

Systemic and Institutional Determinants of Cholera Transmission and Control in the Rohingya Refugee Camps, Cox's Bazar, Bangladesh

Otieno O. D.^{1,2*}, Khan M. F.², Manzur M.², Apolot R.¹, Kaddu SS.¹, Barasa W. A.¹, Abiodun P.¹

¹Department of Public Health, Texila American University, Georgetown, Guyana

²World Health Organization, Cox's Bazar, Bangladesh

***Correspondence to be addressed:**

E-mail - otieno.david14@gmail.com, ORCID: <https://orcid.org/0009-0009-8195-5602>

Cite this article as: Otieno OD, Khan MF, Manzur M, Apolot R, Kaddu SS, Barasa WA, Abiodun P. Systemic and institutional determinants of cholera transmission and control in the Rohingya refugee camps, Cox's Bazar, Bangladesh. Texila Int J Public Health. 2026;14(3). <https://doi.org/10.21522/TIJPH.2013.14.03.Art020>

Received: 01.07.2026

Accepted: 30.08.2026

Published: 30.09.2026

Article Type: Original Research

Abstract Cholera has persisted and periodically surged in the Rohingya refugee camps of Cox's Bazar, Bangladesh, despite sustained humanitarian investment, raising questions about the systemic factors that mitigate or enhance transmission. This study characterised the institutional and infrastructural determinants of cholera transmission and control through a synthesis of surveillance and programmatic data and a documentary review of the response architecture, 2018–2026. A multi-layered surveillance system combining community-based surveillance, indicator-based syndromic surveillance, sentinel rapid testing and laboratory confirmation underpinned outbreak detection. The syndromic burden of acute watery diarrhoea declined steadily, from approximately 231,000 cases in 2018 to approximately 122,000 in 2025, reflecting maturing water, sanitation and hygiene services. Culture-confirmed cholera nonetheless remained endemic with recurrent upsurges, the largest in 2024 (534 cases), demonstrating that infrastructural investment alone is insufficient. Rapid diagnostic test–positive counts exceeded but tracked culture-confirmed counts, indicating substantial laboratory confirmation capacity. Integrated reactive oral cholera vaccination, with coverage exceeding 90% in the 2025 campaign, was associated with rapid outbreak suppression. Persistent transmission was attributed to the fragility of water, sanitation, and hygiene gains against monsoon damage, residual point-of-use and foodborne pathways, a predominantly reactive posture, and funding volatility in a protracted crisis. The findings support a shift towards anticipatory, spatially and temporally targeted, integrated control, including environmental surveillance and preventive vaccination, sustained by predictable multi-year financing and strengthened health and water-sector coordination.

Keywords Cholera, Humanitarian Settings, Oral Cholera Vaccine, Rohingya Refugees, Surveillance, Water and Sanitation.

Introduction

Cholera in displaced populations is shaped not only by individual behaviour and the surrounding environment, but also by systemic factors: the adequacy and maintenance of water, sanitation and hygiene (WASH) infrastructure; the capacity and integration of surveillance; the timeliness and coverage of vaccination; the strength of intersectoral coordination; and the predictability of funding [1, 2]. The Rohingya refugee camps of Cox's Bazar, Bangladesh, which host approximately 1.2 million displaced people across 33 congested camps, have experienced endemic cholera with recurrent outbreaks since 2019, despite substantial and sustained humanitarian intervention [3, 4].

Following the influx in August 2017, WHO, in collaboration with the Civil Surgeon's Office, the Refugee Relief and Repatriation Commissioner, and the Health and WASH Sectors, established an Early Warning, Alert and Response System (EWARS) for acute watery diarrhoea (AWD) alert response; a joint assessment and response team led by the health and WASH sectors across camps, anchored in scenario-based multisectoral AWD/cholera preparedness and response plans; and a multilayered surveillance architecture for priority epidemic-prone diseases, including AWD and cholera [5, 6]. Substantial investment has also been made in WASH infrastructure, repeated oral cholera vaccination (OCV) campaigns, and coordinated outbreak response [7, 8]. Yet cholera has not only persisted but surged, with the 2024 outbreak the largest on record. This indicates that the systemic determinants of transmission and control are not fully understood [9].

