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SUBTITLE: A response to Maitra

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In her commentary on our article originally published in the *Proceedings of the National Academy of Science* (Goldman & Smith, 2002), Maitra discount the importance of factors related to self-management of disease and then claims that economic resources—in particular household wealth and health insurance—are the most important factors explaining the health education gradient (Maitra, 2010). We disagree.

First, our paper is based on three complementary studies. The first involved a national probability sample of HIV-infected individuals (HCSUS) and examined patients receiving highly active antiretroviral therapy (HAART) and their adherence to that regimen. We demonstrated that the fraction using HAART, as well as the fraction adhering to the appropriate regimen, were both strongly related to schooling. For these two adherence measures, all education groups above high school were statistically different than the lowest education category. Finally, we found that both using HAART and effectively adhering to this treatment were associated with improvements in health status over time as measured by changes in general health status and CD4 cell counts per mm. Nowhere in their comment is the evidence from this study contested.

The second—and by far our most important—study was a randomized prospective diabetes clinical trial (Diabetes Control and Complications Trial or DCCT). In this trial, diabetes patients were randomized to either an intensive or conventional therapy and followed through from the mid-1980s until 1993. Randomization is key since assignment to treatment was random by education groups allowing us to estimate differential impacts of enforced effective treatment across patients in different SES groups. DCCT was also our preferred diabetes study since it provided a far more objective health outcome measure—changes in glycosylated hemoglobin.

At baseline of DCCT, the less educated were clearly engaging in worse adherence behavior (ie. the fraction missing an insulin injection among those with a high school degree or less was twice that of those with a post-graduate degree). The intensive therapy in DCCT

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included insulin injections three or more times daily or an external pump and were strictly enforced—patients were seen weekly at the clinic until a stable treatment program was achieved and then at least monthly. Telephone contact was made daily for the first week and weekly thereafter.

Our results clearly showed that imposing intensive regime of adherence had a much larger impact on better health for less educated diabetic patients, and it is from this study that the title of our paper is derived. Being in the treatment group that had good adherence enforced on them eliminated 72% of the health outcome differences by education among these diabetics. Regardless of whether education's effect is causal or not, our paper shows that interventions to improve self-management will be more effective among the less-educated population and can also help reduce health disparities. As the DCCT trials shows, these can be achieved without providing health insurance to everyone (which does not improve adherence in our studies) or giving everyone an extra 'dose' of education. Analysis using randomized data is much less likely to be subject to various estimation biases stemming from non-random assignment or endogeneity encountered in observational studies, including clinical heterogeneity. Our evidence from this DDCT study is not mentioned in this comment.

The third study was a social science survey least well-suited to this task—namely, the Health and Retirement Study (HRS). The label least well suited is applied due both to the subjective health outcome measure, but mostly to the limited information available in the HRS on adherence. HRS diabetic respondents are asked at each wave whether they were taking medication that they swallowed and/or an insulin injection. Since there is no information available on episodes when medication is missed or injections are skipped, we could only use patterns available at the two year intervals of the survey. In spite of the admittedly limited data on adherence behavior, our analysis showed that poor treatment maintenance behavior was more common among the less educated and was negatively correlated with subsequent good health.

While we would prefer the evidence in our paper be considered as a whole, Maitra's (2010) commentary only revisits the HRS observational diabetes study, so a more appropriate title might be "Can Patient Self-Management Explain the Health Gradient? *One third of* Goldman and Smith (2002) Revisited." While we should not be giving new titles to comments on our work, we would like to hold Maitra to the same standard. The original title of our article was "Can Patient Self-Management ***Help*** Explain the Health Gradient?" and we have highlighted the omitted word in bold and italics. Since there was never a claim that adherence behavior was the sole explanation of the SES health gradient or for that matter even the most important, we are a bit puzzled by this comment since it also shows that adherence behavior, even when not well measured, does improve health.

Alternative Mechanisms

In the last half of her paper, Maitra (2010) goes beyond our evaluation of the role of adherence behavior to explore alternative mechanisms that might drive the education health gradient. They divide explanations into four categories—economic factors (net worth, perceptions of hardship, and health insurance), health behaviors (smoking, drinking, and exercise), preferences (risk aversion, value of future), and social connectedness (to near-by relatives, friends, neighbors). Using the same sample of diabetics as before and modeling changes in health over a four year period by examining changes in coefficients on education induced by excluding or including these concepts in the model, Maitra reports essentially no role for health behaviors, preferences, and social connectedness, a small role for cognition and more major roles for economic resources (in particular wealth) and health insurance.

