Supplemental Material

The Indian Ocean Dipole and Cholera Incidence in Bangladesh: A Time Series Analysis

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Supplemental Methods

Models for DMI and NINO3:

$$log[E(Y)] = \alpha + NS(DMI_{0\text{-}3},\ 3\ df) + NS(DMI_{4\text{-}7},\ 3\ df) + NS(DMI_{8\text{-}11},\ 3\ df) + NS(NINO3_{0\text{-}3},\ 3\ df) + NS(NINO3_{4\text{-}7},\ 3\ df) + NS(NINO3_{8\text{-}11},\ 3\ df) + i.month + i.year + AR_1$$

where $E(Y)$ is the expected monthly case count, NS indicates a natural cubic spline function, $DMI_{0\text{-}3}$ and $NINO3_{0\text{-}3}$ represent average DMI and NINO3 at a lag of 0–3 months, respectively, *i.month* represents indicator variables for the month, *i.year* represents indicator variables for the year, and AR_1 represents a first-order autoregressive term. For example, $NS(DMI_{0\text{-}3},\ 3\ df)$ indicates a linear term (raw data) and two spline terms of DMI at a lag of 0–3 months.

Models for SST and SSH:

$$log[E(Y)] = \alpha + NS(SST_{0\text{-}3},\ 3\ df) + NS(SSH_{0\text{-}3},\ 3\ df) + i.month + i.year + AR_1$$

Supplemental Material Table 1.

Diagnostics of models for cholera patients of Dhaka and Matlab hospitals

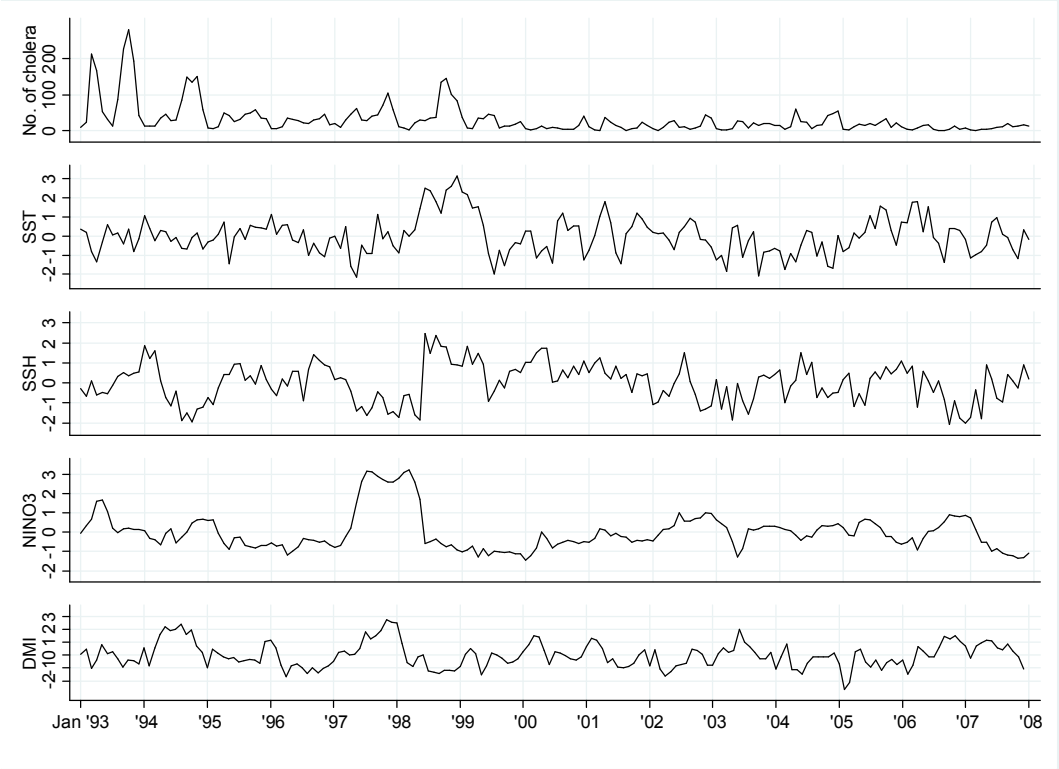
Variable in the model	Dhaka				Matlab			
	AIC	Deviance	Res. Df[a]	(1/df) Deviance	AIC	Deviance	Res. Df[a]	(1/df) Deviance
DMI	8.704	181.800	143	1.271	7.653	194.222	143	1.358
NINO3	8.711	183.156	143	1.281	7.538	194.819	143	1.362
SST	8.755	182.240	149	1.223	7.635	193.253	149	1.297
SSH	8.803	182.937	149	1.228	7.686	194.579	149	1.306
DMI+NINO3	8.721	181.050	134	1.351	7.572	197.310	134	1.472
DMI+SST	8.715	181.910	140	1.299	7.643	193.683	140	1.383
DMI+SSH	8.703	182.440	140	1.303	7.660	196.541	140	1.404

