



Children walk down a street in Nairobi, Kenya. December, 2009

KEY READINGS AND EVIDENCE ON THE IMPACTS OF SANITATION ON PEOPLE AND COMMUNITIES

Improvements in water and sanitation management play a crucial role in protecting human health. Understanding evidence about the effectiveness of sanitation interventions through rigorous studies, from both high and low- and middle-income countries, is critical to our work at the Bill & Melinda Gates Foundation. This overview provides a list of key readings about findings and data that have influenced our strategies and the work of key partners, in the sanitation sector.

SAFELY MANAGED SANITATION IS CRITICAL TO IMPROVING HUMAN HEALTH AND WELL-BEING

A range of historical studies have demonstrated the connection between sanitation, human health and prosperity. In 1855, John Snow showed that cholera breakouts in mid-19th century London were driven by fecal contamination of drinking water. More recently, researchers have demonstrated that the introduction of water filtration and chlorination in the cities in the United States in the early 20th century reduced total mortality by half and infant mortality by three-quarters. Similar historical studies conducted in low-income countries support a strong link between sanitation status and health outcomes. Researchers have shown that cohorts of children exposed to worse community sanitation developed lower hemoglobin levels and displayed higher anemia incidence. Further research found that the large reduction in infant stunting between 2005 and 2010 in Cambodia can be explained almost entirely by the reduction in open defecation.

Sanitation is not simply about building or compelling more people to use toilets, it's about safely managing the entire flow of fecal waste from the toilet to treatment, in order to prevent human exposure to pathogens. Research has helped to highlight the importance of this systemic approach. In Santiago, Chile in 1976, 87% of residents had access to sewerage

sanitation and 95% had access to piped water supply, yet they faced persistent endemic typhoid fever outbreaks between 1976 and 1983. Researchers found that these outbreaks were driven by use of untreated wastewater to irrigate crops, including vegetable crops. A more recent study in Vellore, India— shows that children under age five in households with toilets that discharge directly into open drains have a higher prevalence of enteric infection, when compared with children in other households, even those without toilets.

In addition to health, sanitation has been shown to impact broader economic development. The World Bank's Economics of Sanitation Initiative (ESI) includes country-level reports that estimate the economic losses associated with poor sanitation. A more recent report by Lixil shows that lack of access to sanitation costs the global economy US\$222.9 billion in 2015, equivalent to an average 0.9% of gross domestic product.

KEY READINGS

- John Snow (1855): On the Mode of Communication of Cholera
- David Cutler and Grant Miller (2005): The Role of Public Health Improvements in Health Advances: The 20th Century United States
- Marcella Alsan and Claudia Goldin (2015):

Watersheds in Infant Mortality: The Role of Effective Water and Sewerage Infrastructure, 1880 to 1915

- Diane Coffey, Michael Geruso, and Dean Spears (2017): Sanitation, Disease Externalities and Anemia: Evidence From Nepal
- Sangita Vyas et al. (2016): Disease Externalities and Net Nutrition: Evidence from Changes in Sanitation and Child Height in Cambodia, 2005–2010
- Guy Hutton (2013): Global costs and benefits of drinking-water supply and sanitation interventions to reach the MDG target and universal coverage
- Economics of Sanitation Initiative studies
- Lixil (2016): The True Cost of Poor Sanitation
- Carl Bartone (2011): From Fear of Cholera to Full Wastewater Treatment in Two Decades in Santiago, Chile
- David Berendes et al. (2017): The Influence of Household- and Community-Level Sanitation and Fecal Sludge Management on Urban Fecal Contamination in Households and Drains and Enteric Infection in Children

HUMAN BEHAVIOR PLAYS AN IMPORTANT ROLE IN SAFELY MANAGING SANITATION

The effectiveness of sanitation interventions depends critically on human behaviors related to sanitation infrastructure and systems. A series of studies in rural India clearly demonstrate how important behavior change is in improving sanitation outcomes. Researchers found that a rural sanitation intervention in Odisha, India, which led to a large increase in access to individual household latrines, did not lead to improved environmental fecal contamination or child health. Researchers say that this is likely because while households had access to latrines, there was only a modest increase in the use of the latrines, and therefore a modest reduction in open defecation. Another study showed that over 40% of households with a working latrine have at least one member who still defecates in the open. Conversely, a study on another sanitation intervention, also in rural Odisha, led to large increases in both latrine ownership and latrine use, and resulted in marked improvement in child growth.

