WaSH Policy Research Digest

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Detailed Review of a Recent Publication: High coverage of improved household sanitation is needed in urban areas to reduce environmental fecal contamination

Berendes, D.M., Kirby, A.E., Clennon, J.A., Agbemabiese, C., Ampofo, J.A., Armah, G.E., Baker, K.K., Liu, P., Reese, H.E., Robb, K.A., Wellington, N., Yakubu, H., Moe, C.L. (2018). Urban sanitation coverage and environmental fecal contamination: links between the household and public environments of Accra, Ghana. *PLoS ONE* 13(7): e0199304. doi:10.1371/journal.pone.0199304.

Research suggests that it is imperative that the safe containment, separation and management of human excreta are addressed along the entire sanitation chain, not just within private households or domestic compounds. With over half of the world's population now residing in urban areas, and two-thirds expected to by 2050 (United Nations, 2015), the safe containment and separation of household excreta must be a key priority for protecting public health in urban areas.

In their 2018 paper, Berendes et al. describe a 19-month study undertaken in four low-income neighborhoods (Alajo, Bukom, Old Fadama & Shiabu) in Accra, Ghana, between September 2011 and March 2013. This study sought to explore how differences in the density, level and type of household sanitation coverage might affect concentrations of fecal contaminants in public areas. Samples of soil were collected in public places, and samples of water collected from open public drains in locations that were identified by community leaders and local field staff as areas where children play or have contact with drains. These samples were tested for the presence of fecally derived microorganisms, both *E. coli* (a bacteria commonly found in human feces and thus used as an indicator of fecal contamination) and several types of viruses associated with diarrheal disease. The study also surveyed the sanitation facilities of 793 households, along with public latrines, and categorized each according to whether excreta were disposed of safely (either *in situ* or transported and treated off-site) or not, referred to by the authors as "contained" or "uncontained," respectively. "Contained" sanitation

Key Policy and Programmatic Takeaways

- Incomplete sanitation coverage in urban areas results in contamination of open drains with fecal pathogens.
- Investments in urban sanitation must ensure safe containment, separation and management of human excreta, and must be applied across an entire neighborhood to maximize health benefits.
- Decreasing environmental fecal contamination has a non-linear relationship with diarrhea rates; low environmental contamination levels must be achieved before diarrheal disease can be reduced.
- Sanitation systems without adequate fecal sludge management or sewage treatment only move pollution problems to another location.

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WHO-UNICEF Joint Monitoring Programme Sanitation Service Level Classification

Open defecation: Disposal of human feces in fields, forests, bushes, open bodies of water, beaches and other open spaces or with solid waste

Unimproved: Use of pit latrines without a slab or platform, hanging latrines or bucket latrines

Limited: Use of improved facilities (designed to hygienically separate excreta from human contact, including flush/pour flush to piped sewer system, septic tanks or pit latrines; ventilated improved pit latrines, composting toilets or pit latrines with slabs) shared between two or more households

Basic: Use of improved facilities that are not shared with other households

Safely managed: Use of improved facilities which are not shared with other households and where excreta are safely disposed of *in situ* or transported and treated off-site

included ventilated improved pit latrines, pour-flush or flush toilets emptying into septic or sewage systems, or traditional pit latrines with slabs. "Uncontained" sanitation included bucket latrines and all other latrines, and this category was combined with those with no facility present. Interestingly, the authors reported that the majority of domestic sanitation facilities within the neighborhoods studied were shared by multiple households, meaning that many of the "contained" facilities would actually be classified as limited rather than safely managed sanitation according to the World Health Organization (WHO)-UNICEF Joint Monitoring Programme (JMP) (see box, this page).

The findings revealed that household sanitation coverage didn't just vary significantly from one neighborhood to another, but from one sub-neighborhood to another. Statistical software allowed the identification of groups of households ("clusters") where the proportion of contained sanitation facilities was significantly higher than the proportion of contained sanitation facilities in the rest of that neighborhood. While one neighborhood studied had only 1.5% sanitation coverage overall, two of the sub-neighborhoods had high household sanitation coverage (79% and 70%) and high "contained" household sanitation coverage (44% and 68%). The household survey data collected during this study also revealed that just 7% of households had their own individual facilities. Sanitation facilities were typically shared, with a mean of four households (11 individuals) using each facility. The proportion of shared sanitation facilities was one of the only factors that did not vary significantly between the various neighborhoods studied.

Low sanitation coverage in the urban areas studied resulted in contamination of open drains with fecal pathogens. The data revealed that *E. coli* concentrations in drain samples collected within 50m of clusters with low "contained" sanitation coverage were 5,000 times higher than those in drain samples collected close to clusters with a high level of "contained" sanitation coverage. The authors note that "*E. coli* concentrations in drains showed consistent trends with household sanitation coverage clusters: concentrations were lower in or near clusters of high coverage of household sanitation facilities—especially contained facilities—and vice versa." These levels of contamination turn open drains into "a high risk fecal exposure pathway" that could impact downstream personal exposures and health outcomes (Berendes et al., 2018). *E. coli* concentrations in soil did not appear to show any significant associations with clustering of household sanitation, which the authors point out may suggest that other, unmeasured factors may be important for future investigation.

