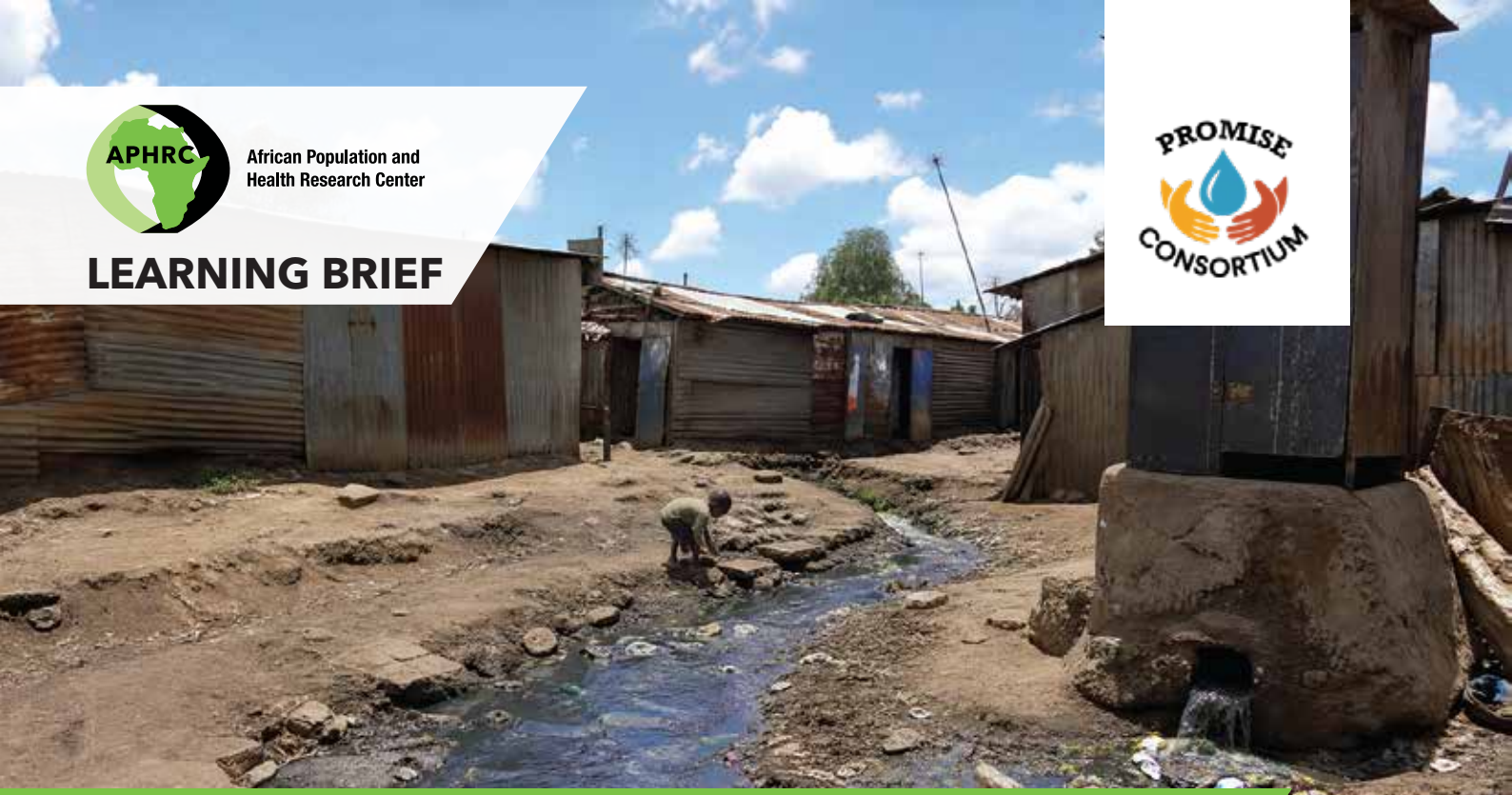
African Population and Health Research Center

LEARNING BRIEF



SANITATION TECHNOLOGIES AND PUBLIC HEALTH RISKS IN INFORMAL URBAN SETTLEMENTS: LESSONS FROM KIBERA, NAIROBI

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INTRODUCTION

Sanitation is an important aspect of public health that is vital for promoting sustainable urban growth, yet some communities, especially in Low and Middle-Income Countries (LMICs) still lack access to adequate sanitation services. In Kenya, only 36% of the population had access to improved sanitation facilities by 2024. These improved sanitation facilities consist of technologies such as flush or pour flush toilets, Ventilated Improved Pit (VIP) latrines, Pit latrines with a cleanable slab, and composting latrines.

