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EDUCATION AND HEALTH: EVALUATING THEORIES AND EVIDENCE

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ABSTRACT

There is a large and persistent association between education and health. In this paper, we review what is known about this link. We first document the facts about the relationship between education and health. The education 'gradient' is found for both health behaviors and health status, though the former does not fully explain the latter. The effect of education increases with increasing years of education, with no evidence of a sheepskin effect. Nor are there differences between blacks and whites, or men and women. Gradients in behavior are biggest at young ages, and decline after age 50 or 60. We then consider differing reasons why education might be related to health. The obvious economic explanations – education is related to income or occupational choice – explain only a part of the education effect. We suggest that increasing levels of education lead to different thinking and decision-making patterns. The monetary value of the return to education in terms of health is perhaps half of the return to education on earnings, so policies that impact educational attainment could have a large effect on population health.

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I. Introduction

There is a well known large and persistent association between education and health. This relationship has been observed in many countries and time periods, and for a wide variety of health measures.[1] The differences between the more and the less educated are significant: in 1999, the age-adjusted mortality rate of high school dropouts ages 25 to 64 was more than twice as large as the mortality rate of those with some college (table 26, National Vital Statistics Reports, 2001).

Substantial attention has been paid to these "health inequalities." Gradients in health by education are now being systematically monitored in many countries (the United States includes them as part of its Healthy People 2010 goals), and countries such as the United Kingdom have target goals of reducing health disparities – whether specifically by education or factors correlated with education.[2] In this paper, we review what is known and not known about the relationship between education and health, in particular about the possible causal relationships between education and health and the mechanisms behind them. We then assess the extent to which education policies can or should be thought of as health policies.

We note at the outset that this is a controversial topic. A number of authors have written about education-related health inequalities, and the conclusions frequently differ. To some extent, this is a result of data limitations. Many of the data sets that we and others employ use health measures that are self-reported. In addition to true differences in health, there will thus be some differences related to knowledge of existing conditions, which may itself be related to education. Also very important, however, is that work on the mechanisms underlying the link between health and education has not been conclusive. Not all relevant theories have been tested, and when they have, studies will often conflict

[1] These relationships have been extensively documented elsewhere. A few references follow. For mortality in the US see Kitagawa and Hauser (1973), Christenson and Johnson (1995), Deaton and Paxson (2001), and Elo and Preston (1996); for risk factors see Berger and Leigh (1988), Sobel and Stunkard (1989), Adler et al (1994); for diseases morbidity see Pincus, Callahan and Burkhauser (1987); for health behaviors see Sander (1995), Kenkel (1991), Meara (2001), and Leigh and Dhir (1997). Several review papers also report these associations; see for example Grossman (forthcoming).

[2] For a discussion of initiatives in the UK, see http://www.dh.gov.uk/PolicyAndGuidance/HealthAndSocialCareTopics/HealthInequalities/fs/en

with each other. We highlight the discrepancies as best we can. We do not resolve the differences here – that is an enormous task, and is not doable with current information. Noting the points of disagreement is important in its own right, however. Along the way, we indicate where more research would be particularly valuable.

II. The Relationship Between Health and Education

To document the basic correlations between education and health, we estimate the following regression:

$$H_i = c + \beta E_i + X_i \delta + \varepsilon_i$$

where H_i is a measure of individual i's health or health behavior, E_i stands for individual i's years of completed education, X_i is a vector of individual characteristics that includes race, gender and single year of age dummies, c is a constant term and ε is the error term. The coefficient on education β (also referred to as the education gradient) is the object of interest, and it measures the effect of one more year of education on the particular measure of health. We focus on individuals ages 25 and above since they have most likely already completed their education. Education is included either in years (as in the labor literature), or using dummies for each year of education, to be as flexible as possible. We first report results for the entire sample, and then for different demographic groups. We estimate linear models for continuous variables. For dichotomous variables we estimate logit probability models and report the marginal effects.

The data we employ are from various years of the National Health Interview Survey (NHIS) in the United States.[3] We use the NHIS because it has a large number of health outcomes and behaviors. Generally, results from the NHIS match other surveys with self-reports (Cutler and Glaeser 2005) and even physical assessments, though clearly there are exceptions, such as weight and height. We note possible reporting issues as we present the results.

[3] See data Appendix for details.

Table 1 reports the coefficient on years of schooling in explaining various measures of health. The first outcome we look at is whether an individual died within 5 years of the interview. In the NHIS this is determined by matching individual information to death certificates through the National Death Index (see Appendix for more details). Then we look at gradients in the self-report of a past acute or chronic disease diagnosis. Most of these diseases are very serious (cancer or heart disease, for example), and people would certainly know if they have had been diagnosed with them (although it is possible that conditional on having the disease, the more educated are more likely to know about it. If that is the case then the gradients we report for these diseases could partially reflect differential diagnosis and knowledge—this is not the case for mortality however). Of course, since the sample is of people who are alive, differential mortality between better educated and less educated is an issue. But this would tend to *reduce* reported gradients, if less educated people die more when they have any disease, and thus are not alive to report the disease.

The first column includes a very basic set of controls: a full set of age dummies, race, and gender. The results (column 1) show that individuals with higher levels of education are less likely to die within 5 years. The second block of the table shows the more educated also report having lower morbidity from the most common acute and chronic diseases (heart condition, stroke hypertension, cholesterol, emphysema, diabetes, asthma attacks, ulcer). The only exceptions are cancer, chicken pox and hay fever. Differential reporting of hay fever could possibly be related to differential knowledge of disease (better educated people will be more likely to go to specialists for testing). This might be the explanation for cancer as well; skin cancer is the most common cancer, and could be subject to reporting bias. But that might not be the whole explanation. Some evidence suggests that some cancer risk factors are adverse for the better educated (as with late childbearing age and breast cancer). It may also be that better educated people are more likely to survive with cancer, or that better care for competing risks keeps the better educated alive long enough to die of cancer.

Differences in chronic disease prevalence are similar. Better educated people are less likely to be hypertensive, or suffer from emphysema or diabetes. The third set of rows shows that physical and

mental functioning is better for the better educated. The better educated are substantially less likely to report themselves in poor health, and less likely to report anxiety or depression. Finally, the last block shows that better educated people report spending fewer days in bed or not at work due to disease, and have fewer functional limitations.

The magnitude of the relationship between education and health varies across conditions, but they are generally large. An additional four years of education lowers five year mortality by 1.8 percentage points (relative to a base of 11 percent); it also reduces the risk of heart disease by 2.16 percentage points (relative to a base of 31 percent), and the risk of diabetes by 1.3 percentage points (relative to a base of 7 percent). Four more years of schooling lowers the probability of reporting in fair or poor health by 6 percentage points (the mean is 12 percent), and reduce lost days of work to sickness by 2.3 each year (relative to 5.15 on average). Although the effects of gender and race are not shown, the magnitude of 4 years of schooling is roughly comparable in size to being female or being African American. These are not trivial effects.

The reasons for these associations are multi-factorial, although it is likely that these health differences are in part the result of differences in behavior across education groups. Table 2 shows the relation between education and various health risk factors: smoking, drinking, diet/exercise, use of illegal drugs, household safety, use of preventive medical care, and care for hypertension and diabetes. Overall, the results suggest very strong gradients where the better educated have healthier behaviors along virtually every margin (although some of these behaviors may also reflect differential access to care). Those with more years of schooling (we report the effects of 4 more years) are less likely to smoke (11 percentage points relative to a mean of 23 percent), to drink a lot (7 fewer days of 5 or more drinks in a year, among those who drink, of a base of 11), to be overweight or obese (5 percentage points lower obesity, compared to an average of 23 percent), or to use illegal drugs (0.6 percentage points less likely to use other illegal drugs, relative to an average of 5 percent). Interestingly, the better educated report having tried illegal drugs more frequently, but they gave them up more readily.

Similarly, the better educated are more likely to exercise and to obtain preventive care such as flu shots (7 percentage points relative to an average of 31 percent), vaccines, mammograms (10 percentage points relative to an average of 54 percent), pap smears (10 percentage points relative to an average of 60 percent) and colonoscopies (2.4 percentage points relative to an average of 9 percent). Among those with chronic conditions such as diabetes and hypertension, the more educated are more likely to have their condition under control. Furthermore, they are more likely to use seat belts (12 percentage points more likely to always use a seat belt, compared to the average of 68 percent) and to have a house with a smoke detector (10.8 percentage points relative to an average of 79 percent) and that has been tested for radon (2.6 percentage points relative to a base of 4 percent). All of these behavioral effects are very large.