Understanding these systemic determinants is essential because the effectiveness of interventions that interrupt cholera—surveillance, safe water, sanitation, hygiene, community-led and culturally appropriate risk communication, community engagement, and oral cholera vaccination—depends on the

institutional capacity to deliver and sustain them [10, 11]. This study therefore characterised the systemic, institutional and infrastructural factors that mitigate or amplify cholera transmission and recurrent outbreaks in the Rohingya camps, drawing on a desk review of existing refugee camp-based surveillance data and programmatic reports, and a review of the response architecture based on structured key informant interviews with experts from humanitarian actors and local authorities, programme coordinators and field response teams, to inform a more anticipatory model for prevention and control.

Materials and Methods

Study Design and Setting

This study used a mixed-methods design, combining desk review and analysis of routine surveillance and programmatic reports with a documentary review of the surveillance and response architecture. Key informant interviews were conducted with programme designers, coordinators, and implementers from local authorities and humanitarian organizations involved in the Rohingya refugee crisis response in Cox's Bazar District, from 2018 to 2026. The camps are characterized by extreme density and fragile WASH services on flood-prone terrain [4].

Data Sources

Quantitative data comprised weekly acute watery diarrhoea (AWD) counts from indicator-based syndromic surveillance, weekly culture-confirmed cholera cases from laboratory surveillance, rapid diagnostic test (RDT)-positive AWD/suspected cholera case counts from sentinel surveillance, and programmatic records of oral cholera vaccine (OCV) campaigns. The documentary component reviewed the structure and functioning of the multi-layered surveillance system, WASH service delivery and maintenance, vaccination, and coordination

arrangements, triangulated with surveillance data.

Analysis

Surveillance data were cleaned and aggregated to annual totals to characterise long-term trends in AWD and confirmed cholera. We compared annual RDT-positive AWD/cholera suspects with culture-confirmed counts to assess diagnostic confirmation patterns. OCV coverage was summarised from campaign records and survey data. The surveillance architecture was described and mapped against the socio-ecological framework, which positions cholera transmission within nested household, community, institutional, and structural domains [12]. Descriptive results were cross-checked against operational WHO epidemiological bulletins. domains [12].

Results

The Multi-layered Surveillance and Early-warning System

The cornerstone systemic asset for cholera control was the multi-layered surveillance and response architecture established by WHO and partners (Figure 1; Table 1). The system integrated four complementary layers, each compensating for the weaknesses of the others: community-based surveillance, which extended reach into households and supplied timeliness; indicator-based syndromic surveillance through EWARS, which provided sensitive but non-specific trend signals; sentinel surveillance with RDT testing, which improved specificity; and laboratory culture confirmation, which improved specificity and definitive cholera diagnosis at the local Institute of Epidemiology, Disease Control and Research (IEDCR) field lab in Cox's Bazar [5, 6]. This integrated architecture was credited with relatively rapid outbreak detection and containment, while each layer retained its characteristic limitations in sensitivity, specificity, cost, or delay [13].