It is important to bear in mind that this study included a significant proportion of shared sanitation facilities, as such facilities have been associated with increased prevalence and odds of diarrhea (Mazeau et al., 2013; Heijnen et al., 2014; Peprah et al., 2015; Fuller et al., 2014). The relationship between shared sanitation and fecal contamination, both within and beyond the household domain, warrants further exploration through studies that specifically target shared sanitation interventions (Brown et al. 2015; Berendes et al., 2018).

Those tasked with protecting public health in urban areas must ensure that a high level of sanitation coverage is achieved—both in terms of the proportion of households covered as well as geographic range of the area being covered—so that the full health benefits of investments in sanitation improvement can be realized. The authors suggest that difficulties in separating exposures occurring at a household level from those occurring elsewhere within the wider public environment may be the reason that some urban sanitation interventions have not resulted in significant human health improvements. With

growth in low-income urban neighborhoods expected to double between 2001 and 2030 (Alirol et al., 2011; Mara et al., 2010), this study provides new evidence that high local coverage of improved household sanitation is necessary to reduce environmental fecal contamination in the wider urban environment.

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Literature Review: The impact of inadequate sanitation systems on urban environmental contamination and disease

The criteria for "safely managed" sanitation systems under the Sustainable Development Goals (SDGs) require waste to either be 1) treated and disposed of *in situ*, 2) emptied and treated off-site, or 3) transported through a sewer and treated off-site (UNICEF and WHO, 2019). However, the literature shows that **the criteria for safely managed sanitation are frequently not met, jeopardizing the wider environment**. In the paper reviewed in this Digest, Berendes et al. (2018) conclude that uneven coverage of improved household sanitation can cause fecal contamination in the public environment in low-income urban areas.

Nakagiri et al. (2016) reviewed the performance of pit latrines in urban areas of sub-Saharan Africa and found their performance unsatisfactory with respect to capacity (problems with full and/or overflowing latrines), smell and insect nuisances. Various studies cited by Nakagiri et al. found that at least 30%, and in some cases over 50%, of latrines studied were full. Jenkins et al. (2014) evaluated on-site sanitation systems in 35 unplanned, low-income communities in the city of Dar es Salaam, Tanzania, and found that while 59% of facilities complied with the JMP definition of "improved" sanitation, only 41% met criteria set by the authors for "hygienically safe and sustainable" facilities. In particular, lack of hygienic pit emptying services resulted in many poor households resorting to "flooding out," a method of partial emptying of pits which involves releasing fecal sludge into the open environment to be washed away by storm water during rains.

Developed countries also have this problem. In Europe, 165 million people use toilets that are connected to a sewerage network that releases sewage without treatment, threatening the health of the surrounding communities and ecosystems (Anderssen et al., 2016). In surveys along the River Danube, which flows through 10 countries of Central and Eastern Europe, critical pollution of surface water with *E. coli* was found in the middle section of the river, most likely due to the lack of wastewater treatment in the cities of Novi Sad and Belgrade in Serbia (Kirschner et al., 2017). Untreated wastewater streams not only have an effect on the ecosystem of the receiving water body, they also affect human health through such activities as swimming. A study by Jovanović Galović et al. (2016) showed the presence of viruses in bathing waters in the Danube. When wastewater treatment plants were installed, for example in Budapest, a decrease in human fecal contamination in the river was seen when comparing data from two consecutive studies of the water quality of the Danube (Kirschner et al., 2017).

It should be noted that **decreasing environmental fecal contamination as a result of sanitation interventions appears to exhibit a threshold effect and does not have a linear relation with diarrheal disease reduction**. Wolf et al. (2019) developed a composite index based on eight WASH criteria (four for sanitation, two for water and two for hygiene), relating to behaviors, and use of, or access to, services. This Faecal Contamination Index (FAECI) was applied to a set of recent sanitation interventions, and the association between these interventions and diarrheal disease was analyzed. Wolf et al. found that diarrheal disease reduction is highest at low contamination levels, and no diarrheal disease reduction was found when contamination remained above a certain level.

In conclusion, **installing sewerage systems without adequate sewage treatment only moves the location of environmental contamination; it does not prevent it**. Safely managed sanitation systems that meet all the criteria for fecal waste containment, transport, treatment and disposal are essential in densely populated urban areas, and a minimum level of environmental contamination must be achieved in order to combat diarrheal disease. The World Health Organization has published risk-based management tools for designing sanitation systems entitled "Sanitation Safely Planning" (WHO, 2015) and "Guidelines on Sanitation and Health" (WHO, 2018), which offer evidence-based guidance for sanitation policies and actions to protect public health.

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