It is worth noting that these health behaviors explain some, but not all of the differences in health. For example, in the famous Whitehall study of British civil servants (Marmot 1994), smoking, drinking, and other health behaviors explain only one-third of the difference in mortality between those of higher rank and those of lower rank. Although that study did not focus on educational differences, we find similar results. In the NHIS, the effect of education on mortality is reduced by 30% when controlling for exercise, smoking, drinking, seat belt use, and use of preventive care (results available upon request). This is perhaps an underestimate – one cares about the length of time smoked, the specific cigarettes smoked, the number of puffs taken, and the like. But absent measurement error in behaviors, the result implies that there must be unobserved health behaviors that also contribute to health differences, or alternatively, that the more educated might be healthier due to reasons/behaviors that are not known to be health improving. Equally important, we do not understand why the more educated make larger investments in their health; we return to this in the next sections.

The relationship between education and health shows up across countries as well. Figure 1 shows the simple correlation between average education (using the well-known Barro-Lee international data) and life expectancy (without any additional controls). As average education increases, life expectancy improves, although the returns appear to be larger for poorer countries.

The same is true within countries as well. The more educated are more likely to live longer not just in the US, but also in Canada (Mustard, et al. 1997), Israel (Manor, et al. 1999) and both Western and Eastern Europe,[4] including Russia (Shkolnikov, et al. 1998). This relationship has also been documented in developing countries, such as Bangladesh (Hurt, et al. 2004), Korea (Khang et al. 2004), and China (Liang, et al. 2000). In most cases, however, education is not associated with lower cancer mortality.

Heterogeneous effects

The basic correlations we just described do not fully describe important aspects of the relationship between education and health. For example, it is important to know whether the returns to schooling are constant for every additional year of school, regardless of the initial level of schooling, or whether the benefits from say primary schooling exceed those from higher education. To better understand the shape of the relationship between education and health, we estimate non-parametric models that include a dummy variable for each year of schooling as explanatory variables (rather than years of education as a continuous variable as in Tables 1 and 2), and include the same basic demographic controls we included previously.

Figure 2 plots the estimated effects for a number of health and health behaviors. We chose four representative health measures (mortality, SRHS, depression and functional limitations) and four measures of behaviors that cover a range of different areas: smoking is an addictive behavior that is known to adversely affect health and has potentially an important social component; colorectal screening is preventive but may be related to access to health care; wearing a seat belt is also preventive but not monetarily costly; and lastly smoke detectors at home, which picks up general safety. Although the estimates are noisy (some education categories have very few observations), they show that for many

[4]For Europe the relationship has been documented in various papers by the Mackenbach group. For example, for Finland, Norway, Italy, the Czech Republic, Hungary and Estonia see Mackenbach et al (1999); for Netherlands, Sweden, Denmark, Norway, France, Italy, Finland and the UK see Kunst and Mackenack (1994). For Switzerland see Bopp and Minder (2003).

outcomes, there are returns beyond high school completion (12 years of schooling). Education matters for health not just because of basic reading and writing skills.

For some outcomes, the relationship between years of schooling and health appears to be linear (see mortality, colorectal screenings and smoke detectors). For other outcomes, such as functional limitations, smoking and obesity, the relationship is non-linear, with an increased effect of an additional year of school only for people who are better educated. In all cases, however, the relationship between education and health is roughly linear after 10 years of school; we do not see large evidence of sheepskin effects in health – that is, there does not appear to be an additional health benefit associated with the completion of a degree, beyond what would be expected given the number of years of schooling (although for some outcomes such as SHRS and functional limitations there may be a small effect of high school graduation). In contrast, there are clear sheepskin effects on wages, for example see Tyler, Murnane and Willet (2000). Subject to the possibility of small effects that we cannot measure accurately, (e.g., the product of the sheepskin effect in wages and the impact of income on health may be small), this allows us to reject the idea that the health returns to education (the health benefit associated with one more year of schooling) are driven by the labor market returns to education This also implies that there may be substantial health returns to education policies that promote college attendance.

The effects of education on health and health behaviors also differ along other dimensions. These effects vary significantly for individuals of different ages. Figure 3 shows the coefficients of education estimated by single year of age. Some of these education gradients (mostly those related to behaviors) fall continuously with age (smoking, seat belt use, smoke detector); whereas others increase with age until middle ages, and then start to fall (functional limitations, depression and colorectal screening). In all cases, however, we find that the effect of education starts to fall sometime between ages 50 and 60. Other studies have also documented smaller effects of education for older ages on mortality (Elo and Preston 1996). Interestingly, some studies also find that the health differences associated with income also diminish after middle age (Smith 2005), though this is not true in all studies (Wolfson 1993).

Some of the decline in the education gradient after age 50 must certainly be due to the selective survival of the more educated (Lynch 2003). There may also be additional cohort effects—education may have become more important for younger cohorts. Or education may simply matter less after retirement, with stable incomes and universal insurance coverage. It is difficult to separate these effects.

There are important differences by gender as well. Table 3 shows the impact of education for men and women (the second and third columns), blacks and whites (the fourth and fifth columns), and rich and poor (the sixth and seventh columns). The table reports whether the marginal effect of education is significantly different for the two groups, as well as the effect of one more year of education as a percentage of the mean level for the group (to account for the fact that different groups may have different baselines). In more than half the cases, education has a statistically indistinguishable effect for men and women. In some cases, education has a greater impact for women (depression and obesity, for example). In other cases, the effect is bigger for men (mortality and heavy drinking). Whether these differences result from biology or behavior is not known.

In the next two columns we compare gradients for whites and blacks. Again, the coefficients are similar most of the time. Where they differ, education gradients are larger for whites than for blacks (with the exception of smoke detectors), although the effects are closer when the effects are rescaled as a percentage of the mean. One possible explanation is that the quality of education is lower for blacks than for whites, though we have no direct evidence on this. These findings are also consistent with lower returns to education on wages among blacks.

Lastly, we examine whether education matters more for those with low family incomes (incomes below $20,000)—although we note here that because education affects income, and health may determine income, it is more difficult to interpret these results. In most cases we examine, education matters more among the non-poor than among the poor. This suggests that income and education are complementary in the production of health. This would be the case if, for example, education allows people to know about particular new treatments and income allows them to purchase the treatment. The results by race and

income together suggest that socio-economic advantages are complementary (or cumulative). They also suggest that interactions between education and other variables may be important.

The education gradient over time

Education gradients in mortality appear to be increasing in both the United States (Pappas, et al. 1993)[5] and Europe (Mackenbach, et al. 2003), (Kunst, et al. 2002). As a result, even though life expectancy is improving for all, the differences in life expectancy between college educated and others have become larger. Other measures of health confirm these findings. For example, Goesling (2005) finds that there has been an increase in the effect of education on self-reported health since 1982. Looking at the same period, Schoeni et al (2005) find that although disability rates in the US have fallen, they have fallen more among the educated. The gradient in some health behaviors is also increasing: there were very small differences in smoking rates between education groups prior to the Surgeon General Report in 1964, but these differences are substantial today (Pamuk, et al. 1998; figure 35). Although compositional changes could be driving the observed differences – educational attainment has increased enormously over time – the results suggest that health inequalities could well continue rising.

Spillovers across people

It is well known that maternal education is strongly associated with infant and child health, both in the US and in developing countries (for developing countries see Strauss and Thomas 1995, for the US see Meara 2001, or Currie and Moretti, 2003). More educated mothers are less likely to have low or very low birth weight babies, and their babies are less likely to die within their first year of life. These effects persist well into adulthood: Case, Fertig and Paxson (2005) find that mother's education predicts self reported health at age 42.

[5] Preston and Elo (1995) find increasing education gradients in the US only for males but not for females.

Recent research further suggests that more educated children have an effect on the health of their parents: Field (2005) finds that parents of individuals who obtained more schooling were subsequently more likely to stop smoking.

It is also possible that having an educated spouse positively affects health. For example, Egeland, (2002) and Bosma et al (1995) find that even controlling for own education, those who are married to more educated spouses have lower mortality rates (although this finding is not universal, for example see Suarez and Barrett-Connor 1984). Having a more educated spouse is also associated with better health and health behaviors such as smoking and excessive drinking (Monden, 2003). Of course it is difficult to know whether this relationship is simply driven by assortative mating or whether it reflects a causal effect.