From this, Maitra reaches the principal conclusion that economic factors such as resource availability and insurance access are the most important mechanisms behind the education gradient (Maitra, 2010).

We will argue instead that the analysis presented by Maitra is completely non-informative about whether or not economic resources and/or insurance access have anything to do with the education gradient in health. The first issue is that there is no such thing as *the* health gradient. This analysis is based on a sample of middle-aged diabetics, and thereby excludes any role factors such as health behaviors (i.e., exercise) and others may have played in determining whether or not one is diabetic, which may be their primary pathway through which they operate. We selected this sample since it helps focus on our specific question about the role of adherence among the chronically ill, but it is a poor sample to use for a more general analysis of the roles of economic factors, health behaviors, preferences, social connectedness and the like.

But the conceptual problems are much deeper than that. First take the case of having health insurance. The variation observed in this data especially across education groups is not simply about having health insurance, but also in the form of health insurance. The large education effects in the data as demonstrated in Maitra (2010) in Table 7 are sharp increases by education in the probability of having employer-provided private health insurance and decreases by education in the probability of having federal insurance and these are associated with deterioration in health. If one re-estimates Maitra's model in Table 6 by including a single variable indicating having health insurance of any form, the effects on the education coefficient are much more modest—half as large for the 16+ years of schooling group for example. A much more likely scenario for the remainder of the effect is that especially in this pre-retirement age group of 51-61 years old at baseline, as people get sicker they leave the labor market foregoing their employer-provided health insurance and obtaining government health insurance in its place. It is not the lack of health insurance that is making them more ill, but rather the type of health insurance they have is a marker for their deteriorating health.

The conceptual problems are even more severe with the primary measure of economic resources used in their study—family net worth. Wealth is by far the most endogenous measure of economic resources, as most individuals start with virtually zero and then try to accumulate by savings over their lifetimes for emergencies, retirement, and bequests. Bad health is a well documented deterrent to the ability to save, depleting previously accumulated assets (Smith, 1999; 2004). But causation could certainly operate in both directions so what is the evidence about the effect of wealth on subsequent health.

One learns nothing about the answer to that question by estimating the kind of models used in this paper—baseline wealth on subsequent health. Resources could improve health (although exactly why is not so clear given their health insurance is controlled), but poor health also inhibits work and reduces income and wealth. The estimated coefficients in the models in this paper tell us nothing about which pathway matters more or at all. To estimate the 'effect of either on the other requires exogenous variation in SES (or health) that is not induced by health (or SES) (Smith, 1999).

A better way of disentangling dual pathways between net worth and health is to use wealth changes that are largely due to changes in asset prices (primarily home prices and stock market). It is not plausible that these wealth changes were due to individual health problems. Especially in the 1980s and 1990s such asset price changes resulted in wealth changes in the hundreds of millions of dollars. In a recent paper (Banks, Muriel, & Smith, 2009), one of us reported that using a long panel of HRS respondents in the same initial age group as used in

this paper, that subsequent mortality or onset of illness was not related to wealth changes experienced during the prior ten year period. The median wealth change between the bottom and top wealth change quintile was over half a million dollars. With the exception of the bottom quintile, estimated effects of the change in wealth on mortality and disease onset were essentially zero in all specifications in spite of the \$455,000 wealth change difference across 80% of the sample. There was no evidence that across most of the sample that increases in wealth—even when large—are protective of subsequent health.

Those in the bottom wealth quintile did have higher mortality compared to any of the other wealth change quintiles. But their wealth actually fell over this period. A more likely explanation is that these individuals were hit by health shocks which lead them to deplete their assets in order to continue to finance their consumption, pay their medical bills, and perhaps to avoid asset tests in social programs. This analysis supports the view that the primarily pathway between health and wealth is that poor health reduces household wealth.

While we are not persuaded by the main arguments of Maitra (2010), we do appreciate her constructive tone and efforts to move the debate forward on these crucial issues on population health on which reasonable people can disagree. We continue to believe that differences in disease self-management among the chronically ill are an important but by no means the only part of the story. We also appreciate the offer from the editors of *Social Science & Medicine* to allow us to respond to this critique.

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