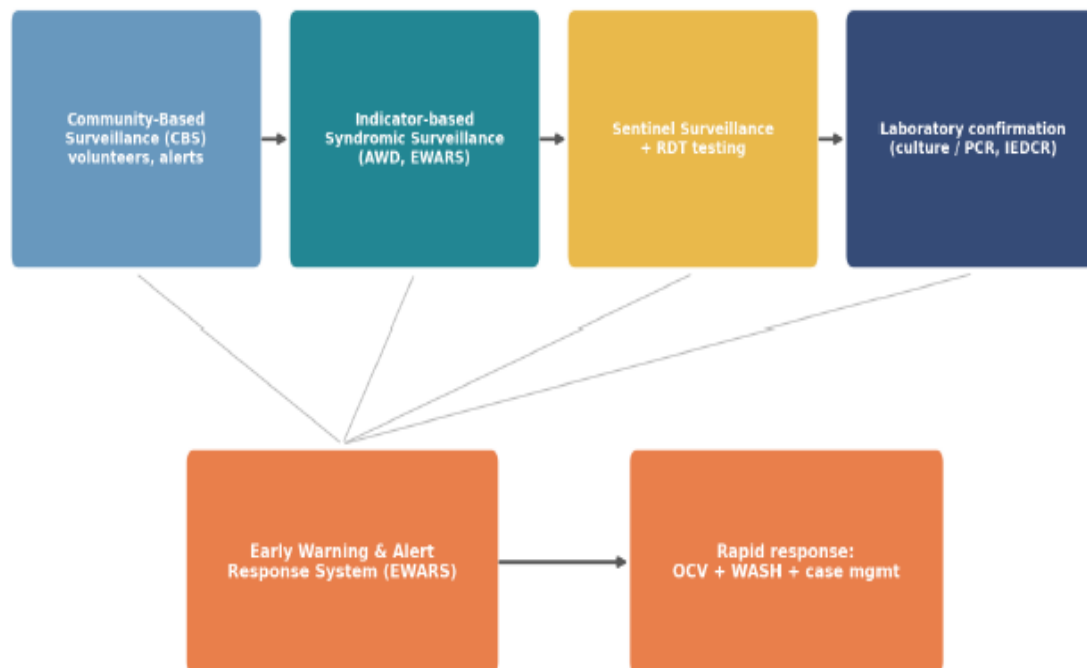


Figure 1. Multi-Layered Cholera Surveillance and Response Architecture, Rohingya Refugee Camps

Table 1. Layers of the Cholera Surveillance and Response System and their Functions

Surveillance Layer	Principal Function	Key Limitation
Community-based surveillance	Household-level signal detection: timeliness and wider population reach	Low specificity
Indicator-based syndrome (EWARS)	Weekly AWD trend monitoring: a sensitive signal	Non-specific
Sentinel surveillance with RDT	Point-of-care testing at designated sentinel testing sites, detection of suspected cholera cases, and a key trigger for alert response by joint assessment and response teams	Inadequate geographical coverage, gaps with testing positivity rates, and over-utilization of kits to test cases
Laboratory (culture)	Definitive confirmation of <i>Vibrio cholerae</i> is key for the indicator for the calibration of alert, action, and epidemic thresholds and outbreak declaration	Resource-intensive; delay; authorities reluctant to declare an outbreak once the epidemic threshold is surpassed
Environmental (wastewater) pilot	Early population-level warning signal	Logistics: scale-up needed, cost-benefit analysis must be explored

EWARS = Early Warning, Alert and Response System; RDT = rapid diagnostic test; AWD = acute watery diarrhea.

Water, Sanitation, and Hygiene Service Delivery

The steady decline in AWD over the study period was the clearest systemic success of the response (Figure 2; Table 2). Annual AWD fell from approximately 231,000 cases in 2018, when WASH services were in the early stage of development, to approximately 122,000 in 2025, a reduction of nearly half, attributable to the cumulative maturation of WASH infrastructure and services, robust preparedness and surveillance systems, expanded chlorination, improved latrine utilization, and

sustained hygiene promotion [10]. However, culture-confirmed cholera remained endemic with recurrent upsurges, with the largest reported in 2024 (534 cases). This demonstrates that WASH infrastructure and services, emergency preparedness, and response-related investments alone are insufficient to extinguish cholera-specific transmission. The persistence of confirmed cholera despite falling AWD indicates residual transmission pathways—point-of-use recontamination, unsafe water and food at the point of consumption, and person-to-person spread that infrastructure alone could not close [11, 14].

