

Health Selection vs. Causation in the Income Gradient: What Can We Learn from Graphical Trends?

Peter Muennig, MD, MPH

Abstract: Income produces health, and sickness negatively affects earnings. These two factors likely explain the income gradient in health, but each has very different policy implications. In this paper, I examine graphical trends in mortality risk between low-income and higher-income people by age and gender. These trends suggest that forward causality (income affecting health) is more important than reverse causality (health affecting income) in the income-health gradient. However, there is some evidence to suggest that reverse causality plays an important role for younger men.

Key words: Socioeconomic status, education, income, distributional effects.

Low income increases one's exposure to a host of health risks, such as crime, poor housing, and poor nutrition.¹ Conversely, sick people both tend to work less and tend to accrue medical bills, thus lowering their household earnings and accumulated wealth.² Therefore, low income can damage health, and sickness can lead to the loss of income.

The association between income and health is large. Approximately 17.4 million excess quality adjusted life years (QALYs) are lost annually in the U.S. among the lower 80% of income earners.³ If most of this excess loss of healthy life is due to the effects of low income on health, the policy priority should include redistributive programs, such as early education interventions, earned income tax credits, or social insurance.⁴⁻⁶ Such programs help to reduce income inequalities, improve earnings, and reduce financial blows associated with job loss, thereby addressing downstream health risks such as exposure to crime or lack of health insurance. On the other hand, if the negative effect of poor health on income explains most of the gradient, then society's resources should be diverted to preventive health interventions and disability insurance.

Researchers examining the question of causal direction have found that both forward and reverse causality play a role in the income-health relationship. For instance, Lynch et al. studied a large cohort of individuals who were healthy, and found a significantly higher risk of later life morbidity among those who had a total household income level less than 200% of the poverty line relative to those who had household earnings greater

PETER MUENNIG is an Assistant Professor in the Department of Health Policy and Management at Columbia University. Please address correspondence to Peter Muennig, MD, MPH, Columbia University, Health Policy and Management, 600 W. 168th St., New York, NY 10032; pm124@columbia.edu.

than 200% of the poverty line the poverty line.⁷ Similarly, Smith examined healthy people of similar income, and found that the household wealth of those who become ill grows much more slowly than that of those who remain well.²

However, there is uncertainty surrounding which effect explains most of the income gradient. For instance, one natural experiment on changes in Social Security payouts in the U.S. suggests that increases in income late in life do not improve health (and may even be harmful).⁸ On the other hand, structural equation modeling suggests that the effect of income on health is greater than the effect of health on income.⁹ These authors found that psychological distress plays a significant role in the socioeconomic status health relationship, accounting for a substantial portion of the previously unexplained variation in this relationship. Thus, the critical public policy question remains: Should society invest more in redistributive interventions (e.g., education programs) or protective interventions (e.g., disability insurance)? One overlooked answer to this question may be found in graphical data describing the changes in relative health risks by age and income.

Hypothetical reverse causality model. Adults are more likely to become sick as they age, so the opportunity for health to adversely affect household earnings grows continuously until around age 65. After retirement, illness should not produce job loss, and Medicare should provide a buffer against medical costs among the under-insured or uninsured. Thus, if health differences explained the health-income gradient, we would expect the health gap between the higher-income and lower-income populations to grow steadily until one reaches his or her mid 60s (Figure 1, panel 1).

We would also likely see gender effects. Men are the dominant income earners in many male-female households, because they both earn more and are more likely to be employed.¹⁰ A woman's loss of her job due to illness or death, on average, therefore has a smaller impact on household earnings than a man's job loss.¹⁰ Thus, if poor health is predominantly driving the income-health gradient, we would expect that the gradient would be weaker for women than for men. Moreover, because men have higher mortality, and mortality rates accelerate with age, there should be relatively greater household income losses as older men die off.¹¹ We would therefore expect the

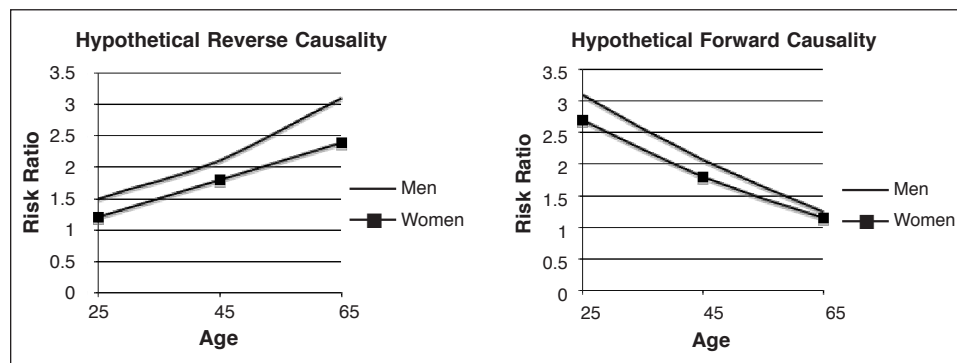


Figure 1. Hypothetical age versus risk ratio graphs for reverse and forward causality in the income gradient. (Data for males and females presented separately.)

relationship between the risk of death and income to strengthen more with age for men than for women (Figure 1, panel 1).

