

Identifying the Hidden Costs of a Public Health Success: Arsenic Well Water Contamination and Productivity in Bangladesh

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Summary

Tests of the principal water sources in rural Bangladesh indicate that a substantial fraction of the Bangladesh population in rural areas is ingesting large amounts of inorganic arsenic. Most of the consequences of arsenic ingestion from drinking and consuming foods grown in and cooked with arsenic-contaminated water, however, are hidden. Bangladeshi citizens do not know the amounts of retained arsenic they have stored in their bodies, as conventional morbidity and physical symptoms are generally unrelated to retained arsenic levels. Neither do they know their own abilities to metabolize ingested arsenic, the effects of diet on the amount of arsenic they consume, metabolize, and excrete, or the consequences for their productivity at work or in the home. The productivity costs are also hidden from researchers and policy-makers - most men in Bangladesh do not earn wages and few women participate in the labor market. Yet, almost all men earn and women contribute importantly to the production of home goods and services, including water retrieval and treatment.

In this paper we use recent evidence from the molecular genetics literature on the genetic basis of arsenic metabolism, and unique information on family links among respondents living in different environments from a large panel survey, within a theoretical framework incorporating optimizing behavior, to uncover some of the hidden costs of arsenic poisoning in Bangladesh. Based on toenail clipping biomarkers, we find that the levels of retained arsenic in the rural Bangladesh population are nearly 20 times those measured in subjects residing in the United States, vary considerably across individuals but are no more elevated in high- than in low-wealth sub-populations. Using these data and information on individual consumption, we implement our identification methodology by first obtaining estimates of the causal effects of the consumption of seven food groups, choice of water source and smoking on arsenic retention. These estimates show that diet matters for arsenic retention, with the consumption of grains, the staple of the Bangladesh diet, significantly increasing, but tubers, in accord with the epidemiology literature, reducing measured arsenic concentrations. We also find that using non tubewell water sources for cooking reduces retained arsenic concentrations by 18%.

We then examine the relationship between retained arsenic and measures of individual cognitive and physical capabilities, schooling attainment, health, occupational choice, entrepreneurship and income using as instruments measures of arsenic retention net of the influence of diet, water-source choices, and village fixed effects of separated family members. We find that performance on a test assessing cognition was significantly lower the higher are levels of retained arsenic and that the significant negative effects on cognition are manifested in lower schooling attainment especially for young males - the estimates indicate that cutting average levels of retained

arsenic in half would increase years of schooling attained by more than a year and a half. Young men with higher concentrations of retained arsenic not only have lower schooling attainment, but are also significantly less likely to have a skilled occupation or to become entrepreneurs. We show that these results are not due to a direct correlation in genes associated with arsenic methylation and genes associated with cognition and strength by estimating correlations among the relevant genes using newly-available genomic data on human populations. We also can find no relationship between arsenic retention and BMI and conventional morbidity symptoms reported in our survey data, consistent with the productivity effects of arsenic contamination being hidden in the population.

Using information on household expenditures, we obtain estimates of the effects of variation in retained arsenic among prime-age males regardless of their status as wage or self-employed workers. The estimates indicate that lowering the amount of retained arsenic among Bangladesh prime-age males to those levels in uncontaminated countries would increase total household expenditures and thus earnings by 9% for each prime age male. We also find that retained arsenic reduces the productivity of women in home production, and that home goods and purchased goods are complements. These latter results imply that the estimated increase in total household expenditures obtained by eliminating arsenic, which form only a part of total household consumption, closely corresponds to the overall consumption benefits to the household.

What do our estimates imply for policies that may reduce the economic burden of arsenic-contaminated wells? First, while we have found that diet matters for arsenic retention, the beneficial effects of dietary changes are relatively small - for example, doubling tuber consumption would only reduce retained arsenic by 5%. Second, while we obtained estimates that implied that if everyone switched from tubewells as their source of cooking water, retained arsenic would decline by 18%, that would only represent less than 20% of the gap between average retained arsenic levels in the rural Bangladesh population and that in non-contaminated populations, and would only increase incomes by less than 2%.

The convenient provision of non-contaminated water that would eliminate the problem of arsenic contamination, through a one-time investment in the provision of piped water or simple treatments of contaminated water, is obviously costly in a rural population. Our estimates suggest, however, that the economic benefits from increased productivity are not trivial, even ignoring all of the potential health costs in later life (e.g., cancers). The annual benefits include a rise in earnings for every male worker of \$54 per year. If the value of time of women is half of that of men, and the loss in productivity is similar, recalling that we find evidence of a significant loss in nonmarket productivity for women, that would imply an additional benefit of \$27 per year. Added to this would be a reduction in women's time spent fetching water, which our data suggests is on average 20 minutes per day. Valued at half of the male wage, the freeing up of women's time from having convenient, clean water available would add an additional benefit of \$13 per year. The present discounted value of the per-household gain of \$94 over twenty years ranges from \$1400 to \$1000 for discount rates of from 3% up to 8%. The added consumption through productivity improvements, of course, assumes that there would be no economic growth. As income grows, the hidden cost of not improving clean water availability also grows. And the loss in human capital from the reductions in cognition and human capital investment suggest that growth rates may also be reduced.