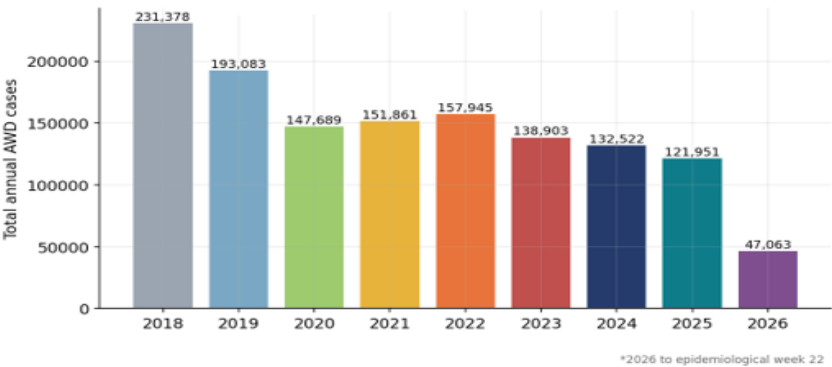


Figure 2. Annual Acute Watery Diarrhea Case Burden, 2018–2026

Table 2. Annual Acute Watery Diarrhea and Culture-Confirmed Cholera Burden, 2018–2026

Year	AWD Cases	Confirmed Cholera	RDT-Positive (Approx.)
2018	231,378	—	—
2019	193,083	183	260
2020	147,689	5	20
2021	151,861	136	210
2022	157,945	70	120
2023	138,903	81	140
2024	132,522	534	760
2025	121,951	59	95
2026*	47,063	8	15

*2026 data are partial (to epidemiological week 22). RDT = rapid diagnostic test; figures are approximate. AWD declined steadily while confirmed cholera fluctuated episodically.

Diagnostic Confirmation Capacity

A comparison of annual RDT-positive and culture-confirmed counts clarified the diagnostic confirmation pathway (Figure 3). RDT-positive counts consistently exceeded culture-confirmed counts, as expected given the higher sensitivity but lower specificity of rapid testing, but the two series tracked one another

closely, both rising sharply in 2024. This indicates that the culture-confirmed series reliably reflected the underlying epidemic dynamics while providing the specificity required for surveillance, and it further quantifies the substantial laboratory confirmation burden borne by the system during outbreak periods [13].

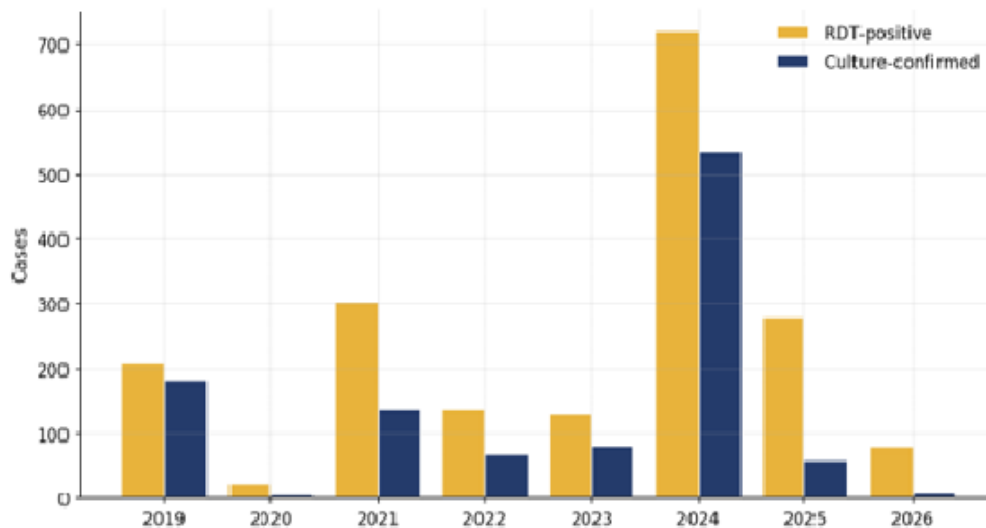


Figure 3. Rapid Diagnostic Test–Positive Versus Culture-Confirmed Cholera, by Year

Oral Cholera Vaccination

Oral cholera vaccine (OCV) was a decisive reactive tool. During the 2021 and 2024–2025 outbreaks, WHO-led health-sector teams rapidly deployed OCV campaigns closely integrated with water, sanitation, and hygiene

(WASH) interventions, suppressing transmission within two to three weeks of campaign completion in affected camps [7, 8]. These campaigns achieved high administrative coverage: approximately 77–81% in 2021 and approximately 93–94% in January 2025.

