Supplementary Material

**Using a Distributed Lag Non-Linear Model to Identify Impact of Temperature Variables on Hemorrhagic Fever with Renal Syndrome in Shandong Province**

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A





B

**Figure S1** The relative risk (RR) of HFRS by mean temperature (A) and DTR (B) at a specific lag day (0, 5, 10, 15, 20, 25 and 30 days) for male cases, controlling for relative humidity, precipitation, weekly effects, seasonality and long trends. The maximum likelihood estimate of RRs is shown as smooth red lines and the pointwise 95% confidence intervals are shown in the gray regions.



A





B

**Figure S2** The relative risk (RR) of HFRS by mean temperature (A) and DTR (B) at a specific lag day (0, 5, 10, 15, 20, 25 and 30 days) for female cases, controlling for relative humidity, precipitation, weekly effects, seasonality and long trends. The maximum likelihood estimate of RRs is shown as smooth red lines and the pointwise 95% confidence intervals are shown in the gray regions.

**Table S1**. Results of sensitivity analyses (changing the *df* of daily mean temperature and DTR from 3-5) (QAIC)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Relative risk (RR) | | |
| **Mean Temperature(℃)** | *df*=3 | *df*=4 | *df*=5 |
| -5.52 | 0.664 | 0.646 | 0.629 |
| -3.18 | 0.624 | 0.601 | 0.639 |
| 4.08 | 0.643 | 0.685 | 0.686 |
| 22.71 | 0.429 | 0.426 | 0.463 |
| 26.64 | 0.167 | 0.176 | 0.175 |
| 28.25 | 0.108 | 0.116 | 0.120 |
| QAIC | 8752.724 | 8742.512 | 8749.955 |
| **DTR(℃）** | *df*=3 | *df*=4 | *df*=5 |
| 3.11 | 0.013 | 0.012 | 0.010 |
| 4.46 | 0.134 | 0.138 | 0.147 |
| 6.69 | 1.191 | 1.169 | 1.133 |
| 10.74 | 0.342 | 0.342 | 0.370 |
| 13.25 | 0.519 | 0.501 | 0.518 |
| 14.53 | 2.283 | 2.374 | 2.229 |
| QAIC | 8747.494 | 8743.533 | 8766.336 |

**Table S2** Results of sensitivity analyses (two alternative methods of controlling the longer and seasonal trends for model of daily mean temperature)

|  |  |
| --- | --- |
| Method | QAIC |
| **Month** |  |
| Total | 8742.512 |
| Male | 8097.828 |
| Female | 4946.603 |
| **Season** |  |
| Total | 8921.774 |
| Male | 8087.009 |
| Female | 4984.629 |

**Table S3** Relative risk (RR) and 95% confidence intervals (*CI*) for HFRS cases (total, male and female) associated with changes in mean temperature (1, 5, 25, 75, 95and 99 % percentiles) at different lag days and the overall effect with reference at 14.83°C

