. Then the debate could be confidently joined about which policies have the greatest promise of reducing over time identified inequalities in health in Latin American countries, and thereby strengthen efforts to ameliorate the region's notably high level of earnings inequality.

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