Notably, these high coverage levels, although sustained for a few years, were gradually reduced by continued seeding of confirmed cases in camps. This is consistent with projected time-bound waning protection by OCV within a three-year window, pockets of children initially ineligible for vaccination who gradually entered the susceptible population over time, and a new influx of susceptible people during the 2024 wave with unverified vaccination status. This was further aggravated by suboptimal WASH infrastructure and services below SPHERE standards, reinforcing the well-established perspective that OCV is not a single magic bullet for cholera control and is most effective when integrated with appropriate WASH interventions rather than deployed alone [15, 16]. Documented seasonal transmission patterns support a shift from a predominantly reactive to an anticipatory vaccination strategy, timed to precede the high-risk season in the highest-burden camps [17].

Coordination, Governance, and Systemic Fragility

The response operated within a complex governance architecture involving the Government of Bangladesh, United Nations agencies, and numerous non-governmental partners coordinated through the Health and WASH Sectors [18]. Effective inter-sectoral coordination—particularly the integration of joint health and WASH assessment and response mechanisms at camp levels, the utilization of the early warning and alert response system (EWARS) data for rapid alert response, and seamless flow of tested samples from sentinel testing sites to the local field laboratory for confirmatory detection—was a critical enabler of rapid containment. The trusted and dedicated surveillance networks established by the WHO, a large pool of 1700 community health workers coordinated by community health working group partners, were indispensable to both surveillance and risk communication, complemented by the critical

roles of hygiene promoters [19]. However, the study noted some unresolved gaps in the coordination of WASH and Health sectors, highlighted erratic coordination of joint WASH and health sectors' quarterly performance review meetings, and inconsistent sharing of surveillance data across the two sectors, limited engagement of the nutrition sector in cholera response, and a completely missing role of the meteorology department in plugging climate data to strengthen the early warning and surveillance information. Nevertheless, the Health Sector, through epidemiology, case management, and Infection Prevention and Control TWGs, has maintained the central coordination mechanism in AWD and cholera preparedness and response in close collaboration with the district civil surgeon for Cox's Bazar district, the Refugee Relief and Repatriation Commission (RRRC), the Directorate of Public Health Engineering, and the WASH sector. The second layer of AWD and cholera response comprises the emergency preparedness and response committee that domiciles the emergency mobile medical teams (eMMTs) and is closely linked to the district health emergency operation center (HEOC) to coordinate disaster risk management with secondary response to diseases like AWD and cholera after monsoon rainfall storms floods, and landslides in camps. These two sectors have an established linkage with community health working groups to coordinate community-level surveillance and community case management of AWD, and a risk communication and community engagement committee that rapidly develops and deploys culturally appropriate government-endorsed risk communication messages on cholera and other priority communicable diseases through various platforms that effectively reach the refugee population. The final consequential response piece is scaling up the OCV campaign, led jointly by the WHO's Immunization and Vaccines Development (IVD) unit, with support from epidemiology

and surveillance, communicable diseases services, local health authorities, and partners. The socio-ecological framework (Figure 4) situates these institutional factors between the structural conditions of displacement and climate and the proximate household behaviours, clarifying how systemic capacity mediates the translation of structural risk into

protection. Across this, funding volatility and the crisis's protracted nature made systemic gains reversible: the camps' flood-prone terrain exposed WASH infrastructure to recurrent monsoon damage, and the sustainability of maintenance, surveillance, vaccination, and community engagement depended on predictable financing [20].