In Kibera, one of Nairobi's largest informal settlements, most of the population still lack access to improved sanitation facilities. This forces them to rely on sanitation facilities that are shared among households. Most of these sanitation technologies include traditional pit latrines, some of which drain directly to the environment, exposing the population to health risks such as diarrheal disease, especially among children.

Understanding exposure to fecal pathogens from sanitation technologies is important for public health interventions, yet most urban interventions in such settlements and in LMICs often prioritize examining discharge standards over the actual removal of pathogens. Thus, a gap remains in monitoring pathogen-related hazards in resource-constrained informal settlements like Kibera. This study assessed the effectiveness of sanitation technologies in reducing exposure to E. coli. The findings provide evidence to inform sanitation policies and public health interventions in urban informal settlements and similar resource constrained settings.



METHODOLOGY

Setting: The study was conducted in Kibera settlement in Nairobi, Kenya. Kibera is characterized by a high population density which relies heavily on onsite sanitation technologies. We collected our data across all the villages in the study area.

Design: The study employed a mixed-methods approach, collecting both qualitative and quantitative data as shown in Figure 1.

Sample population and sampling: We conducted surveys with 209 sanitation users and collected fecal samples from 240 sanitation technologies across eight containment systems. Additional samples were collected from open defecation sites (n=32) and open drains (n=37).

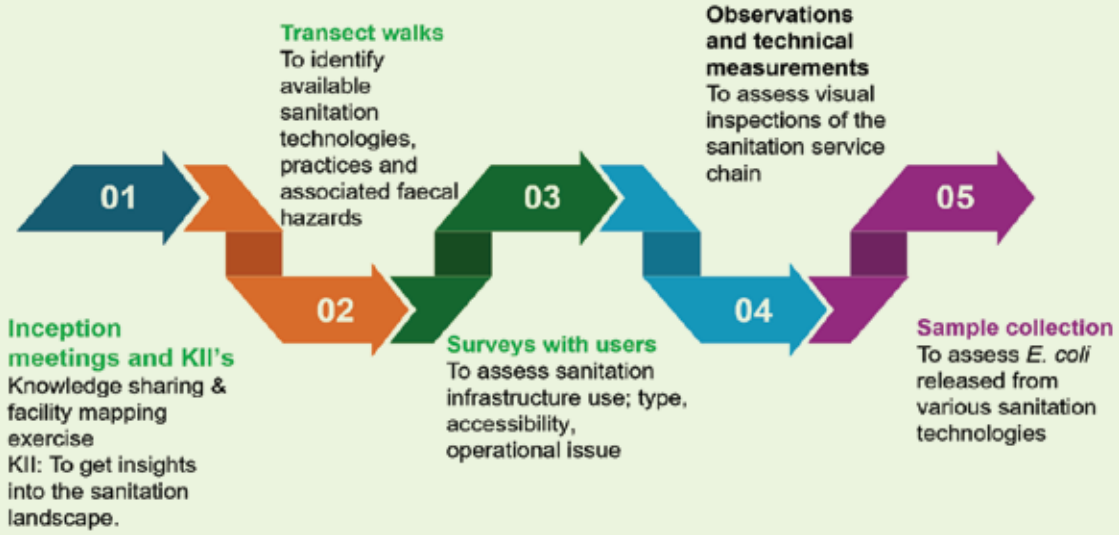


Figure 1: Overview of data collection methods and activities

KEY FINDINGS

1. Household Demographics and Sanitation Technologies

Overall, households had an average of five people, and about half (51.2%) had at least one child under the age of five. Two-thirds of the respondents were renters, with an average monthly household income of KES 17,172. Most sanitation technologies were located within compounds, as shown in Figure 2.