Hypothetical forward causation model. On the other hand, if causality moves predominantly from income to health, one would expect to see a diminishing difference in risk of mortality between low-income and high-income subjects as they age (Figure 1, panel 2). Adverse environmental conditions associated with low income affect the organism throughout the lifecycle, causing low-income populations to die prematurely.¹² Only those low-income individuals with the strongest genes or the most favorable environmental circumstances are likely to survive to an old age. The resulting gradual improvement in risk for low-income relative to high-income populations with age is known as the *survivor effect*.¹² If low income is the primary force driving the income gradient in health, therefore, the survivor effect is likely to result in an overall decline in relative mortality risk by income as low-income populations age (Figure 1, panel 2).

The difference in risky health behaviors by social class is much greater among men than among women.¹³ Thus, men should generally have a higher differential mortality risk by household earnings than women regardless of whether the income-health relationship runs predominantly in the forward or reverse direction. However, because selection factors are greater for men (e.g., they have a higher prevalence of risky health behaviors), we should see convergence in mortality risk by gender as subjects age due to the survivor effect (Figure 1, panel 2).

Methods

To examine the relative contribution of forward causality and reverse causality, I defined the predicted shape of the curves *a priori*, as shown in Figure 1. I then inspected actual data to ascertain whether the curves suggested dominance of forward or reverse causality in the gradient.

The two graphs in Figure 1 demonstrate the hypothetical relationship between age and the relative risk of mortality by low relative to high household earnings. If both played an equal role, we would expect to find that the relationship remained relatively constant up to age 65.

In Figure 2, we see actual trends for both household income and educational attainment, adjusted for age, within each interval. These graphs were generated from data analyses by Sorlie et al. using the National Mortality Follow-up Survey (NMFS).¹¹ The NMFS included a representative sample of 530,507 non-institutionalized persons living in the U.S. and followed from 1979 through 1989. Of these subjects, 54,304 died during the study interval. Because the NMFS is very large, it is highly unlikely that any graphs generated using these data will contain random contour variations.

Results

In Figure 2 (panel 1), we see that the risk of death clearly trends downward with age. We also see evidence of survival bias in the male cohort, also supporting the hypothesis that income predominantly produces health.

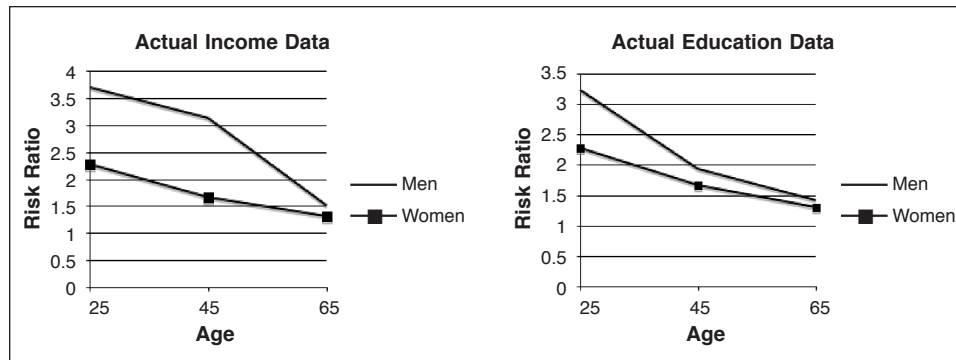


Figure 2. Age versus risk ratio graphs for income (\$12,600 relative to \$126,100 in 2007 dollars) and education (grade school only relative to college graduates). 1980 U.S. dollars were adjusted to 2007 U.S. dollars using the Consumer Price Index to provide readers with a better sense of modern disparities in income.

Moreover, the relationship between educational attainment and mortality risk by age shows somewhat similar trends as household income and mortality risk by age, suggesting that income trends are consistent with other factors in the SES gradient (panel 2). Because most people complete their education by age 25, the education gradient is not susceptible to reverse causality to the same extent that income may be.

However, educational attainment is positively correlated with household income, and this could explain the shape of Figure 2. To control for such confounding, the same graph must be generated after controlling for educational attainment, employment status, marital status, and household size. When this is done, the slope over the 45–65 age interval becomes even steeper (Figure 3). Thus, isolating the effects of household income on the risk of mortality only strengthens the argument that the bulk of the causal association is forward.

One exception here can be found for men between the ages of 25 and 45. Here, we see a slight increase in risk with age before the risk again drops off. While the relative deterioration in health is mild in this age range, younger households are uniquely susceptible to economic shocks; such households have not generally had a chance to build wealth. Therefore, it is possible that this represents evidence of reverse causality in this age range.