Figure 4. Socio-Ecological Framework of Cholera Transmission in Refugee Camps, Showing Nested Structural, Institutional, Community, and Household Domains

Discussion

This analysis explains why cholera has persisted despite genuine systemic progress. The decline in AWD demonstrates that WASH investment works; the persistence of confirmed cholera demonstrates that infrastructure alone is insufficient [10, 11]. The camps' flood-prone terrain renders WASH gains fragile and reversible, and the residual transmission pathways lie partly beyond the reach of infrastructure. The multi-layered surveillance system has enabled rapid detection and containment, and integrated reactive OCV has suppressed outbreaks quickly, but the predominantly reactive posture leaves the

system perpetually responding to, rather than pre-empting, transmission [13, 17].

A central systemic insight is that WASH protection is not a stock but a flow: it must be continuously produced through chlorination, repair, desludging, and monitoring, and it degrades rapidly when any component lapses [14, 21]. The monsoon imposes an annual shock that degrades the system as transmission conditions build, so the protective margin is thinnest in the run-up to the high-risk season. Maintenance capacity – the human and financial resources dedicated to keeping the system functioning through the monsoon – is therefore as important a determinant of transmission as the capital infrastructure itself

and should be resourced and monitored accordingly [22].

Two enhancements to the surveillance architecture follow from the findings. First, environmental (wastewater) surveillance, piloted in selected camps, can provide an earlier, population-level warning signal by detecting *V. cholerae* shed by mild and asymptomatic infections that never reach the health system [23, 24]. Second, incorporating seasonal and climatic risk information as a predictive input could prime the system ahead of the high-risk season [17]. The protracted nature of the crisis creates tension between emergency and development modes of operation: effective interventions must be sustained, integrated, and anticipatory, yet the funding environment favours short, reactive cycles [20, 25]. Bridging this gap requires multiyear financing, institutionalised surveillance and WASH maintenance capacity, and planning horizons matched to the recurrent, seasonal nature of the threat. This study is limited by its reliance on routine surveillance data subject to under-ascertainment and by the descriptive, thematic nature of the systemic synthesis.

The community health-worker network warrants particular emphasis as a systemic asset that links the surveillance, WASH, vaccination, and risk communication functions at the household level where transmission ultimately occurs. Embedded within the community, these workers detect the earliest alerts, deliver targeted risk communication, support household water treatment and hygiene, and facilitate case-area interventions around confirmed cases [19]. Their effectiveness, however, depends not only on their presence but on the continuity of their training, supervision, supply, and remuneration, similarly to the surveillance networks that deliver technical response and support supervision in camps, all of which are vulnerable to the funding volatility that characterises the response. Investment in these

networks is therefore a high-leverage component of an anticipatory strategy, because it operationalises the integrated control that the systemic analysis identifies as necessary. Sustaining it through predictable financing would convert an intermittently resourced asset into a durable backbone for cholera prevention and for epidemic preparedness more broadly.

Conclusion

A multi-layered surveillance architecture has enabled relatively rapid detection and containment of cholera outbreaks in the Rohingya camps, and integrated reactive vaccination has suppressed outbreaks quickly. Maturing WASH service delivery drove a steady decline in acute watery diarrhoea, but infrastructural gains remain fragile against monsoon damage and insufficient on their own to close point-of-use and foodborne transmission pathways, so confirmed cholera has remained endemic with recurrent upsurges. Effective health–WASH coordination and community engagement were critical enablers, while funding volatility and the protracted crisis rendered systemic gains reversible. The findings support a shift from reactive to anticipatory, spatially and temporally targeted, integrated control—incorporating environmental surveillance and preventive vaccination—sustained by predictable multi-year financing and strengthened coordination [17, 24]. Strengthening the maintenance capacity that keeps WASH systems functioning through the monsoon is as important as the capital infrastructure itself.

Conflict of Interest

The authors declare no conflict of interest.

Acknowledgements

The authors sincerely thank Hossain Md Sabbir, Sami Momtahn, Rafi Abdur, and Islam Md Sahidul of the World Health Organization's Health Emergencies Programme in Cox's Bazar, the Civil Surgeon's Office for supporting data collection by reviewing and

uploading the data collection tools to a digital platform for use; the Health and WASH Sectors; the District Civil Surgeon Office RRRC; and the camp-based surveillance and Rohingya refugee leaders and community members for participating in this study through key informant interviews and focus group discussions.