III. Is the effect of education on health causal?

In a very broad sense, there are three possible reasons for the link between health and education. One possibility is that poor health leads to low levels of schooling. Another possibility is that increasing education improves health. And lastly there may be third factors that increase both schooling and health. It is important for policy to understand how much of the observed correlation between education and health can be explained by each of these explanations. Subsidies for schooling would only be effective in improving the health of the population if in fact education causes health.

A causal relationship from health to education could result from experiences during childhood, if children in poor health obtain less schooling and they are also more likely to be unhealthy adults. For example, children that are born with low or very low birth weight (a health marker at birth) obtain less schooling that those born with higher weights (even among twins, see Behrman and Rosenzweig, 2004, Black, Devereux and Salvanes 2005). Low birth weight is also predictive of poor health later in adulthood (Barker, 1995; Roseboom et al., 2001). Similarly, older children that are sick or malnourished during childhood are more likely to miss school, less likely to learn while in school, and ultimately obtain fewer years of schooling (Case, Fertig and Paxson 2005). And again, sick children are also more likely to

become sick adults (Case, Lubotsky, and Paxson 2002). Miguel and Kremer (2004) and Bleakley (2002) show that provision of deworming drugs significantly increased years of schooling in contemporary Kenya and the pre-war American south, respectively.

What is not clear is the extent to which the observed correlation between education and health in the current United States is driven by the effects of disease on children's development. We doubt this can be the entire explanation. If this was important, one would expect the education gradient to be diminishing over time: very few children in the US today are unable to attend school because of their health. But the education gradient is rising.

Unobserved factors such as family background, genetic traits or other individual differences, such as the ability to delay gratification, could also explain why the more educated are healthier. For example richer parents are more likely to invest more in their children's health and in their education. Smarter individuals may be more likely to obtain more schooling and also take better care of themselves. Another often-cited possibility is that individuals with lower discount rates are more likely to invest more heavily in both education and health (Fuchs 1982).

Although in principle any of these third factors could account for the entirety of the correlation, there are reasons to be skeptical. Previous attempts to control for these factors have generally found that they cannot explain all of the effect of education on health (this will be reviewed in more detail in the next sections). To look at this further, we added measures of family background and individual characteristics to our NHIS results. Column 2 of tables 1 and 2 adds to column 1 controls for Hispanic ethnicity, family income, family size, major activity, region, MSA, marital status, and health insurance coverage. Adding these measures lowers the effect of education – on average the effect of education declines by about 38% for health measures, and about 28% for health behaviors[6]– but it generally remains large and significant, (similar to findings in Elo and Preston, 1996).

[6] We calculated the average reduction in the coefficient of education only among measures for which the coefficient of education was significant and for which education improved the outcome (for health outcomes we excluded cancer, hepatitis, chicken pox, hay fever, and asthma self reports; and among behaviors we excluded recent use of

The last possibility is that more/better education leads to improved health. Some recent evidence from quasi-natural experiments suggests that at least part of the correlation between education and health is indeed causal.

One set of studies has focused on the correlation between own education and health measures in adulthood. To obtain a causal estimated of education, these studies have looked to see if individuals who were forced to go to school through various policies were subsequently healthier than those who were not. Lleras-Muney (2005) considers the case of the US in the first half of the 20th century, when many states increased the number of years children had to attend school. She shows that individuals born in states that forced them to go to school obtained more education and, conditional on surviving to adulthood, they also had substantially lower mortality rates much later in life. Similarly, Oreopolous (2003), Arendt (2005) and Spasojevic (2003) also find that increases in minimum schooling laws in England and Ireland, Denmark and Sweden respectively, improved the health of the population. Other studies provide additional quasi-experimental evidence that education improves health, see Grossman (forthcoming), but only for primary and secondary schooling.

There is also evidence of a causal effect of maternal education on infant health. Currie and Moretti (2003) look at the effect of increases in the availability of colleges (which lowers the cost of attending school) on women's educational attainment and their infants' health. They find that women in counties where colleges opened were more likely to attend college and had healthier babies. These health improvements resulted in part because these women engaged in healthier practices during pregnancy (they were less likely to smoke and drink and obtained more prenatal care), and also because education altered their reproductive behavior: more educated women were more likely to be married at the time of birth and have fewer children.

The evidence from natural experiments supports the theory that there is a causal effect of education on health. It is important to note that all of these papers look at quantity of schooling—there is no

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marijuana and cocaine, lead test in home, had an STD in past 5 years, behaviors among diabetics and high BP cured).

evidence that we know of on the quality of education.[7] There is also no causal evidence on whether the content of education matters for health, whether for example, the returns to vocational versus academic curricula are different, or whether it matters whether individuals major in science or humanities. Moreover these papers do not entirely explain why education improves health, although several theories have been proposed about how more education can result in better health. We review them next.

We also note another drawback of these natural experiments: they rely on manipulations that affect individuals whose return to schooling is likely to be different from the average returns of the population. For example compulsory schooling laws were intended to increase the education of those at the lower end of the distribution of education; they most likely had no impact on those that were planning to go to college. This makes it difficult to predict the effect of programs that affect everyone in the population or that are directed towards different populations. Using the results from these studies, it is therefore not possible either to quantify how much of the observed correlation between education and health in the population can be accounted for by reverse causality or by third factors.

IV. Possible mechanisms for the relationship between education and health

The central question raised by these results is why education affects health. Without a clear understanding why, it is difficult to know what interventions will be most effective.

Income and access to health care. Education may improve health simply because it results in greater resources, including access to health care. This is perhaps the most obvious economic explanation. The fact that the health returns to education were increasing in the 1980s and 1990s at the same time that the labor returns to education were rising (Autor, Katz and Kearney 2005) is consistent with this theory. This theory is not the whole of the explanation, for several reasons. First, as documented in Tables 1 and 2, controlling for income and health insurance (and other basic predictors of labor market success such as

[7] Although Ross and Mirowsky (1999) find that college selectivity in addition to years of schooling is predictive of health.

marital status and ethnicity) does not seem to explain away the effect of education; rather, these variables, most particularly income, account for about a third of the effect.[8] But because income is measured with substantial error, and because measures of permanent income are generally not available, it is possible that a larger fraction of the effect of education may be due to income.

However, it is unlikely income and health care can *entirely* account for the association between education and health. Differences in health across education groups often emerge before the health care system becomes involved: as documented in the previous section, there are significant education differences in the incidence of disease and in the risk factors associated with disease, such as smoking. Also, as we showed in Table 2, there are education gradients in seat belt use, exercise and reading food labels and other behaviors for which neither income nor health insurance is important. Finally, smoking, illegal drug use and excessive drinking are more prevalent among the less educated, even though these behaviors are financially costly.

Labor market. More highly educated individuals may have "better" jobs that, in addition to paying higher incomes and providing health insurance, offer safer work environments. But this too, cannot be the entire explanation. Previous studies (for example Lahelma et al 2004) find that controlling for job characteristics such as occupation is not sufficient to explain education health gradients. We reproduce these findings here. In both Tables 1 and 2, we add controls for occupation and industry dummies (column 3). For the majority of health measures we examine (Table 1), adding these has very little effect on the coefficient of education, and in some cases the effect of education actually becomes stronger. The effect of education on health behaviors (Table 2) is generally either reduced by adding these controls (for example for smoking, or days drinking), or it remains stable, But in all cases, the effect of education remains significant (except for marijuana use). Because there are significant health gradients for women as well as men, and since gradients can be observed early in life, it is unlikely that current or past

[8] Clearly, it may not be legitimate to include these as controls since both income and insurance could be endogenous, determined by health and health behaviors.

characteristics of the labor environment are at the root of education gradients, unless they operate, for example, through intergenerational transmission. Thus, although education changes an individual's labor market experience, this does not appear to be the main mechanism by which education results in better health.

Snowdon, in his famous series of studies (collected in his book Aging with Grace, 2001), finds that "the sisters with a college degree has a much better chance of surviving to old age (…) (the Sisters of Notre Dame) had similar lifestyles whether or not they graduated from college: Income was not a factor, they did not smoke, and they shared virtually the same health care, housing and diet." (page 41) Interestingly, language ability upon entrance to the convent (for example, the complexity of sentences) predicted the onset of Alzheimer's, suggesting instead a role for cognition and information, which we also discuss later.

Value of the Future. Though income, health insurance and other resource factors may not affect health per se, they may change an individual's incentives to invest in health: if education provides individuals with a better future along several dimensions—because it gives access to more income, it makes one happier, and generally improves one's outlook on the future (in economic terms it increases the present discounted value of future lifetime utility), people may be more likely to invest in protecting that future. Similarly, in their theoretical model Murphy and Topel (2005) find indeed that as incomes rise, willingness to pay for health improvements increases as well. This theory would also explain why the less educated are more likely to engage in riskier behaviors (the value of living to advanced ages is lower), and is also consistent with smaller gradients for women and for blacks. This theory is difficult to test, so we do not have a sense about its quantitative importance.