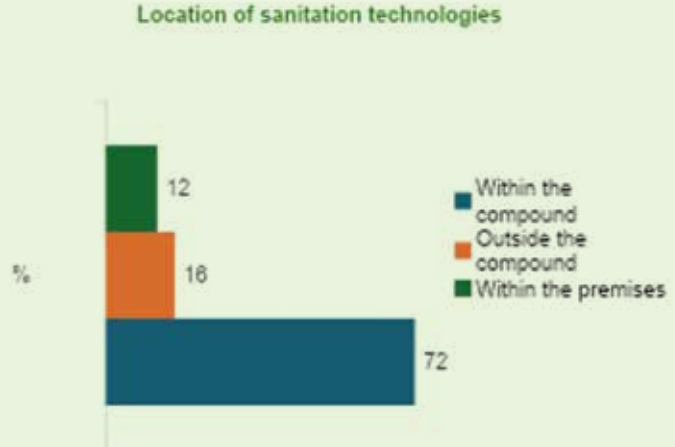


Figure 2: Location of sanitation Technologies

2. Types of Sanitation Technologies Observed in Kibera

A total of 240 sanitation technologies and containment systems were observed. These included lined pit latrines (LPs), fully lined/sealed tanks (FT), unlined pit latrines, community toilets, urine diverting toilets (UDT) (Figure 3), partially lined tanks (LT), and sewer systems (SS).

3. Fecal Exposure and Environmental Contamination

User-interface: Among all the 240 sanitation technologies, 203 (84.6%) had solid floors that separated the user from excreta.

Emptying: Over 60% of the technologies required emptying, yet 30% had poor physical access to emptying equipment and depended on manual emptying as shown in Figure 3.

Faultiness: Thirty percent of sewer lines had blocked or damaged pipes, with 24% showing leakages into the immediate environment as shown in Figure 3.

Proximity to water sources: Ninety percent of technologies draining directly to the environment were located within 30 meters of a stream or a drinking water source.



Figure 3: Examples of Fecal Exposure Practices and Pathways Observed. The left image depicts manual emptying of a pit latrine while the right image shows a burst sewer manhole overflowing into the environment.

4. E. Coli Concentration and Health Outcomes

Sanitation technology performance: Sewer overflows and sanitation technologies draining directly to the environment showed significantly higher E. coli concentrations compared to lined pits, UDT and fully lined tanks as shown in Figure 4.

