

## **Policy Brief for Grant 12-040KU Combating Cholera Caused by Climate Change (C5)**

### **Executive summary:**

This brief provides an overview of the Combating Cholera Caused by Climate Change (C5) project's main objectives, findings, and conclusions. Low-income households in the Global South are especially vulnerable to the impacts of climate change and at high risk of water stress. The C5 looked at how water quantity and quality relate to the hygiene behaviors of people living in Arichpur, a slum area in Dhaka, Bangladesh, and how this links to the onset of diarrheal diseases, including cholera. The results from the C5 study show:

- The domestic domain, particularly the kitchen, to be an important hotspot for bacteria and pathogen transmission;
- On average, food, rather than drinking water, is the most significant contributor to a person's daily intake of *E.coli* bacteria;
- *E.coli* bacteria found in the household's water and food was mainly of animal origin;
- Flies can potentially play an important role as vectors in cholera and *E. coli* transmission;
- When faced with temporary water stress, low-income households will reduce the quantity of water used for kitchen hygiene, not personal hygiene;
- The economic burden of one episode of non-severe diarrhea (97% of diarrhea episodes) for low-income households is equivalent to a one-day household income.

In sum, the project highlights that the quantity of water available may play a more dominant role than water quality itself in pathogen transmission in low-income households. It is important to stress that the C5 study is limited to *Vibrio cholera* and *E.coli* bacteria and does not account for, e.g., any viral or protozoan pathogens that also play a significant role in diarrhea cases in low- and middle-income countries. Likewise the results are based on investigations of one slum area in Dhaka, Bangladesh.

These results will, hopefully, create a bigger focus on the water quantity. Future household upgrades should include latrines and water supply, but consider animal excreta and fly management. Most importantly, the kitchen area is the main contamination hotspot of low-income households. This project also has implications for future assessments of the economic burden of diarrheal disease in Bangladesh and the real cost-benefit that WASH interventions can have in settings like Arichpur.

### **Introduction:**

The aim of Combating Cholera Caused by Climate Change (C5) project was to investigate how water stress influences cholera spread in a slum population in Dhaka, Bangladesh. However, the study's underlying objective was to gain an in-depth knowledge of diarrheal diseases, including cholera, and the relationship between water quantity, quality, and the hygiene behaviors of a slum population. The project's findings will help the policymakers understand the contributable risks and effects of climate change to the low-income urban water-stressed communities to reduce cholera and diarrheal illnesses.

### **Background:**

Climate change is causing increasing water stress in the Global South. Despite the global concern of climate change and WASH-related infectious diseases, a significant gap remained within the scientific community on transmission dynamics of these. Little attention was provided to know whether or not water quantity increases the risk of diarrheal diseases through compromised personal (cleaning of body and body parts) and domestic hygiene (cleaning kitchens, floors, toilets) behavior. What effect this decreasing hygiene will have on the transmission

routes of cholera and *E.coli* in the households is unknown, but a highly relevant question to ask in a world where climate change will increase. The water and health outcomes are complex, and the array of different transmission pathways and their relation to climate-induced water stress situations urged a novel multidisciplinary research approach and involved microbiologists, anthropologists, public health experts, engineers, epidemiologists, and hydrologists. C5 followed 477 households in Arichpur, a slum area in Dhaka, Bangladesh, for two years, identifying parameters of diarrhea episodes, personal and household water use practices and perception, food, water, hygiene, and microbiological mapping of the households' contamination hotspots. Thus, this holistic approach of multidisciplinary experts enriched the methodology of the study and provided high-quality, real-time data in an in-depth and contextual manner.

### **Results:**

This study highlighted that the domestic domain, particularly the kitchen, is the central hotspot for bacteria and pathogen transmission in an average low-income household in Arichpur. A recently washed food plate is surprisingly far more contaminated with *E.coli* (potential pathogen and an indicator for fecal contamination) than the toilet doorknob! The bacteria on the surfaces in the kitchen (plate, glass, kitchen table, etc.) is easily transferred to the cooked food, thereby making the food the biggest contributor to a person's daily intake of *E.coli* bacteria. If a person eats food that has been left in the kitchen for 2 hours after cooking, 95% of the daily intake of *E.coli* would come from food and only 5% from the drinking water, even if the drinking water is extremely polluted (999 *E.coli* per 100 ml). In line with other studies, the C5 shed light on the drinking water's considerable in-house pollution, and similar to the food plate, also substantial contamination from the drinking glass. Besides, behavioral data showed that when households are exposed to temporary water stress, they substantially reduced the quantity of water used to maintain the kitchen's hygiene, including kitchen utensils, and not for personal hygiene.

The *E.coli* bacteria found on the food could come from various sources, but the majority was believed to originate from domestic and wild animals and not humans. The C5 found the gutting of fish capable of polluting a kitchen environment with contaminated slime scales, etc. The study also found that flies could deposit a considerable number of *E.coli* on the food after each landing, and cholera bacteria could survive for a long time on kitchen surfaces.

The study also captured the community burden of diarrhea through a real-time innovating methodology using mobile-phone-based longitudinal data collection, which addressed the methodological gap of diarrhea data collection. Most of the epidemiological and disease burden studies depended on <7 days recall period and/or projected the burden of the disease using hospital data. Thus, this study informed the global community about the non-severe (mild and moderate) diarrhea burden hidden within the community due to a lack of community-based real-time methodology. This is the most significant fraction of the diarrhea cases (as only 3% of the diarrhea cases visit health facilities or formal healthcare providers), where the disease is treated in-house and not demanding hospital treatment. The cost of non-severe diarrhea was estimated, which showed that in a poor household in Arichpur, the economic burden of one episode of non-severe diarrhea (medicine (antibiotics), potential wage loss) is equivalent to a one-day household income.

### **Limitations:**

C5 only included the pathogens *Vibrio cholera* and *E. coli*. Therefore, the results only represent these two fecal bacteria and do not account for any viral or protozoan pathogens that also play a significant role in diarrhea cases in low- and middle-income countries. The results represent one low-income community in Arichpur, Dhaka, Bangladesh.

### **Conclusions:**

C5 highlighted the importance of having enough water available for daily kitchen hygiene, and to a lesser extent, the importance of the quality of this water. A potential problem in a Climate changed future where the available freshwater resources are believed to be depleting.

**Implications:**

We can start putting a price on hidden diarrhea, which newer shows up in the statistics as it never reaches the hospitals. Nevertheless, it has tremendous economic importance, as each episode costs the same as a daily wage from a low-income family. We can now produce a better estimate of the benefit of WASH interventions, as these will be hugely underestimated if we only look at hospital statistics.

More focus should be given to the quantity of water available. If only the quality is in focus, the high cost of obtaining a perfect quality could come at the expense of the quantity and the household hygiene. Likewise, the management of animal feces in urban areas needs urgent attention.

**Recommendations:**

Future studies and interventions should have a more significant focus on the amount of water available, rather than just on clean water. Upgrading households should include the latrine and water supply and take into account fly control, animal excreta management, and the kitchen area, as this is the main contamination hotspot of any household.

**Overview of some of the main findings can be found in:**

Peter Kjær Mackie Jensen, Stephen Grant, Mads Linnet Perner, Zenat Zebin Hossain, Jannatul Ferdous, Rebeca Sultana, Sara Almeida, Matthew Phelps and, Anowara Begum, 2021, **Historical and contemporary views on cholera transmission: are we repeating past discussions? Can lessons learned from cholera be applied to COVID-19?** APMIS. DOI: 10.1111/apm.13102