Author Contributions

David Odhiambo Otieno conceptualized the study, assembled and analysed the data, and drafted the manuscript. M. F. Khan and Manzur M contributed to the review of data collection tools and critical revision of the manuscript. R. Apolot, K. S. Kaddu and P. Abiodun contributed to interpretation and final revisions. All authors read and approved the final manuscript.

References

- [1]. Connolly MA, Gayer M, Ryan MJ, Salama P, Spiegel P, Heymann DL. Communicable diseases in complex emergencies: impact and challenges. *Lancet*. 2004;364(9449):1974-83. [https://doi.org/10.1016/S0140-6736\(04\)17481-3](https://doi.org/10.1016/S0140-6736(04)17481-3)
- [2]. Spiegel PB, Le P, Ververs MT, Salama P. Occurrence and overlap of natural disasters, complex emergencies and epidemics during the past decade. *Conflict Health*. 2007;1:2. <https://doi.org/10.1186/1752-1505-1-2>
- [3]. Khan AI, Chowdhury F, Harris JB, LaRocque RC, Faruque ASG, Ryan ET. Diarrhoea and cholera surveillance for early warning and preparedness among Rohingya populations. *PLOS Glob Public Health*. 2024;4(2):e0002791. <https://doi.org/10.1371/journal.pgph.0002791>
- [4]. United Nations High Commissioner for Refugees. Rohingya refugee response: Cox's Bazar operational data portal. Geneva: UNHCR; 2024. https://data.unhcr.org/en/situations/myanmar_refugees

Ethical Approval

The study used routine, de-identified surveillance and programmatic data generated through the operations of the World Health Organization and partner institutions, used with appropriate authorisation for academic purposes. Ethical approval was secured from Cox's Medical College's Research and Ethics Committee and the Refugee Relief and Repatriation Commission (RRRC).

Data Availability

The aggregated surveillance and programmatic data analysed in this study are available from the corresponding author on reasonable request, subject to the data-sharing policies of the responsible institutions.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

- [5]. World Health Organization. Early Warning, Alert and Response System (EWARS) bulletins, Cox's Bazar. Dhaka: WHO Bangladesh; 2024. <https://www.who.int/bangladesh>
- [6]. Cousins S. Rohingya threatened by infectious diseases. *Lancet Infect Dis*. 2018;18(6):609-10. [https://doi.org/10.1016/S1473-3099\(18\)30304-9](https://doi.org/10.1016/S1473-3099(18)30304-9)
- [7]. Qadri F, Azman AS, Chowdhury F, Khan AI, Saha A, Khan IA. Emergency deployment of oral cholera vaccine for the Rohingya in Bangladesh. *Lancet*. 2018;391(10133):1877-9. [https://doi.org/10.1016/S0140-6736\(18\)30993-0](https://doi.org/10.1016/S0140-6736(18)30993-0)
- [8]. Hsiao A, Desai SN, Mogasale V, Excler JL, Digilio L. Lessons learnt from 12 oral cholera vaccine campaigns in resource-poor settings. *Bull World Health Organ*. 2017;95(4):303-12. <https://doi.org/10.2471/BLT.16.175166>
- [9]. Global Task Force on Cholera Control. Ending cholera: a global roadmap to 2030. Geneva: World Health Organization; 2017. <https://www.gtfcc.org/about-cholera/roadmap-2030/>