Information and cognitive skills. Education can also provide individuals with better access to information and improved critical thinking skills (although of course note that those with higher skills

may also be more likely to get more education). The more educated do appear to be better informed, and appear to make use of new health related information first. For example, the educated were more likely to quit smoking after the 1964 Surgeon General Report first publicized the dangers of smoking (de Walque 2004). Similarly, de Walque (2005) finds that educated women in Uganda were more likely to use condoms and less likely to have AIDS, but this relationship emerged only in 2000 after a decade of information campaigns (in 1990 education did not predict incidence of AIDS).

However, differences in information can explain only a small part of the differences across education groups (Meara 2001, Kenkel 1991). Today most individuals are well aware of the dangers associated with smoking and yet smoking is more prevalent among the uneducated. The same is true of obesity, which is inversely related to education in women.

These results do not imply health education should not be undertaken; reducing education gradients is only one of many possible objectives of policy interventions. Rather, it suggests that health education programs will not diminish education gradients in health, indeed they may increase gradients, at least for several decades.

How information is used and the manner in which it is received matters. The more educated are more likely to trust science: According to a 1999 National Science Foundation survey (National Science Foundation 2000), 71 percent of those with a college degree or higher thought that the benefits of new technologies strongly outweigh the harmful results, whereas only 25 percent of those with less than a high school degree thought so. This may be due in part to the fact that they are more likely to understand the nature of scientific inquiry.[9]

Education might matter for health not just because of the specific knowledge one obtains in school, but rather because education improves general skills, including critical thinking skills and decision-making abilities. Reading is one of those skills. Small studies find that patients with poor reading

[9] According to the same survey, 53 percent of those with more than a college degree understand the nature of scientific inquiry (measured by individuals' understanding of the value of randomized experiments and of probabilities), whereas only 4 percent of those with less than a high school degree do.

skills were less likely to understand discharge instructions after emergency room visit (Spandorfer, et al. 1995), and are less likely to know about their asthma condition or utilize their inhalers correctly (Williams, et al. 1998). Education may improve decision making by teaching individuals how to avoid common errors in cognition, such as small sample biases, or by lowering deliberation time and costs.

More generally the more educated could be better at learning. There is some suggestive evidence consistent with this hypothesis. Lleras-Muney and Lichtenberg (2002) find that, controlling for income and insurance, the more educated are more likely to use drugs more recently approved by the FDA, but this is only true for individuals who repeatedly purchase drugs for a given condition, so for those that have an opportunity to learn. Similarly Lakdawalla and Goldman (2001) and Case, Fertig and Paxson et al. (2005) find that the health gradient is larger for chronic diseases, where learning is possible, than for acute diseases.

Alternatively the more educated could have an advantage in using complex technologies. Rosenzweig and Schultz (1989) show that contraceptive success rates are identical for all women for "easy" contraception methods such as the pill, but the rhythm method is much more effective for educated women. Goldman and Smith (2002) report that the more educated are more likely to comply with AIDS and diabetes treatments, both of which are notoriously demanding. This may be true for some behaviors, where regular self-monitoring or therapy is required, but is unlikely to be the only mechanism. Many non-complex health behaviors have strong education gradients, such as seat belt use.

It seems that part of the gradient between education and health is a result of the cognitive skills that come with education (although no causal evidence is available). There are no estimates of the share of the education effect attributable to this channel, however.

Preferences. Education may alter other important individual characteristics that affect health investments and ultimately health. Becker and Mulligan (1997) suggest that higher schooling causes lower discount rates. One possible mechanism is that education raises future income, thus encouraging individuals to invest in lowering their discount rate. Going to school is in itself an exercise in delaying gratification, so

it may contribute to lower discount rates that way. Data on discount rates by education are difficult to come by. The more educated appear to have lower discount rates although the relationship is weak (Fuchs 1982). There is no evidence we know of that education lowers discount rates.

Alternatively education could affect health through risk aversion. People who have more schooling could learn to dislike risk more. However, the empirical relationship between education and risk aversion appears to be u-shaped and thus not consistent with health gradients: very high and very low education levels are associated with more risk taking, whereas individuals with moderate amounts of schooling are the most risk averse (Barsky et al 1997).

Moreover the available evidence suggests that changes in preferences are not the main reason why education affects health. The few studies that we know of that have investigated this question by directly including measures of risk aversion (Fuchs, 1982) and discount rates (Leigh, 1990, Fuchs, 1982) in models explaining health behaviors find that only a small portion of the education gradient is explained by differences these preference parameters.[10] Of course it is worth keeping in mind that these parameters are difficult to measure. Also, economic analyses consider only single measures of risk aversion and time preferences, and these are generally related to individual preferences over monetary outcomes. Risk preferences with respect to health and life may differ from risk preferences over money; the same may be true for discounting.

Rank. Education might matter for health because it changes one's relative position or rank in society, and rank by itself might affect health. Health in animals (for example see Sapolsky, 1993, 1998; though perhaps not, see Pettecrew and Davey-Smith 2003) and perhaps in humans (Marmot 2002) depends on the relative position one has in the social distribution. It is hypothesized that this relationship emerges because individuals at the lower end of the hierarchy have lower control over their lives and are

[10] Leigh finds that controlling for time and risk preferences reduces the effect of education on seat belt use by 25-35 percent. He uses several proxies for both time preferences and risk aversion; it is not clear that they are only measuring the parameters of interest. And he only looks at seat belt use. Fuchs finds almost no reduction of the effect of education on composite measures of self-reported health.

constantly subjected to arbitrary demands by others, causing increases in stress and subsequently resulting in stress-related diseases. More educated individuals are indeed less likely to report negative emotions, including depressive symptoms, anxiety and hostility, which are associated with worse health later in life (Adler et al 1994, Gallo and Matthews, 2003). When faced with negative life events, the more educated are less emotionally responsive as well (McLeod and Kessler 1990). They also report higher sense of control and higher self esteem, which are associated with better health (Ross and Mirowsky 1999). In studies that document these correlations, it is not clear whether education leads to changes in rank, which in turn affects self control, or whether self control affects education and rank.

While the evidence for these theories is intriguing, it cannot be all of the explanation.[11] Life expectancy in the US and other western countries has increased in the last 30 years even though the level of various likely stressors (income inequality, crime, and other measures of low social capital) has increased. Also, Link et al (1998) suggests that cardiovascular disease (which is argued to be correlated with stress) was more prevalent in high SES groups 60 years ago. More generally Link et al argue that there are gradients in diseases that are not known to be related to stress.

Social networks. A different theory stresses social support systems: the more educated have larger social networks which provide financial, physical and emotional support, and may in turn have a causal effect on health (Berkman 1995). The available evidence suggests that even though the more educated are overall more socially connected (for example they have more friends and are more likely to be married), social networks do not appear to explain the association between health and measures of SES (Berkman and Syme 1979). A clinical trial conducted in the late 1990s found that initiation of cognitive behavioral

[11] Although it is worth noting that this theory is difficult to test. For example it is not clear whether ordering alone within the hierarchy matters, or whether distance would matter as well. Also, although in social animals rank may be easily defined (groups tend to be small and hierarchies uniquely defined), it is much less clear how to measure rank in modern industrial societies. There are a variety of reference groups that individuals may fit into, defined by their workplace, educational status, or geographic location, and individuals may have different ranks within each of these groups simultaneously (Deaton and Paxson, 1999).

therapy and antidepressant medication after people had a heart attack did not improve event-free survival (Berkman et al., 2003).

Beyond support, friends and family provide peer recognition or disapproval. Through that mechanism, peers can also have a large influence on negative behaviors, such as drinking and smoking. A large literature shows that individuals with friends who smoke, drink, do drugs, or commit suicide are more likely to engage in the same activities. Use of natural experiments suggests that at least part of this relationship is causal (Sacerdote 2001). If more educated people have more educated friends, who are more likely to behave healthily and value health, the peer effects of networks exacerbate the effects of own education. Although this does not explain why the more educated behave differently to begin with, it is important for policy to know whether there are indeed multiplier effects.