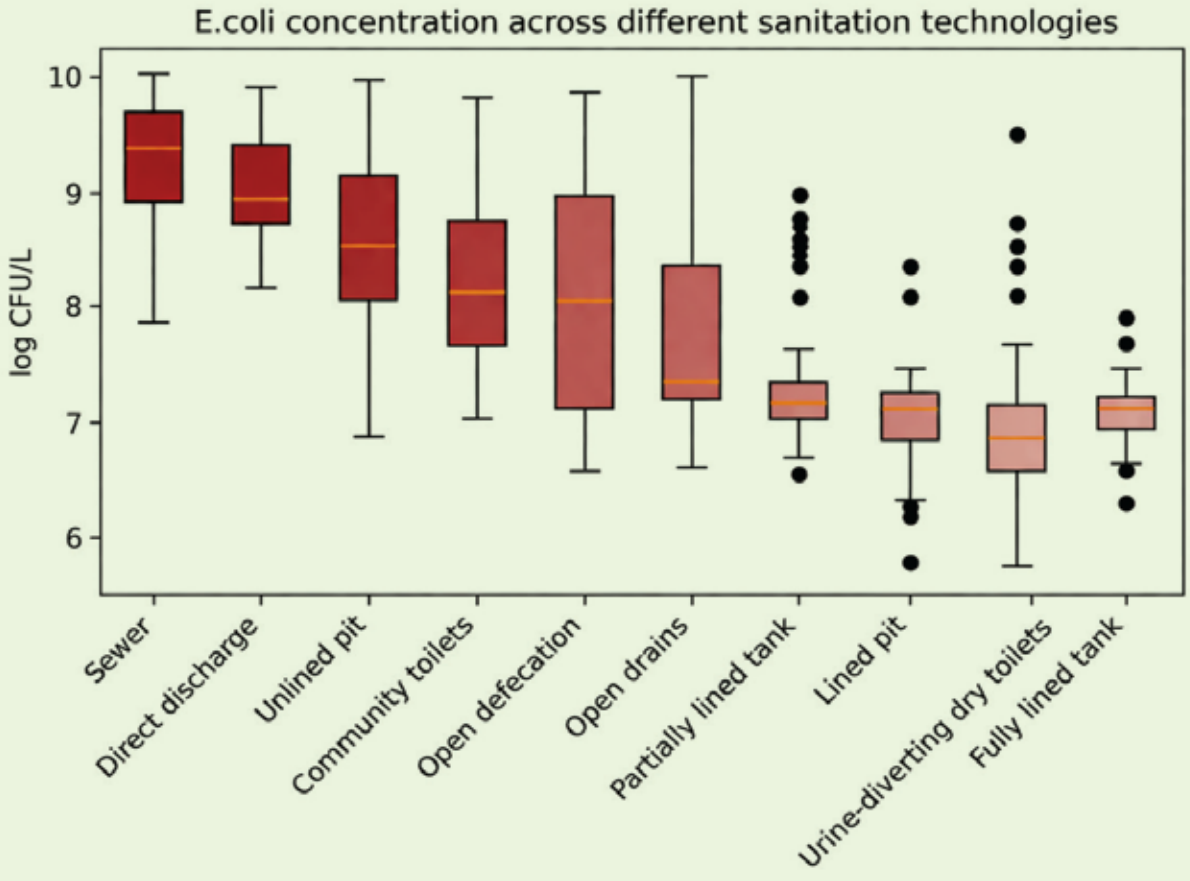


Figure 4: E. Coli concentrations across different sanitation technologies

Health Burden: Approximately 25% of study participants reported to have experienced diarrhea within the previous two weeks, and 36% reported experiencing stomach illnesses. This may indicate a link between environmental contamination and public health.

IMPLICATIONS FOR POLICY AND PRACTICE

The population in Kibera is exposed to various health risks due to overcrowded living conditions coupled with human behaviors such as poor waste disposal practices and inadequate sanitation systems that do not effectively contain fecal waste. These risks are compounded when sanitation systems overflow or discharge fecal matter into the environment. Our findings show that different sanitation technologies and containment systems vary in their effectiveness in reducing exposure to fecal contamination. Thus, there is need to:

1. **Improve fecal sludge management practices:** In low-income settlements like Kibera, improving fecal sludge containment and disposal is vital. Sanitation technologies should be maintained in ways that effectively prevent exposure of the population to fecal matter and reduce environmental contamination.

2. **Design sanitation infrastructure suited to informal settlements:** Urban planners should design safe waste management infrastructure that responds to physical constraints of informal settlements, including limited space, high population density, poor road access and flood risks. Systems should allow pits and tanks to be safely emptied before they overflow.

3. **Strengthen routine public health and environmental monitoring:** Public health systems should incorporate regular monitoring of pathogen concentration in sanitation systems, open drains and other environmental exposure points. This can help identify technologies that are less effective in containing pathogens and guide targeted improvements or replacement.

4. **Promote community engagement and safe waste disposal practices:** Community-based, government and non-governmental organizations should conduct regular community engagement and education on safe waste disposal. In addition, supporting village sanitation committees can strengthen local governance, oversight, and community-led maintenance of these sanitation technologies.

5. **Establish clear operation and maintenance responsibilities:** County government, landlords, service providers, and community structures should have clearly defined roles for maintaining sanitation technologies, reporting faults, organizing emptying services and preventing overflow or leakage.

CONCLUSION

The study highlights that inadequate sanitation infrastructure and poor fecal waste management continue to expose residents of informal settlements to public health risks. Investments in safer sanitation technologies, improved waste management and community-led initiatives will be vital to reducing the exposure of residents to contamination and disease and improve health outcomes in urban informal settlements such as Kibera.

Acknowledgements
This study was implemented by the African Population and Health Research Center (APHRC) in collaboration with the PROMISE consortium, which brings together partners from Uganda, Tanzania, Senegal, Ghana, Zambia, Bangladesh, Malawi, University of North Carolina and Emory University. We also collaborated with Kenya's Ministry of Health, the Sub-county Ministry of Health team in Kibera, local stakeholders, community leaders, and residents, whose support and participation we gratefully acknowledge.

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