Conclusion

In sum, income-health trends by age suggest that income predominantly produces health. Nevertheless, this graphical relationship could still be explained by unmeasured covariates confounding the relationship. Moreover, while the data suggest the relative importance of each variable, this analysis does not lend itself to a precise quantification of reverse or forward causality; it merely shows that the net causal direction is forward. Still, it does reinforce the growing consensus in the public health literature that much

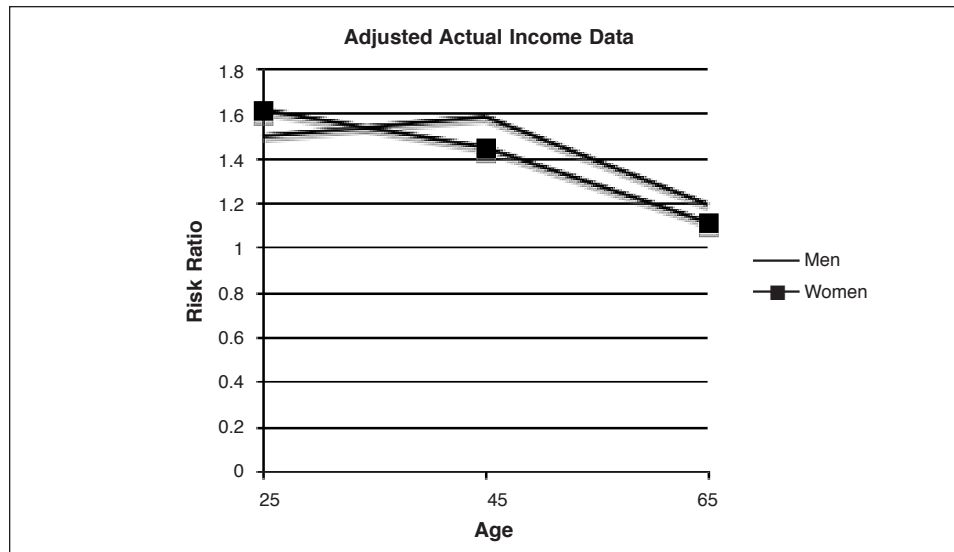


Figure 3. Actual age versus risk ratio (\$12,600 relative to \$126,100 in 2007 dollars) after adjusting for educational attainment, marital status, employment status, and household size. 1980 U.S. dollars were adjusted to 2007 U.S. dollars using the Consumer Price Index to provide readers with a better sense of modern disparities in income.

of the strong association between income and health is due to forward causality. This study thus further supports previous findings suggesting that redistributive social investments, such as in education, will produce large health benefits.^{14,15}

Acknowledgment

This study was supported by a Minority Research Fellowship grant from Columbia University.

Notes

1. Adler NE, Ostrove JM. Socioeconomic status and health: what we know and what we don't. *Ann N Y Acad Sci.* 1999;896:3–15.
2. Smith JP. Healthy bodies and thick wallets: the dual relation between health and economic status. *J Econ Perspect.* 1999 Spring;13(2):144–66.
3. Muennig P, Franks P, Jia H, Lubetkin E, Gold MR. The income-associated burden of disease in the United States. *Soc Sci Med.* 2005 Nov;61(9):2018–26.
4. Mechanic D. Disadvantage, inequality, and social policy. *Health Aff (Millwood).* 2002 Mar–Apr;21(2):48–59.
5. Deaton A. Policy implications of the gradient of health and wealth. *Health Aff (Millwood).* 2002 Mar–Apr;21(2):13–30.
6. Muennig P. How education produces health: a hypothetical framework. *New York: Teachers College Record 2007 (Online Exclusive), 2007.* Available at <http://www.tcrecord.org/content.asp?contentid=14606>.

7. Lynch JW, Kaplan GA, Shema SJ. Cumulative impact of sustained economic hardship on physical, cognitive, psychological, and social functioning. *N Engl J Med.* 1997; 337(26):1889–95.
8. Snyder SE, Evans WN. The impact of income on mortality: evidence from the social security notch. *Rev Econ Stat.* 2006;88(3):482–95.
9. Mulatu MS, Schooler C. Causal connections between socio-economic status and health: reciprocal effects and mediating mechanisms. *J Health Soc Behavior.* 2002; 43(1):22–41.
10. U.S. Census Bureau, Denavas-Walt C, Proctor BD, Lee CH. Income, poverty, and health insurance coverage in the United States, 2004. Washington, DC: U.S. Bureau of the Census, 2005.
11. Sorlie PD, Backlund E, Keller JB. US mortality by economic, demographic, and social characteristics: the National Longitudinal Mortality Study. *Am J Public Health.* 1995 Jul;85(7):949–56.
12. Arrighi HM, Hertz-Picciotto I. The evolving concept of the healthy worker survivor effect. *Epidemiology.* 1994;5(2):189–96.
13. Lantz PM, House JS, Lepkowski JM, Williams DR, Mero RP, Chen J. Socioeconomic factors, health behaviors, and mortality: results from a nationally representative prospective study of US adults. *JAMA.* 1998;279(21):1703–8.
14. Muennig P, Woolf SH. The cost-effectiveness of education as a health intervention: an analysis of the health and economic benefits of reducing the size of classes. *Am J Public Health.* 2007;97(11).
15. Levin H, Belfield C, eds. *The price we pay: economic and social consequences of inadequate education.* Washington, DC: Brookings Institution Press, 2007.