

VIEWPOINT

## The 21st-Century Trajectory for Global Health



Stephen G. Waller, MD  
Bethesda, MD

“History is merely a list of surprises. It can only prepare us to be surprised yet again.”

*Kurt Vonnegut*

Much of what happens in our world is linear and predictable, like clockwork in some cases. In other areas, nonlinear and startling trajectories best describe the behavior of economies, political movements, or complex health systems. In global health, progress has been surprising and dramatic in some areas, but discouraging and slow in others. Its future might be more plodding slowly forward, or it might behave as other complex open systems do, in spectacular and nonlinear ways.

Many complex physical processes, such as chemistry “saturation” curves, the growth curve of populations, and improvements in national longevity follow a sigmoid (S-shaped) curve. Input in the early stages does not create much response, until reaching a tipping point and breaking into an exponential rise, when return on investment vastly out-runs input. After the dramatic rise, output stabilizes and reaches a plateau, when saturation or carrying capacity is achieved, and additional input produces diminishing returns. I believe that 21st-century growth in most global health indices will describe a sigmoid curve.

Samuel Preston demonstrated this behavior in his description of the relationship of longevity to per capita gross national product (GNP).<sup>1</sup> At relatively low GNP values (\$2000), average national longevity rises dramatically with small incremental increases in economic activity. Many of the developing world nations are poised today at the base of the

steep up-sloping segment of Preston’s curve. At about \$5000 GNP per capita, the remarkable longevity gains flatten out, and slowly inch up as GNP increases to about \$20,000 per capita. Preston’s curve has been plotted for each decade since his original report in 1975, and the sigmoid shape of the curve has not changed. Swedish epidemiologist and YouTube star Hans Rosling tells us this story in four minutes in his unforgettable and energetic style.<sup>2</sup>

We should not be surprised to find nonlinear or exponential growth in global health. Simplistic paradigms have often proven to be false in the past. Newtonian physics was supposed to allow predictions for all celestial objects for all time, not to have messy outcomes from relativity or “dark matter”; the Mendelian expression of genetic traits was supposed to be simple, not modified by epigenetic phenomena. As Einstein advised us, “Keep things as simple as possible, but not simpler.” Likely the assumption that global health will maintain the same slow linear progress will also turn out to be “too simple”—reductionist and incorrect.

Most exciting for me as a global health advocate is that moving rapidly up Preston’s curve could happen in the near future for many countries, and for a small additional investment in resources. Improving education of women, internet connectivity, and other social determinants of health may produce a spectacular, “emergent” leap in longevity and better health for developing countries. Progress, both economic and health, could be startling. The rapid rise may plateau at some future date, when marginal improvements come at greater effort and cost, or the resource limitations of a closed global system

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From the Department of Preventive Medicine, Uniformed Services University of Health Sciences, Bethesda, MD. Address correspondence to S.G.W. ([stevegwall@gmail.com](mailto:stevegwall@gmail.com)).

produce diminishing returns. Global health will not experience an endless exponential upward trajectory. But for the near term, outsized gains may occur routinely.

Preston's curve does not demonstrate the sigmoid shape at low GNP value. A truly sigmoid function should have a flat "tail" at low values, before beginning the exponential rise. I suspect most human societies have been on that part of the curve throughout history, only in recent centuries reaching the upslope as a group. Some of the poorest nations are still mired in that phase today, when investments in global health programs show little return. If sigmoid behavior describes the global health progress of nations, we should not be surprised when decades of past interventions show little progress in desperately poor areas of the world. We should still be optimistic for them.

Bloom and Canning give some reasons for a nonlinear trajectory in global health.<sup>3</sup> Their work shows that Preston's curve works both ways—income creates better health, and better health contributes to increased income. They describe the impact of health on productivity, education, and a "demographic dividend" of decreasing child mortality and maternal fertility rate. The bidirectional nature of the health-income relationship creates a "virtuous spiral," with positive feedback spinning both parameters upward in surprising ways.

It is certainly possible that global health output will not increase exponentially, despite Preston's work and my hopes. The trajectory could be a

parabolic, with a downturn after a peak, as climate change or political instability dominate. Continued application of resources may produce progress that is linear and the gently upward. Economist Jeffrey Sachs and others, however, have made a compelling case for redoubling our global health efforts in anticipation of a new era of rapid progress in the near future. The work of Sachs, Bloom, Rosling, and Preston all demonstrate that we may expect dramatic returns on investment in global health activities in the coming years.

The failure of past economic and humanitarian aid to produce substantial gains in some developing world scenarios is discouraging. However, the broad applicability of sigmoid behavior—especially Preston's work—suggests that a new paradigm is imminent. As a species, we may be on the cusp of a dramatic breakthrough. Support for the United Nation's new Sustainable Development Goals may create astonishing successes, as recipient countries reach the steep upslope of their health outcomes trajectory.

I admit to having a vested interest in the outcome, as a passionate teacher of global health. But I don't think my bias has fooled me this time.

Vonnegut's quote at the beginning of this essay comes from his novel, *Slapstick*, whose protagonists have a partnership, the sum of which enhances their collective ability out of proportion to their individual abilities. I predict the future trajectory for global health will also exceed the sum of our collective and individual efforts in a surprising and positive way.

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