KEY READINGS

- Clasen et al. (2014): Effectiveness of a rural sanitation programme on diarrhoea, soil-transmitted helminth infection, and child

malnutrition in Odisha, India: a cluster-randomised trial

- Coffey et al. (2014): Revealed Preference for Open Defecation Evidence from a New Survey in Rural North India
- Reese et al. (2018, forthcoming): Effectiveness of a combined household-level piped water and sanitation intervention in rural Odisha, India on health: a matched cohort study

POPULATION DENSITY HEAVILY IMPACTS SANITATION AND HEALTH OUTCOMES

Given the externalities of poor sanitation (i.e. one household's poor sanitation impacts their neighbors as well), it is reasonable to expect that sanitation services are most critical in places with high population density, such as informal settlements in cities, or highly dense peri-urban or rural areas. Using data from the series of Demographic Health Surveys, matched with population density at subnational levels, researchers have shown that the association between sanitation and child health is indeed stronger in places with higher population density. Specifically, the association between open defecation and infant mortality, for example, is about twice as much in places with the average population density of Bangladesh (or in the similarly dense, largely rural Indian states of Uttar Pradesh and Bihar) as it is in places with the average population density of sub-Saharan Africa.

KEY READING

- Hathi et al. (2017): Place and Child Health: The Interaction of Population Density and Sanitation in Developing Countries

INCLUSIVE SANITATION APPROACHES ARE NEEDED TO SOLVE URBAN SANITATION CHALLENGES

Many cities in developing countries aspire to install sewer network coverage—considered by many as the gold standard for sanitation—for as many of their citizens as possible. The reality is that sewers offer important but limited value in many cities. The capital costs, water and energy requirements, project development timelines and complexities inherent to centralized sewerage projects help to explain the history of incomplete and delayed projects, failed infrastructure, and marginal improvements to city services. The expense of these efforts results in debt burdens to utilities, cities, and country governments that often cannot be practically covered by user fees or tariffs.

Mandates, budgets, and regulatory service level

performance targets for providing non-sewered sanitation services—used by 80% of urban populations—on the other hand are by and large non-existent or undefined at the city level. Toilet construction, sludge emptying and transportation services tend to be delivered by an unregulated, inefficient private sector with no incentive or ability to deliver services that protect public or environmental health, consumers, or to ensure services reach the poor. Sanitation facilities themselves, like sludge treatment facilities, tend to be insufficient and poorly functioning. Households reliant on these poorly delivered inefficient services often pay exceedingly high prices, or they find ways to bypass the need for services by directly discharging waste into the open environment at an extraordinary cost to public and environmental health, which affects the poor most acutely.

Solving the sanitation challenges facing urban populations is complex, but by using a city-wide inclusive approach, we will more likely develop

and implement solutions that are sustainable and meet the needs of the urban poor. A growing body of evidence is beginning to help the sanitation sector understand how to develop safe, city-wide, inclusive sanitation (CWIS) approaches that use a diverse set of approaches to meet community needs.

KEY READINGS

- Dodane et al. (2012): Capital and Operating Costs of Full-Scale Fecal Sludge Management and Wastewater Treatment Systems in Dakar, Senegal
- Peal et al. (2014): Fecal Sludge Management: a comparative analysis of 12 cities
- Guy Hutton and Mili Varughese (2016): The Costs of Meeting the 2030 Sustainable Development Goal Targets on Drinking Water, Sanitation, and Hygiene
- Citywide Inclusive Sanitation (2018): Key Principles to Deliver CWIS



Eram Scientific Solution's Children E-Toilets in Kerala, India. November, 2013