

Editorial

The risk of unimproved water and sanitation and the global burden of disease

The authors of the Global Burden of Disease (GBD) estimates for 2010 (Lim *et al.* 2012) have suggested that unimproved water and unimproved sanitation contribute less to the global disease burden than previously thought. This needs explanation.

The GBD estimates started from a global annual total of 52.8 million deaths. Diarrheal disease was estimated to cause 1.45 million of those deaths (each death is attributed to one cause). The GBD also identified 67 risk factors that affect disease outcomes including unimproved water and unimproved sanitation, and then attributed 116,000 deaths to unimproved water (risk ranked 33rd) and 244,000 deaths to unimproved sanitation (ranked 26th), nearly the same risk as dietary zinc deficiency (ranked 31st).

The easy conclusion might be that improved water and improved sanitation are not important risk factors for disease, although this contradicts decades of evidence to the contrary (for example, Fewtrell *et al.* 2005). However, a more thorough interpretation of the GBD provides clarification.

COUNTERFACTUALS

Risk is determined by comparing the risk exposure to a lower risk alternative. The optimal exposure (or, theoretical minimum risk exposure) is known as the *counterfactual*. For example, if the risk exposure is the *proportion of households using an unimproved water source* and the counterfactual is *all households use an improved water source*, then the risk is evaluated by comparing health outcomes for the risk exposure and the counterfactual.

Specifically, for the risk of unimproved water, the comparison made in the GBD estimate for 2010 is the health outcome of unimproved water (including unprotected

wells or springs, vendor-provided water, tanker trucks, and surface water) as compared to improved water (including household connection, a public tap or standpipe, a tubewell or borehole, a protected well or spring, or rainwater collection). For several reasons, this could lead to an underestimate of the burden of disease. For example, the physical difference between the improved and unimproved sources can be slight. Moreover, some public taps (improved) do not provide safe water, and the converse, some tanker trucks (unimproved) do provide safe water. Furthermore, some 'improved' water has been shown to be fecally contaminated in developing countries. More significant health outcomes of improved water access would be measured if the counterfactual were defined as (i) safe water that meets WHO guidelines on drinking water quality or (ii) household connections.

On the other hand, too idealistic a counterfactual could lead to an exaggerated estimate, measured from an unachievable baseline. For instance, the original GBD estimate in 2002 took as counterfactual a typical developed country, in which even fecal-orally transmitted food-borne diarrhea had been somehow prevented by, for example, improving hand hygiene before food preparation (Prüss *et al.* 2002). With such an idealistic counterfactual, the estimated risk of unimproved water is overestimated.

The choice of counterfactual can have a disproportionate influence on the rank of any given risk factor. One example of a particularly rigorous counterfactual was for household air pollution where the counterfactual was defined as *all households using clean fuels for cooking (vented gas, electricity)*. This counterfactual represented the gold standard for household air. Similarly, the counterfactual for zinc deficiency is *no inadequate zinc intake*.

In contrast, the choice of counterfactual for unimproved sanitation does not reach the gold standard level of risk,

corresponding to the ideal level of provision. The counterfactual is *all households use improved sanitation* (which includes flush toilets connected to public sewers, but also includes simple pit latrines with squatting slabs). Perhaps the ideal counterfactual is a flush toilet system accompanied by a wastewater treatment system.

RISK FACTORS

Besides a counterfactual, another prerequisite for calculating the burden of disease associated with a risk factor is a systematic review of the literature to assess the strength of association between the risk factor and the disease. For instance, several reviews of the health impact of basic sanitation have found it to be associated with a reduction in diarrhea risk by about 30%.

However, systematic reviews do not always reach such a consensus. In practice, they require many decisions involving judgment. For instance, how high a standard of methodological rigor is required of studies included in the review? If the standard is set too low, the result is unreliable; if too high, there is a danger that the small number of qualified studies is not representative of the overall sector knowledge.

The authors of the GBD estimate for 2010 carried out systematic reviews of the health benefits of water supply and sanitation as part of the exercise. These are not yet published, but we have been advised that they do not include any possible benefit from house connections because the only study of this benefit that met their inclusion criteria did not show a statistically significant health effect of household connections (Lim 2012, personal communication).

One reason for the lower estimate of risk from unimproved water and sanitation in the 2010 analysis is that, fortunately, child mortality rates have fallen in the last decade. Another is that the current definitions for improved water and improved sanitation are so broadly inclusive that some of the improvements do not yield health impacts.

Finally, the literature studies selected to assess the association between unimproved water and diarrheal disease did not acknowledge the benefit of in-house piped water.

Sandy Cairncross

London School of Hygiene and Tropical Medicine,
Keppel St, London WC1E 7HT,
United Kingdom

Helen Petach (corresponding author)

Biomedical Science Advisor,
US Agency for International Development,
1300 Pennsylvania Ave, NW,
Washington, DC 20523,
USA
E-mail: hpetach@usaid.gov

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