

# Modelling the cholera outbreak in Yemen

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## Background

In war-torn Yemen, reports of confirmed cholera started in late September 2016. Cholera continues to plague Yemen today in what has become the largest documented cholera epidemic of modern times. We aim to describe key epidemiological features of this epidemic, including the drivers that triggered the massive surge of cholera cases in May 2017.

## Methods

The Health Authorities of Yemen set up a national cholera surveillance system to collect information on suspected cholera cases presenting at health-facilities and MSF cholera treatment centres. We first conducted descriptive analyses at national and governorate levels.

We reconstructed the changes in cholera transmission over time by estimating the instantaneous reproduction number,  $R_t$ . Finally, we estimated the association between rainfall and the daily cholera incidence during the increasing phase of the second epidemic wave, from April 15 to June 24 2017, by fitting a spatiotemporal regression model.

## Results

From 28 September 2016 to 12 March 2018, 1,103,683 suspected cholera cases (attack rate 3.69%) and 2,385 deaths (case fatality risk 0.22%) were reported countrywide. The epidemic comprised of two distinct waves with a surge in transmission in May 2017, corresponding to a median  $R_t > 2$  in 13 of 23 Governorates. Microbiological analyses suggested that the same *V. cholerae* O1 Ogawa strain circulated in both waves. We found a positive, non-linear, association between the weekly rainfall and cholera incidence in the following 10 days, with weekly rainfall of 25 mm being associated with a 1.42-fold (95% CI: [1.31 – 1.55]) increase in cholera risk compared to a week without rain.

## Conclusion

Our analysis suggests that the small first cholera epidemic wave seeded cholera across Yemen during the dry season. When the rains returned in April 2017, they triggered widespread cholera transmission that led to the large second wave.

We modelled the plausible drivers of cholera transmission during the course of the outbreak in Yemen. We found a strong association between rainfall and the massive surge of cholera cases in May 2017.