Supplementary web appendix 2:

SUMMARY OF THE EVIDENCE ON THE ASSOCIATION BETWEEN HEALTH AND INCOME

GLOBAL HEALTH 2035

In a prescient early paper, published in 1952, Gunnar Myrdal outlined important mechanisms through which health improvements could influence (and be influenced by) the economic productivity of households and nations.[1] In the 1960s and 70s, there was relatively little research on the link between health and income, despite the rapid growth, from the 1960s, of research on the economic consequences of better education.[2]

An important exception was the landmark paper by Selma Mushkin, published in 1962, called "Health as an investment." Health outlays, argued Mushkin, "improve the labor product and continue to yield a return over a period of years".[3]

The World Bank's 1980 World Development Report (WDR 1980), on poverty and human development, made major advances on Myrdal's early work and pointed to the significance for development policy of the documented links among health, fertility, education, and poverty.[4] WDR 1993 provided a fresh update of this evidence in the context of arguing the potential for sound policy to effect rapid changes in population health, changes that would lead not only to increased economic output but rapid gains in welfare for the poor.

The WHO Commission on Macroeconomics and Health and, more recently, Bloom and Fink provide valuable updates on the literature.[5,6,7]

Evidence on the relationship between health improvements and economic development comes from historical studies (discussed in the main report), microeconomic studies, and macroeconomic studies.

Microeconomic studies

A growing number of economic studies have examined the links between health and income at the individual (microeconomic) level. Advantages of focusing on individuals rather than countries include the use of more detailed measures of health and income, as well as their determinants, and the ability to conduct randomized controlled trials or natural experiments.[7] Such microeconomic studies can provide important information about biological or behavioral causality.[8]

Reviews of microeconomic studies suggest that there is an association between nutritional status and labor outcomes, particularly productivity.[7,8,9] Better nutritional status in early childhood is associated with an increase in the amount of school completed and in later height, which correlates with earnings.[10] For example, in the Indonesia Family Life Survey, a 1% increase in height was associated with a 5% increase in earnings in adult Indonesian males.[8] Multiple randomized trials have found an association between iron supplementation and improved worker performance.[8] A non-randomized study in Tanzania found a positive association between receiving iodine in utero (through supplements given to pregnant women) and improved educational attainment, and a recent study of salt iodization in the United States found a positive association with cognitive function.[11,12]

The evidence on parasitic disease control or elimination, however, is more mixed. Natural experiments on eradicating hookworm and malaria in the American South and malaria in parts of Latin America found associations between disease eradication, improved education outcomes, and higher incomes.[7,13,14] For example, in the early 1900s in the American South, about 40% of schoolchildren had hookworm. Bleakley found that counties with higher levels of infection saw larger increases in school attendance and literacy after the eradication campaign; long-term follow up of affected cohorts suggested that eradication was associated with increased earnings.[13]

But the evidence from randomized controlled trials is less clear-cut. For example, a randomized trial of school-based intermittent preventive treatment for malaria found that while the intervention improved attention, it had no effect on educational achievement.[15] And a 2012 Cochrane systematic review of randomized trials of deworming found that the evidence of benefit in relation to cognition, school attendance, and school performance is "generally poor, with no obvious or consistent effect".[16] Bundy and colleagues recently provided a critique of this Cochrane review, arguing that (a) the trials included in the review were not properly

designed or adequately powered to detect long-term differences in cognitive outcomes, and (b) there are major limitations in pooling randomized trial data for evaluating large-scale deworming interventions.[17]

Macroeconomic studies

Since microeconomic studies do not capture the effects of growth on a country's aggregate income, it is important to complement such studies with macroeconomic research that uses country-level growth measures. Cross-country studies of the impact of health on income have generally shown positive effects. These effects had already been demonstrated by the time that WDR 1993 was published. For example, background papers prepared for WDR 1980 by Wheeler and Hicks had summarized the results of cross-country studies on the relationship between health and economic growth.[18,19] These studies found results that foreshadow much of the recent literature. For example, Wheeler found that improved health is associated with improved labor productivity and income.[18] However, the quality of the cross-country datasets that Wheeler and Hicks were working with was far more limited than current studies.

Several macroeconomic studies conducted over the last two decades suggest that the impact of improved health on income at the country level may be greater than the effects seen at the individual level.[20,21,22] The macroeconomic evidence linking health to income was summarized by the influential 2001 report of the Commission on Macroeconomics and Health.[5] Jamison and colleagues reviewed the historic, microeconomic, and macroeconomic literature and concluded, on the basis of their own analyses, that about 12% of economic growth in low- and middle-income countries in the period 1970-2000 resulted from reductions in levels of adult mortality.[23] In an extensive reanalysis of 67 previously analyzed potential determinants of long-term growth, Sala-I-Martin and colleagues found 18 of these determinants to be "significantly and robustly partially correlated with long-term growth," which they then ranked in order of the strength of evidence.[24] One of these 18, initial levels of life expectancy, was ranked eighth (most variables on the list were of no policy relevance, e.g. "being a country from east Asia").

As is typical of cross-country studies, causality is difficult to establish, and is often best provided by ancillary evidence from microeconomic and historical studies, as we have seen above. The literature on the relationship between health and economic growth is no exception. A recent paper by Acemoglu and Johnson finds that although health improvements do lead to income growth, they also lead to more than compensatory reductions in fertility and a potential reduction in per capita income.[25] Bloom, Canning, and Fink provide a detailed critique, which was followed by a similarly detailed response from Acemoglu and Johnson and a further response by Bloom et al.[26,27]

Overall, the preponderance of information from multiple sources about the favorable impact of health on growth and the inherent plausibility of the finding lead us to conclude that the effects are very likely real and causal.

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