Other theories

Inspired by Link and Phelan (1995), Cutler, Deaton and Lleras-Muney (forthcoming) propose that gradients in health arise or increase when there is knowledge and technology available to prevent or treat disease (a similar theory is tested in Glied and Lleras-Muney, 2003),[12] because there is a universal demand for better health, and those with more education (or more income, or more power) are likely to use new knowledge and new techniques more rapidly and more effectively. This idea is consistent with the fundamental causes of disease hypothesis (Link and Phelan 1995) that suggests that education gives an individual "a wide range of serviceable resources, including money, knowledge, prestige, power and beneficial social conditions, that can be used to one's health advantage". In the absence of knowledge and technology, gradients may exist for other reasons (such as stress), or even be reversed (as is the case with cancers of the reproductive system among women). However this suggests that, in the absence of policies that specifically address health inequalities, increases in medical innovation will result in larger, not

[12] Glied and Lleras-Muney (2003) provide suggestive evidence that education gradients are larger for diseases with more medical progress, although a substantial part of the gradient remains even after accounting for medical progress and its interaction with education.

smaller, gradients (see also van Doorslaer, 1997). This theory is consistent with the evidence that health is improving for all education groups but more so for the more educated. However this theory does not explain why there are gradients in diseases with no treatment; or why differences in smoking and seat belt use have persisted so long.

Summary

Several mechanisms are likely to be involved in better health to some degree and for at least some outcomes, though the relative magnitude of different explanations is unknown. Some hypotheses seem unlikely to be very important: presence of health insurance, and preferences over time and risk do not appear to account for a good part of the association between education and health. Differences in information and cognition, especially in the presence of medical innovations may matter quite a bit, though we are not completely certain about the magnitude of the effect. The role of stress is uncertain.

V. Policy implications

People value health highly. As a result, the health returns to education can outweigh even the financial returns. Many estimates suggest that a year of education raises earnings by about 10 percent, or perhaps $80,000 in present value over the course of a lifetime. We calculate rough estimates of the monetary returns of one more year of schooling in terms of increased life expectancy. These numbers are only suggestive, as they are based on multiple assumptions (most importantly, we use OLS estimates of the effect of education on mortality and interpret them as causal effects). Using data from the National Longitudinal Mortality Study (NLMS) we find that 1 more year of education increases life expectancy by 0.18 years if we use a 3 percent discounting rate; or by 0.6 years without any discounting (it is not clear that one would want to discount health improvements in the same manner one discounts income streams over time). Assuming that a year of health is worth $75,000 – a relatively conservative value (Cutler 2004) – this translates into about $13,500 to $44,000 in present value. These rough calculations suggest that the health returns to education increase the total returns to education by at least 15 percent, and

perhaps as much as 55 percent. Such returns suggest public policy should do more to promote educational attainment.

Even if we accept that a large part of the association between education and health is causal, and that increasing educational attainment improves health, some important questions remain before we can have an appropriate policy response. Causal effects of education on health would call for education subsidies only to the extent there is a market failure and individuals are investing at suboptimal levels; otherwise, individuals would base their education decisions on the health benefits along with the financial benefits. Possible rationales for education subsidies include the idea that individuals may be unaware of the health benefits of education when they make their education decisions, that they be credit constrained, that some groups do not know about or are excluded from higher education, or that there are externalities beyond the individual affected to education and health.[13] Although there are known externalities in the case of infectious diseases, these are a relatively small share of the health profile in the US today, where most of the health benefits to education are in lower chronic disease. There is substantial evidence for the effects of mother's education on children's health; whether one considers these externalities or not is somewhat subject to debate. There may be other externalities across individuals, but causal estimates of these are not available. Whether the other market failures exist or not is empirically less clear. The results in Lleras-Muney (2005) do suggest individuals are not fully aware of the health returns to education, since compulsory schooling yielded such large returns in terms of mortality. Oreopoulous (2006) also finds evidence that individuals' education investments are sub-optimal given the rate of return. Whether this is due to lack of information or credit constraints is not known.

The issue of causality is also important. Although there is evidence of causal effects of education on health at lower levels of schooling (as we reviewed in the previous section), it is not known if the education returns observed after that level are causal. Nor is it known if there are returns to higher quality education. Better understanding of the heterogeneity of the returns to education is also needed. In order

[13] Some believe that disparities by themselves are externalities – if people do not enjoy living in an unequal society. Others have argued that inequality leads to worse health outcomes. Both of these are controversial, so we do not push these factors greatly.

to improve health, it may prove more cost effective to target populations with the largest returns to health, even though this may exacerbate inequities.

In addition, understanding the mechanism by which education affects health is important for policy. It may be more cost effective to tap the mechanism than to increase educational attainment. For example if all of the education effect operated through income, and income improved health, then it would possibly be cheaper to transfer income directly, rather than to subsidize schooling. But increasing educational attainment may prove to be the correct policy response if, for example, there is no alternative (or cheaper) method to acquire the skills that ultimately affect health.

Finally, understanding the general equilibrium effects is important as well. If the effect of education operates mainly through income, increasing the education level of those with the least education may lower the income returns to schooling, and thus ultimately decrease the corresponding health benefits. On the other hand, if the effect operates mainly through the acquisition of information in school, this would not be the case. Spillovers would also increase the returns to education.

In spite of these caveats, education policies have the potential to have a substantial effect on health. Assuming that the observed correlations between education and health are long term causal effects from education to health, that the relationship is linear and identical across gender, race and other groups, we can roughly calculate the health returns of education policies. Dynarski (2003) finds that offering $1,000 (in 1998 dollars) of grant aid results in an increase in education of 0.16 years, which translates into 0.03-0.10 years of additional life (depending on discounting). This is roughly $2,250-$7,200 in present value. This is a very large rate of return. If there is any uncertainty about whether education truly improves health, it is far better to err on the side on more subsidies as opposed to less.

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Data Appendix

We draw on data from the 1990, 1991 and 2000 waves of the National Health Interview Survey (NHIS). Whenever possible, we use data from the 2000 survey, which allow us to control for health insurance coverage. (The 1990 and 1991 surveys did not collect health insurance data.) From 1990, we use the Health Promotion and Disease Prevention Supplement to analyze self-reports of high cholesterol, fair or poor health, and attempted smoking cessation, in addition to all outcomes related to household safety, automobile safety, and control of hypertension. All data on illegal drug use are drawn from the Drug and Alcohol Use Supplement to the 1991 NHIS. The remaining outcome variables are from the Person and Adult Sample of the 2000 NHIS. We analyze data on individuals at least 25 years old, dropping observations with missing data for any of the covariates.

For our mortality analyses, we also link the 1990 data to the National Death Index (NDI), a centralized, nation-wide database of information from death certificates. Individuals from the NHIS missing key identification data were deemed ineligible by the NDI, so we omit them from our analyses. Our mortality measure is a binary indicator of death from any cause before the start of 1996.

Most of our other outcomes are self-explanatory, but a few require a bit more clarification on details. Self reports of acute or chronic disease diagnoses came from questions of the form, "Has a doctor ever told you that you have ...?" The heart condition variable reflects whether the respondent has ever been diagnosed with hypertension, coronary heart disease, angina, a heart attack, or any other heart condition/disease. The pain variable reflects whether the respondent had joint aches in the past 12 months or neck pain, lower back pain, jaw pain, or severe headaches in the past 3 months. The sickness variable reflects whether the respondent had a cold or stomach problems over the past 2 weeks.

Mental health outcomes were constructed by summing the respondent's subjective assessments of feelings of nervousness, restlessness, sadness, hopelessness, effort, and worthlessness. The respondent estimated how often he or she had experienced each of these affective states over the past 30 days: none of the time, a little of the time, some of the time, most of the time, or all of the time. These responses were coded 0-4, respectively, and then summed to produce scales of anxiety (the sum of nervousness and restlessness) and depression (the sum of sadness, hopelessness, effort, and worthlessness). With regard to depression interfering with the respondent's life, the relevant question was asked only of individuals who reported experiencing at least one negative affective state, most or all of the time.

