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Short Communication

Water, sanitation and hygiene: A leading cause of viral transmission in Pakistan?

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The rise of viral diseases has highlighted the long-lasting inequalities in water, sanitation and hygiene access across Pakistan in recent years [1]. The response of the water sector has been particularly difficult across urban slums in under-developed regions across the country where most action plans have so far been temporary with no guarantee to sustainable access of services. To curtain widespread transmission of viral disease such drug-resistant typhoid, hepatitis A, and more recently compounded by SARS-CoV-2, water utilities have been the frontline response by public health specialists [2]. To understand the role that water, sanitation and hygiene plays for viral transmission in Pakistan, it is important to understand the impacts on authorities, service providers and the organizations that are responsible for water management.

In places like the *Lyari slum* in Karachi, Pakistan, around two-thirds of the population, comprising 16 million people, lives in slums; also known as an informal urban settlement [3]. Residents in the settlement do not have access to running water and they instead buy water from tankers, which may cost $100 or upwards per month; the equivalent of the standard monthly wage for laborers in Pakistan [3]. With such intricacies in pricing, supply and demand, water is used sparingly, wherein it is considered a luxury only used for cooking or handwashing. These urban slums are also called *black spots* of Pakistan due to the lack of sewage systems, running water, and reliable electrical supply [3]. Much to the dismay of world public health and virology organizations, there is no centralized system that provides data for the millions of residents living in these under-resourced areas. Hence, positing and applying policy frameworks may be considered near impossible in developing countries like Pakistan.

A UNICEF report found that 22.2 million Pakistani residents do not have proper sanitation and toilets, in a country of 200 million; with around 10% of the population lacking such privileges, diseases like polio, XDR typhoid, diarrhea, hepatitis, and cholera take the center stage [4]. These water-borne diseases lead to the death of nearly 94,000 people every year where 53,000, nearly 56.4%, of them are children under the age of 5 [4]. A team of researchers estimated the risk of hepatitis A infection transmission through water sources using a quantitative microbial risk assessment (QMRA) model across primary schools in Sindh, Pakistan [5]. The QMRA model was utilized to identify the risks of HAV using indicators such as fecal coliforms, where the dose-response model was employed to calculate likely infection [5]. The study found that the daily risk of HAV infection among school children in Karachi, Sindh was 35 per 10,000 school children, with a risk of 3 per 10,000 school children in Larkana [5]. The mortality indicator estimated 4 to 29 deaths per 10,000 children per annum [5]. The study concludes that the quality of water across primary schools in Sindh is very poor and the risk of hepatitis A among primary school children is extremely high [5].

Viral gastroenteritis, owing to the possible widespread prevalence of enteric viruses in Pakistan is grossly under-documented across the country [6]. A study identified the presence of human adenovirus, human enterovirus, and genotype A rotavirus in tap water, using a sample PCR approach where 20%, 43% and 23% of the respective viruses were identified in tap water [6]. Recently, public health researchers have aimed to focus on sewage water and quality in Karachi. A team of researchers and epidemiologists at The Aga Khan University, The World Health Organization (WHO) Pakistan office and the National Institute of Health (NIH) announced a pilot project to test wastewater

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samples for coronavirus and its concentration [7]. Similar sewerage surveillance systems have been introduced in Australia, United States of America, Canada and other developed countries [7]. Once piloted, such projects can aid in detecting viruses in sewage 7–19 days before the viral levels could rise, thus enabling public health and virology experts to take the required actions [7]. Wastewater sampling may act like a sensitive viral predictor, which once assessed for feasibility in Karachi, can be scaled up to the provincial and national level.

While noting the trends of SARS-CoV-2 transmission, a team of researchers used the current polio environmental surveillance network in Pakistan to present the prevalence of COVID-19 across 78 wastewater samples from 38 districts in Pakistan [8]. Of those collected, 21 wastewater samples were positive on RT-PCR testing for SARS-CoV-2, meaning that 27% of the water samples were tainted [8]. The study found that wastewater surveillance has an epidemiologic potential that may be used to monitor viral tracking and circulation in cities that have a visibly low burden of COVID-19 disease and in areas where door-to-door tracing may be difficult [8]. The development of sensitive assays can serve as scalable, valuable virtual monitoring tools to provide early warning signs to countries, states, cities, and settlements in unison.

As per an update from WHO in 2018, more than 5200 people were then infected with extremely drug-resistant (XDR) typhoid [9]. The strain, *Salmonella enterica* serovar Typhi, was resistant to five different classes of antibiotics, first reported in the Qasimabad sub district of Hyderabad, Sindh and the Latifabad subdistrict, Sindh [9]. Salmonella Typhi transmission has been highly prevalent across Pakistan in areas with poor sanitation, hygiene and in areas with insufficient access to clear water. The failure of antibiotics compounded by Pakistan's abysmal water and sewage systems on top of the low vaccination rates and overpopulated living spaces led to the extensive spread of XDR typhoid. While earlier, water and sanitation were a provincial responsibility, the governance was transferred to newly created local government institutions. On the grassroots level, the Orangi Pilot Project, Lodhran Pilot project, Community-led total sanitation and Karachi Bulk Water Supply Project have gained minor to moderate traction in improving water and sanitation measures [10].

Moving forward, the water sector is recommended to prioritize public safety by regularly providing essential water and sanitation services while protecting the staff during and post the COVID-19 pandemic [1]. The well-being and social outcomes of vulnerable populations must be safeguarded on four different levels. First, preventing and responding to future health crises, second, improving access to sanitation and water, third, promoting irrigation systems for long-term food and water security and fourth, incorporating digital technologies for adequate awareness of water-viral transmission. These crises can be slowly and steadily mitigated by adopting water, sanitation, and hygiene (WASH) in public health strategies. WASH access is in accordance with the Sustainable Development Goal 6 (SDG-6), which will require large investments when exploring methods to improve sanitation services [1]. Whether the ongoing pandemic has plunged Pakistan into a pathway of water and sanitation is yet to be determined in the subsequent years.

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Zouina Sarfraz and Azza Sarfraz conceptualized the paper, acquired the materials used for the paper, worked on the manuscript-initial draft and final review. Aman Siddiqui, Ali Totonchian, Muzna Sarfraz and Ivan Cherrez-Ojeda worked on manuscript writing-initial draft and final reviews. All authors approved the final manuscript. Zouina Sarfraz and Azza Sarfraz are co-guarantors of the paper.

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Declaration of competing interest

None.

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