NINO3+SST	8.712	183.745	140	1.312	7.558	195.280	140	1.395
NINO3+SSH	8.715	183.536	140	1.311	7.536	197.380	140	1.410
SST+SSH	8.761	182.255	146	1.248	7.627	195.472	146	1.339
DMI+NINO3+SST	8.732	181.639	131	1.387	7.592	197.677	131	1.509
DMI+NINO3+SSH	8.714	181.697	131	1.387	7.586	199.120	131	1.520
DMI+SST+SSH	8.699	182.568	137	1.333	7.639	196.771	137	1.436
NINO3+SST+SSH	8.710	183.870	137	1.342	7.550	198.202	137	1.447
DMI+NINO3+SST+SSH	8.715	182.169	128	1.423	7.597	200.105	128	1.563

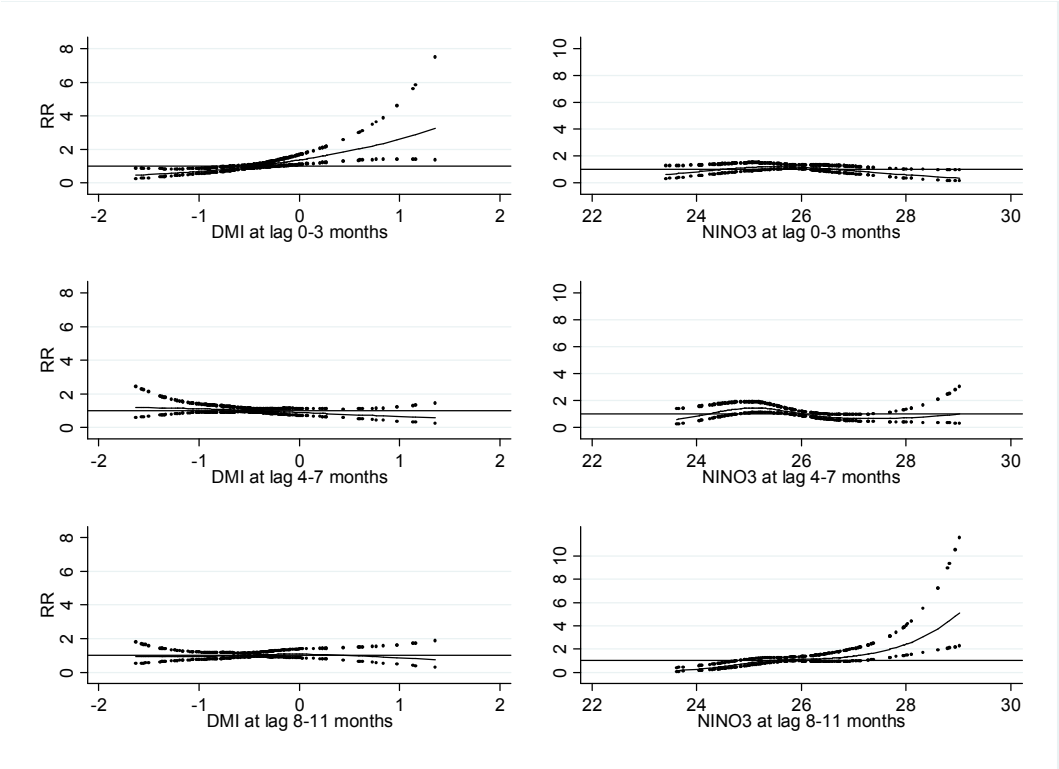
[a]Residual degrees of freedom

Models include a linear term and natural cubic splines of DMI, NINO3, SST or SSH, indicator variables of months and indicator variables of years.