Table 1: Effect of education on health, adults 25 and over

	w/ Limited Controls		w/ Broader Controls		w/ Occupation and Industry			
Dependent Variable	Years of Education	SE	Years of Education	SE	Years of Education	SE	Obs	Mean
5-year mortality	-0.0047**	[0.0005]	-0.0026**	[0.0006]	-0.0026**	[0.0006]	35393	0.11
Self Report of Disease Diagnosis								
Heart condition	-0.0054**	[0.0011]	-0.0035**	[0.0013]	-0.0033*	[0.0014]	28343	0.31
Cancer	0.0018**	[0.0004]	0.0011*	[0.0005]	0.0009	[0.0005]	28180	0.07
Stroke	-0.0010**	[0.0002]	-0.0004*	[0.0002]	-0.0003*	[0.0001]	22480	0.03
Ulcer	-0.0032**	[0.0005]	-0.0012*	[0.0006]	-0.0006	[0.0006]	28255	0.08
Hepatitis	0.0008	[0.0004]	0.0013**	[0.0005]	0.0013**	[0.0005]	27821	0.04
Chickenpox	0.0096**	[0.0008]	0.0058**	[0.0009]	0.0048**	[0.0009]	26410	0.85
Hay fever or sinusitis, past 12 mos	0.0075**	[0.0010]	0.0064**	[0.0012]	0.0046**	[0.0013]	28307	0.22
Pain, past 12 mos	-0.0060**	[0.0012]	-0.0053**	[0.0015]	-0.0037*	[0.0015]	28345	0.49
Sickness, past 2 weeks	-0.0037**	[0.0008]	-0.0025**	[0.0009]	-0.0032**	[0.0010]	28334	0.15
Asthma episode, past 12 mos	-0.0007	[0.0004]	-0.0002	[0.0004]	-0.0007	[0.0004]	28156	0.03
Ulcer, past 12 months	-0.0024**	[0.0002]	-0.0009**	[0.0003]	-0.0006**	[0.0002]	27584	0.02
Hypertension	-0.0066**	[0.0009]	-0.0048**	[0.0011]	-0.0046**	[0.0011]	28321	0.25
High cholesterol °	-0.0059**	[0.0014]	-0.0045**	[0.0016]	-0.0036*	[0.0017]	20110	0.32
Emphysema	-0.0011**	[0.0002]	-0.0006**	[0.0001]	-0.0004**	[0.0001]	23997	0.02
Asthma	0.0002	[0.0007]	0.0008	[0.0008]	-0.0003	[0.0008]	28258	0.09
Diabetes	-0.0032**	[0.0004]	-0.0015**	[0.0004]	-0.0016**	[0.0004]	28151	0.07
Functioning								
In fair or poor health °	-0.0152**	[0.0006]	-0.0082**	[0.0005]	-0.0073**	[0.0005]	35774	0.12
Anxiety (scale from 0 to 8)	-0.0483**	[0.0041]	-0.0286**	[0.0046]	-0.0316**	[0.0050]	28350	1.05
Depression (scale from 0 to 16)	-0.1268**	[0.0068]	-0.0748**	[0.0077]	-0.0711**	[0.0084]	28350	1.2
Effect of Health								
# work loss days, past 12 mos	-0.5768**	[0.0857]	-0.4680**	[0.0933]	-0.4082**	[0.1086]	19112	5.15
# bed days, past 12 mos	-0.5623**	[0.0663]	-0.3442**	[0.0776]	-0.3767**	[0.0875]	27935	4.75
Depression hindered life, past mo	-0.0165**	[0.0024]	-0.0061*	[0.0027]	-0.0063*	[0.0028]	7722	0.62
Any functional limitations	-0.0160**	[0.0011]	-0.0104**	[0.0013]	-0.0104**	[0.0014]	28263	0.33

Note: The first column (limited controls) includes a full set of age dummies, race, and gender. The second column (broader controls) adds Hispanic origin, family income, family size, major activity, region, MSA, marital status, and whether covered by health insurance. Outcomes marked with ° came from waves of the NHIS that did not collect health insurance data, so health insurance is not included in these regressions. The third column adds occupation and industry dummies to the limited and broader controls.

Table 2: Effect of education on health behaviors, adults 25 and over

	w/ Limited Controls		w/ Broader Controls		w/ Occupation and Industry			
Dependent Variable	Years of Education	SE	Years of Education	SE	Years of Education	SE	Obs	Mean
Smoking								
Current smoker	-0.0218**	[0.0009]	-0.0186**	[0.0011]	-0.0141**	[0.0012]	28154	0.23
# cigs a day (smokers)	-0.3780**	[0.0672]	-0.4129**	[0.0703]	-0.2926**	[0.0736]	6276	16.65
Made serious attempt to quit °	0.0133**	[0.0025]	0.0105**	[0.0027]	0.0084**	[0.0028]	9211	0.62
Alcohol								
Had 12+ drinks in entire life	0.0187**	[0.0009]	0.0097**	[0.0011]	0.0098**	[0.0011]	28042	0.78
Drink at least once per month	0.0319**	[0.0014]	0.0183**	[0.0016]	0.0183**	[0.0017]	27711	0.45
# days had 5+ drinks past year	-1.7572**	[0.1711]	-1.5787**	[0.1858]	-1.2149**	[0.2094]	16311	11.1
Average # drinks on days drank	-0.1720**	[0.0138]	-0.1410**	[0.0136]	-0.1131**	[0.0157]	16491	2.38
Diet/Exercise								
Body mass index (bmi)	-0.1996**	[0.0127]	-0.1270**	[0.0150]	-0.1269**	[0.0157]	27253	26.88
Overweight (bmi>=25)	-0.0172**	[0.0013]	-0.0122**	[0.0015]	-0.0113**	[0.0016]	27253	0.6
Obese (bmi>=30)	-0.0129**	[0.0009]	-0.0087**	[0.0011]	-0.0088**	[0.0012]	27237	0.23
How often eat fruit or veggies per day	0.0658**	[0.0033]	0.0585**	[0.0039]	0.0515**	[0.0040]	28350	1.88
Ever do vigorous activity	0.0489**	[0.0015]	0.0359**	[0.0017]	0.0322**	[0.0018]	28000	0.38
Ever do moderate activity	0.0418**	[0.0014]	0.0306**	[0.0016]	0.0286**	[0.0017]	27724	0.51
Illegal Drugs (Ages 25-44)								
Ever used marijuana °	0.0189**	[0.0018]	0.0085**	[0.0021]	0.0092**	[0.0024]	16220	0.46
Used marijuana, past 12 months °	-0.0009	[0.0007]	-0.0021*	[0.0008]	-0.001	[0.0009]	16212	0.08
Ever used cocaine °	0.0055**	[0.0011]	0.0003	[0.0013]	0.0009	[0.0014]	15929	0.15
Used cocaine, past 12 months °	-0.0003	[0.0003]	-0.0004	[0.0003]	-0.0001	[0.0003]	15247	0.02
Ever used any other illegal drug °	0.0047**	[0.0013]	0.0005	[0.0015]	0.0023	[0.0018]	16175	0.2
Used other illegal drug, past 12 ms °	-0.0015*	[0.0006]	-0.0012	[0.0007]	-0.0007	[0.0007]	15726	0.05
Household Safety								
Know poison control number °	0.0466**	[0.0025]	0.0337**	[0.0029]	0.0301**	[0.0032]	8517	0.6
1 + working smoke detectors °	0.0207**	[0.0009]	0.0113**	[0.0009]	0.0101**	[0.0010]	34455	0.79
House tested for radon °	0.0066**	[0.0004]	0.0038**	[0.0003]	0.0032**	[0.0004]	33478	0.04
Home paint ever tested for lead °	-0.0001	[0.0007]	0.0001	[0.0006]	-0.0007	[0.0006]	11519	0.05

Table 2 (continued)