- [10]. Wolfe M, Kaur M, Yates T, Woodin M, Lantagne D. A systematic review and meta-analysis of the association between water, sanitation, and hygiene exposures and cholera in case-control studies. *Am J Trop Med Hyg.* 2018;99(2):534-45. <https://doi.org/10.4269/ajtmh.17-0897>
- [11]. Taylor DL, Kahawita TM, Cairncross S, Ensink JHJ. The impact of water, sanitation and hygiene interventions to control cholera: a systematic review. *PLoS One.* 2015;10(8):e0135676. <https://doi.org/10.1371/journal.pone.0135676>
- [12]. Sallis JF, Owen N, Fisher EB. Ecological models of health behavior. In: *Health behavior: theory, research, and practice*. 5th ed. San Francisco: Jossey-Bass; 2015. p.43-64. <https://www.wiley.com/>
- [13]. Ratnayake R, Finger F, Azman AS, Lantagne D, Funk S, Edmunds WJ. Highly targeted spatiotemporal interventions against cholera epidemics, 2000-19: a scoping review. *Lancet Infect Dis.* 2021;21(3):e37-48. [https://doi.org/10.1016/S1473-3099\(20\)30479-5](https://doi.org/10.1016/S1473-3099(20)30479-5)
- [14]. Lantagne D, Yates T. Household water treatment and cholera control. *J Infect Dis.* 2018;218(Suppl 3):S147-53. <https://doi.org/10.1093/infdis/jiy488>
- [15]. Bi Q, Ferreras E, Pezzoli L, Legros D, Ivers LC, Date K. Protection against cholera from killed whole-cell oral cholera vaccines: a systematic review and meta-analysis. *Lancet Infect Dis.* 2017;17(10):1080-8. [https://doi.org/10.1016/S1473-3099\(17\)30359-6](https://doi.org/10.1016/S1473-3099(17)30359-6)
- [16]. Azman AS, Luquero FJ, Ciglenecki I, Grais RF, Sack DA, Lessler J. The impact of a one-dose versus two-dose oral cholera vaccine regimen in outbreak settings: a modeling study. *PLoS Med.* 2015;12(8):e1001867. <https://doi.org/10.1371/journal.pmed.1001867>
- [17]. Moore SM, Azman AS, Zaitchik BF, Mintz ED, Brunkard J, Legros D. Prediction of cholera outbreaks with seasonal climate information. *Proc Natl Acad Sci U S A.* 2017;114(17):4436-41. <https://doi.org/10.1073/pnas.1614702114>
- [18]. Inter-Agency Standing Committee. *Inter-agency coordination in protracted humanitarian crises*. Geneva: IASC; 2019. <https://interagencystandingcommittee.org/>
- [19]. Perry HB, Zulliger R, Rogers MM. Community health workers in low-, middle-, and high-income countries: an overview of their history, recent evolution, and current effectiveness. *Annu Rev Public Health.* 2014;35:399-421. <https://doi.org/10.1146/annurev-publhealth-032013-182354>
- [20]. Spiegel PB. The humanitarian system is not just broke, but broken: recommendations for future humanitarian action. *Lancet.* 2017. [https://doi.org/10.1016/S0140-6736\(17\)31278-3](https://doi.org/10.1016/S0140-6736(17)31278-3)
- [21]. Bartram J, Cairncross S. Hygiene, sanitation, and water: forgotten foundations of health. *PLoS Med.* 2010;7(11):e1000367. <https://doi.org/10.1371/journal.pmed.1000367>
- [22]. Cronk R, Bartram J. Environmental conditions in health care facilities in low- and middle-income countries: coverage and inequalities. *Int J Hyg Environ Health.* 2018;221(3):409-22. <https://doi.org/10.1016/j.ijheh.2018.01.004>
- [23]. Diamond MB, Keshaviah A, Bento AI, Conroy-Ben O, Driver EM, Ensor KB. Wastewater surveillance of pathogens can inform public health responses. *Nat Med.* 2022;28(10):1992-5. <https://doi.org/10.1038/s41591-022-01940-x>
- [24]. World Health Organization. *Multisectoral cholera prevention and control in humanitarian settings: operational guidance*. Geneva: World Health Organization; 2025. <https://www.who.int/publications>
- [25]. Checchi F, Warsame A, Treacy-Wong V, Polonsky J, van Ommeren M, Prudhon C. Public health information in crisis-affected populations: a review of methods and their use for advocacy and action. *Lancet.* 2017;390(10109):2297-313. [https://doi.org/10.1016/S0140-6736\(17\)30702-X](https://doi.org/10.1016/S0140-6736(17)30702-X)