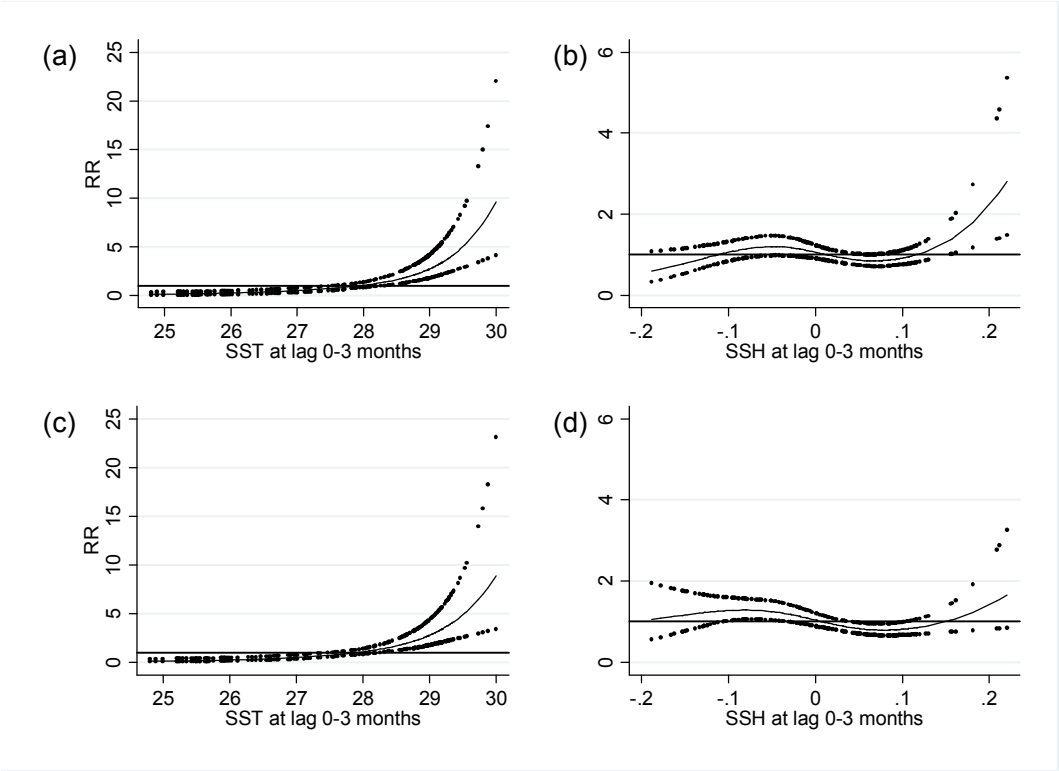
Supplemental Figures



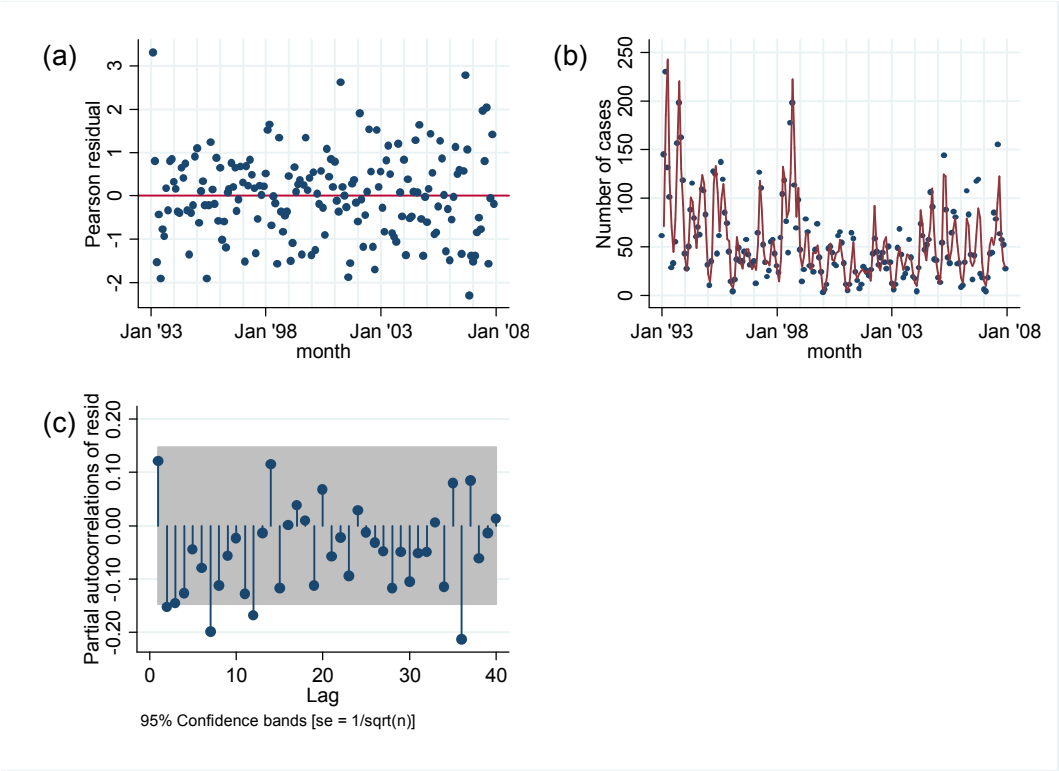
Supplemental Figure 1. Time series for the number of cholera patients each month in ICDDR,B Hospital in Matlab, standardized anomalies of the sea surface temperature (SST) and sea surface height (SSH) in the Bay of Bengal, the NINO3 SST and the Dipole Mode Index (DMI) relative to the 1993–2007 mean for each variable (The standardized anomalies were calculated only for descriptive analysis and raw data were used for regression analysis).



Supplemental Figure 2. Relationships between the relative risk (RR) of cholera scaled to the mean monthly number of patients in Matlab hospital and the Dipole Mode Index (DMI) and the NINO3 SST adjusted for potential mutual confounding between DMI and NINO3. The center line in each graph shows the estimated spline curve, and the upper and lower dots represent 95% confidence limits.



Supplemental Figure 3. Relationships between the relative risk (RR) of cholera scaled to the mean monthly number of patients in Matlab hospital and sea surface temperature (SST) and sea surface height (SSH) in the Bay of Bengal unadjusted (a, b) and adjusted (c, d) for potential mutual confounding between SST and SSH. The center line in each graph shows the estimated spline curve, and the upper and lower dots represent 95% confidence limits.



Supplemental Figure 4. Diagnostics of cholera-DMI models; patients of Dhaka hospital: (a) plots of model residuals, (b) predicted and observed time series plots, (c) partial autocorrelation function of the residuals.