	w/ Limited Controls		w/ Broader Controls		w/ Occupation and Industry			
Dependent Variable	Years of Education	SE	Years of Education	SE	Years of Education	SE	Obs	Mean
Automobile Safety								
Always wear seat belt °	0.0295**	[0.0011]	0.0236**	[0.0012]	0.0185**	[0.0013]	35585	0.68
Never wear seat belt °	-0.0097**	[0.0005]	-0.0078**	[0.0006]	-0.0057**	[0.0006]	35567	0.09
Preventive Care-recommended population								
Ever had mammogram (age 40+)	0.0149**	[0.0011]	0.0081**	[0.0013]	0.0072**	[0.0013]	10126	0.86
Had mammogram, past 2 yrs (age 40+)	0.0270**	[0.0021]	0.0153**	[0.0025]	0.0155**	[0.0026]	10061	0.55
Ever had pap smear test	0.0045**	[0.0004]	0.0028**	[0.0004]	0.0022**	[0.0003]	15064	0.96
Had pap smear, past yr	0.0258**	[0.0017]	0.0143**	[0.0019]	0.0121**	[0.0020]	15129	0.62
Ever had colorectal screening (age 40+)	0.0217**	[0.0014]	0.0169**	[0.0016]	0.0153**	[0.0016]	17586	0.29
Had colonoscopy, past yr (age 40+)	0.0060**	[0.0008]	0.0045**	[0.0008]	0.0034**	[0.0008]	17490	0.09
Ever been tested for hiv	0.0126**	[0.0013]	0.0132**	[0.0015]	0.0113**	[0.0016]	26456	0.32
Had an std other than hiv/aids, past 5 y	0.0003	[0.0004]	0.0000	[0.0004]	0.0001	[0.0004]	14659	0.02
Had flu shot past 12 mo	0.0172**	[0.0012]	0.0123**	[0.0014]	0.0091**	[0.0014]	28013	0.31
Ever had pneumonia vaccination	0.0052**	[0.0007]	0.0045**	[0.0008]	0.0046**	[0.0008]	27554	0.16
Ever had hepatitis b vaccine	0.0185**	[0.0011]	0.0178**	[0.0013]	0.0126**	[0.0014]	26826	0.2
Received all 3 hepatitis B shots	0.0154**	[0.0009]	0.0147**	[0.0011]	0.0097**	[0.0011]	26453	0.15
Among Diabetics								
Are you now taking insulin	-0.0008	[0.0038]	-0.0039	[0.0046]	-0.0031	[0.0048]	2006	0.33
Are you now taking diabetic pills	-0.0059	[0.0040]	-0.0023	[0.0048]	-0.0011	[0.0049]	1997	0.66
Among Hypertensives								
Still have high bp °	-0.0104**	[0.0022]	-0.0079**	[0.0024]	-0.0077**	[0.0026]	8591	0.49
High bp is cured (vs controlled) °	0.0006	[0.0027]	-0.0022	[0.0031]	-0.0023	[0.0033]	4185	0.26
Blood pressure high at last reading °	-0.0043**	[0.0005]	-0.0033**	[0.0005]	-0.0029**	[0.0005]	33569	0.08

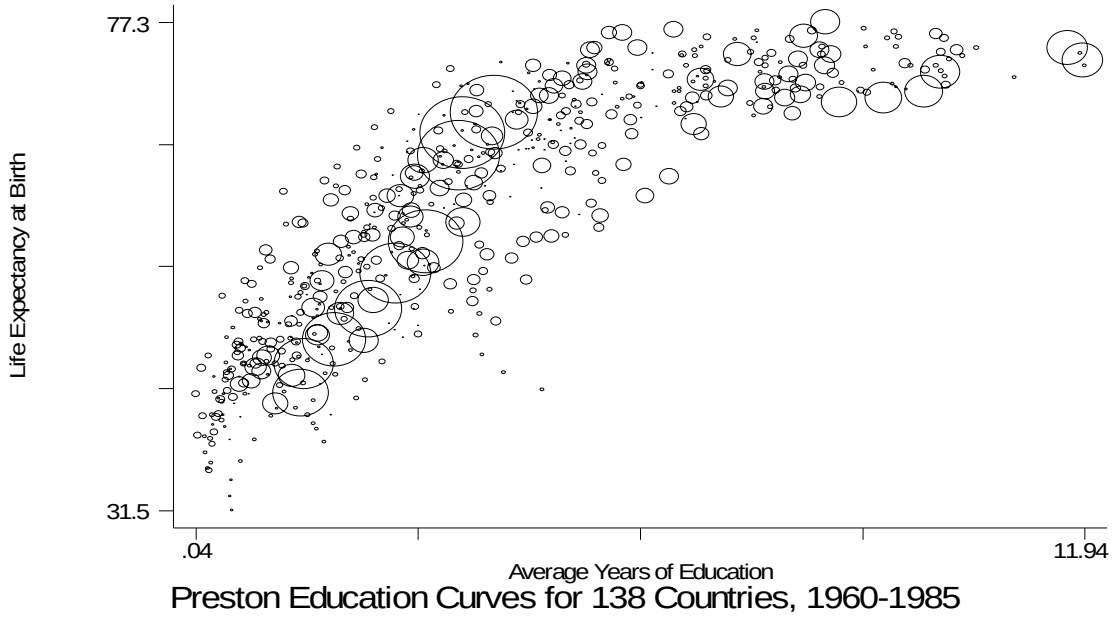
Note: The first column (limited controls) includes a full set of age dummies, race, and gender. The second column (broader controls) adds Hispanic origin, family income, family size, major activity, region, MSA, marital status, and whether covered by health insurance. Outcomes marked with ° came from waves of the NHIS that did not collect health insurance data, so health insurance is not included in these regressions. The third column adds occupation and industry dummies to the limited and broader controls.

Table 3: Effect of education by gender, income and age for selected outcomes

All	Male	Female	≠ sig?	White	Black	≠ sig?	Inc ≥ 20k	Inc < 20k	≠ sig?
5-year mortality									
-0.005	-0.006	-0.003		-0.005	-0.007		-0.004	-0.005	
(0.001)	(0.001)	(0.001)		(0.001)	(0.002)		(0.001)	(0.001)	
[-4.16%]	[-4.76%]	[-3.21%]		[-4.22%]	[-2.94%]		[-4.16%]	[-2.88%]	
Any functional limitations									
-0.016	-0.014	-0.018		-0.018	-0.012		-0.013	-0.003	**
(0.001)	(0.001)	(0.002)		(0.001)	(0.003)		(0.001)	(0.002)	
[-4.94%]	[-4.95%]	[-4.93%]		[-5.21%]	[-5.81%]		[-4.68%]	[-0.62%]	
In fair or poor health									
-0.015	-0.013	-0.017		-0.015	-0.022	**	-0.008	-0.021	**
(0.001)	(0.001)	(0.001)		(0.001)	(0.002)		(0.001)	(0.001)	
[-12.21%]	[-11.63%]	[-12.61%]		[-12.93%]	[-7.44%]		[-11.28%]	[-8.85%]	
Depression scale (0=lowest, 16=highest)									
-0.127	-0.093	-0.161	**	-0.132	-0.138		-0.101	-0.074	
(0.007)	(0.009)	(0.010)		(0.008)	(0.019)		(0.008)	(0.014)	
[-10.5%]	[-9.0%]	[-11.9%]		[-13.2%]	[-10.5%]		[-10.1%]	[-3.6%]	
Obese (BMI ≥ 30)									
-0.013	-0.009	-0.017	**	-0.013	-0.012		-0.014	-0.005	**
(0.001)	(0.001)	(0.001)		(0.001)	(0.003)		(0.001)	(0.002)	
[-5.69%]	[-4.00%]	[-7.52%]		[-5.98%]	[-4.11%]		[-6.63%]	[-2.04%]	
Moderate activity									
0.042	0.043	0.04		0.045	0.035		0.041	0.027	**
(0.001)	(0.002)	(0.002)		(0.002)	(0.004)		(0.002)	(0.002)	
[8.14%]	[8.36%]	[7.95%]		[8.43%]	[11.23%]		[7.47%]	[7.46%]	
Current smoker									
-0.024	-0.03	-0.018	**	-0.024	-0.019	**	-0.028	-0.008	**
(0.001)	(0.002)	(0.001)		(0.001)	(0.003)		(0.001)	(0.002)	
[-9.25%]	[-10.4%]	[-7.78%]		[-9.54%]	[-8.49%]		[-11.71%]	[-2.70%]	
Number of days had 5+ drinks past year									
-1.744	-2.556	-0.450	**	-1.888	-2.478		1.571	-1.257	
(0.170)	(0.275)	(0.095)		(0.197))	(0.553)		(0.178)	(0.335)	
[-15.8%]	[-14.1%]	[-13.4%]		[-17.6%]	[-18.6%]		[-15.4%]	[-6.9%]	
Ever had colorectal screening (age 40+)									
0.022	0.027	0.017		0.024	0.014		0.024	0.014	**
(0.001)	(0.002)	(0.002)		(0.002)	(0.003)		(0.002)	(0.002)	
[7.39%]	[8.83%]	[5.96%]		[7.86%]	[10.77%]		[8.16%]	[4.73%]	
Always wear seat belt									
0.03	0.031	0.029		0.032	0.019	**	0.032	0.017	**
(0.001)	(0.002)	(0.001)		(0.001)	(0.003)		(0.002)	(0.002)	
[4.32%]	[4.83%]	[3.97%]		[4.62%]	[5.40%]		[4.51%]	[2.84%]	
Has smoke detector									
0.021	0.021	0.02		0.019	0.034	**	0.014	0.02	**
(0.001)	(0.001)	(0.001)		(0.001)	(0.003)		(0.001)	(0.002)	
[2.60%]	[2.70%]	[2.50%]		[2.39%]	[2.69%]		[1.63%]	[2.92%]	

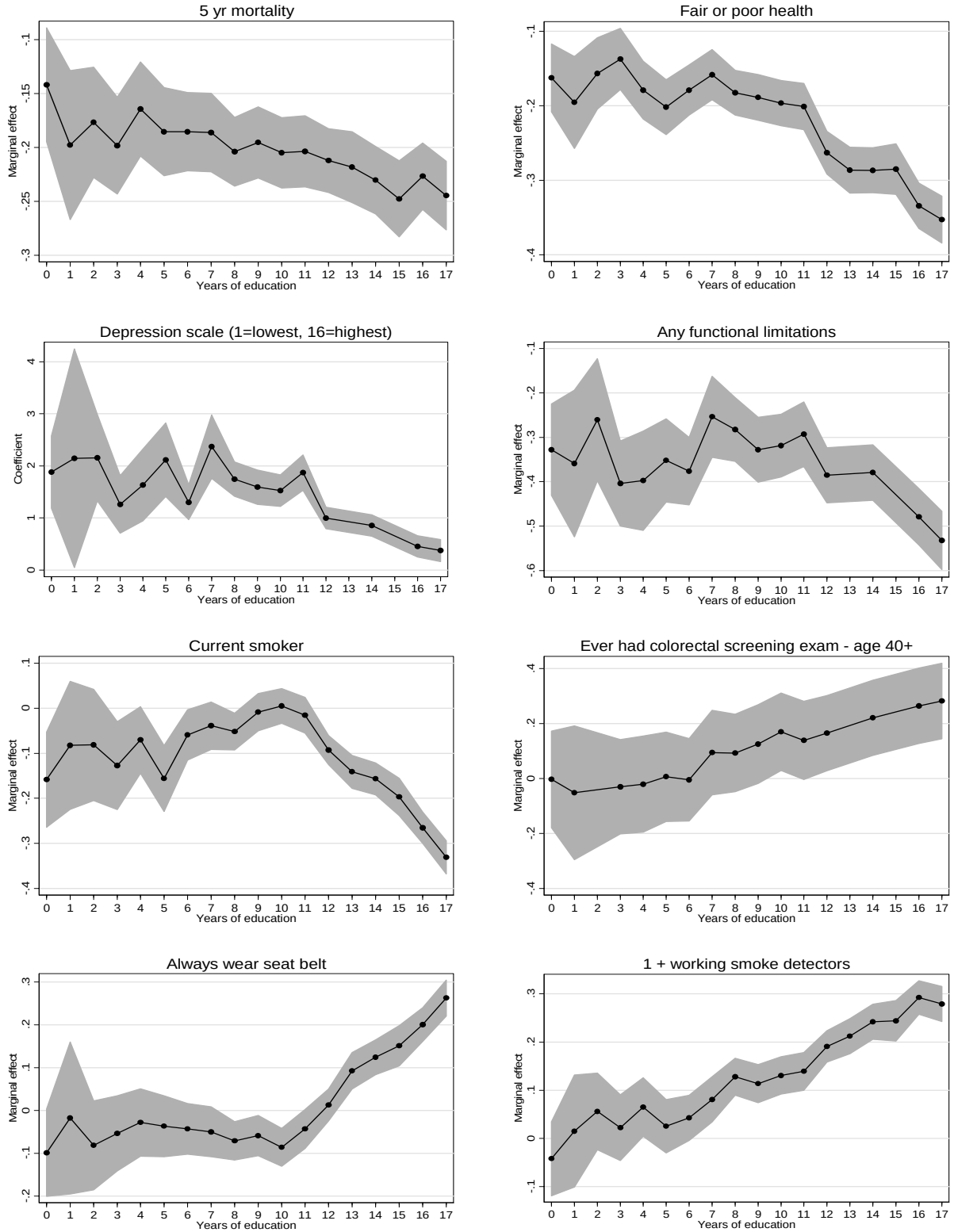
Note: OLS coefficients or marginal effects with standard errors in parentheses. Brackets express the coefficient as a percentage of the variable mean. Asterisks are for tests of equality between coefficients: * 10%, ** 5%.

Figure 1: The relationship between education and life expectancy across countries



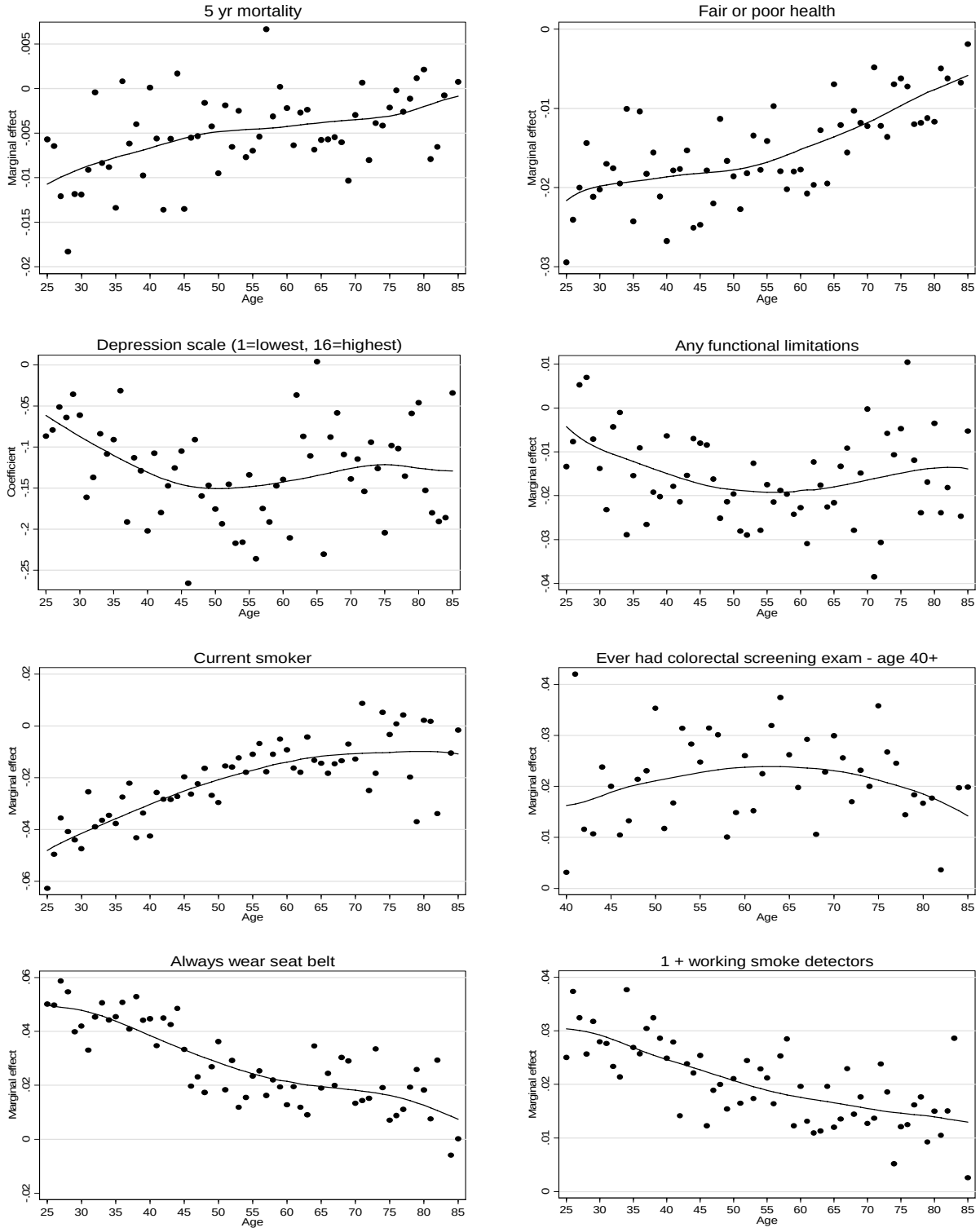
Note: Circle size proportional to country population. Authors' calculation using the Barro-Lee international data.

Figure 2: Effect of education on various health measures, by single year of schooling



Note: Marginal effects from logit regressions on education, controlling for race and gender. The shaded areas are 95% confidence intervals for each coefficient.

Figure 3: Effect of education on various health measures, by single year of age



Note: Marginal effects from age-specific logit regressions on education, controlling for race and gender. Curve fitted using a locally weighted regression smoother, with a bandwidth of 0.8.