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Mean**  **Temp** | 95% *CI* (Confidence Interval) | | | | | |
| ***P1*(-5.52℃)** | ***P5*(-3.18℃)** | ***P25*(4.08℃)** | ***P75*(22.71℃)** | ***P95*(26.64℃)** | ***P99*(28.25℃)** |
| Total |  |  |  |  |  |  |
| lag0 | 1.32(1.07-1.62)\* | 1.24(1.04-1.48)\* | 1.11(0.98-1.25) | 0.94(0.84-1.05) | 0.99(0.83-1.19) | 1.02(0.82-1.28) |
| lag5 | 1.02(0.94-1.10) | 1.00(0.94-1.08) | 1.00(0.95-1.05) | 0.96(0.92-1.00)\* | 0.95(0.89-1.02) | 0.95(0.87-1.03) |
| lag10 | 1.02(0.97-1.07) | 1.00(0.97-1.04) | 0.99(0.97-1.02) | 0.97(0.95-0.99)\* | 0.95(0.92-0.99)\* | 0.94(0.90-0.99)\* |
| lag15 | 1.00(0.94-1.05) | 0.99(0.94-1.04) | 0.98(0.95-1.02) | 0.98(0.96-1.00)\* | 0.95(0.91-0.99)\* | 0.93(0.89-0.98)\* |
| lag20 | 0.96(0.92-1.00)\* | 0.96(0.93-0.99)\* | 0.97(0.95-1.00)\* | 0.98(0.97-1.00)\* | 0.94(0.91-0.97)\* | 0.92(0.89-0.96)\* |
| lag25 | 0.90(0.86-0.95)\* | 0.92(0.89-0.96)\* | 0.96(0.94-0.99)\* | 0.99(0.97-1.01) | 0.93(0.90-0.96)\* | 0.90(0.87-0.94)\* |
| lag30 | 0.85(0.76-0.95)\* | 0.88(0.81-0.96)\* | 0.95(0.90-1.00)\* | 0.99(0.95-1.03) | 0.92(0.86-0.99)\* | 0.89(0.84-0.97)\* |
| Cumul | 0.65(0.38-1.11)\* | 0.60(0.40-0.90)\* | 0.68(0.51-0.92)\* | 0.43(0.33-0.54)\* | 0.18(0.11-0.29)\* | 0.12(0.06-0.21)\* |
| Male |  |  |  |  |  |  |
| lag0 | 1.22(0.97-1.52) | 1.15(0.95-1.39) | 1.06(0.93-1.21) | 0.93(0.82-1.05) | 0.97(0.79-1.18) | 1.00(0.78-1.27) |
| lag5 | 1.01(0.92-1.10) | 1.01(0.93-1.08) | 1.01(0.96-1.07) | 0.97(0.92-1.01) | 0.97(0.90-1.04) | 0.97(0.89-1.07) |
| lag10 | 1.02(0.97-1.07) | 1.01(0.97-1.05) | 1.00(0.98-1.03) | 0.97(0.95-1.00)\* | 0.96(0.92-1.00)\* | 0.95(0.90-1.00)\* |
| lag15 | 1.00(0.96-1.07) | 1.00(0.95-1.05) | 0.99(0.96-1.03) | 0.98(0.95-1.00)\* | 0.95(0.91-0.99)\* | 0.93(0.89-0.98)\* |
| lag20 | 0.97(0.93-1.01) | 0.97(0.93-1.01) | 0.98(0.95-1.00)\* | 0.98(0.96-1.00)\* | 0.94(0.91-0.97)\* | 0.92(0.88-0.96)\* |
| lag25 | 0.92(0.87-0.97)\* | 0.93(0.89-0.97)\* | 0.96(0.93-0.98)\* | 0.98(0.96-1.01) | 0.94(0.90-0.97)\* | 0.91(0.87-0.95)\* |
| lag30 | 0.87(0.77-0.98)\* | 0.89(0.81-0.98)\* | 0.94(0.88-1.00)\* | 0.99(0.94-1.03) | 0.93(0.86-1.01) | 0.90(0.82-0.99)\* |
| Cumul | 0.67(0.37-1.19) | 0.62(0.40-0.97)\* | 0.72(0.53-0.99)\* | 0.44(0.33-0.57)\* | 0.21(0.12-0.34)\* | 0.15(0.07-0.28)\* |
| Female |  |  |  |  |  |  |
| lag0 | 1.54(1.08-2.19)\* | 1.41(1.04-1.92)\* | 1.16(0.94-1.43) | 0.98(0.82-1.18) | 1.06(0.79-1.43) | 1.10(0.77-1.59) |
| lag5 | 1.06(0.92-1.21) | 1.02(0.90-1.14) | 0.98(0.91-1.07) | 0.92(0.86-0.99)\* | 0.90(0.80-1.01) | 0.89(0.77-1.02) |
| lag10 | 1.02(0.94-1.11) | 1.00(0.93-1.06) | 0.97(0.93-1.02) | 0.96(0.93-1.00)\* | 0.93(0.88-0.99)\* | 0.92(0.86-0.99)\* |
| lag15 | 0.98(0.89-1.08) | 0.97(0.90-1.05) | 0.97(0.92-1.02) | 0.98(0.95-1.02) | 0.95(0.89-1.01) | 0.93(0.86-1.01) |
| lag20 | 0.92(0.86-0.99)\* | 0.94(0.88-0.99)\* | 0.97(0.93-1.01) | 0.99(0.96-1.02) | 0.94(0.89-0.99)\* | 0.92(0.86-0.98)\* |
| lag25 | 0.86(0.78-0.94)\* | 0.90(0.84-0.96)\* | 0.96(0.96-1.01) | 0.99(0.96-1.03) | 0.92(0.87-0.97)\* | 0.89(0.83-0.95)\* |
| lag30 | 0.79(0.65-0.96)\* | 0.85(0.73-0.99)\* | 0.96(0.87-1.07) | 0.98(0.92-1.06) | 0.87(0.79-1.01) | 0.85(0.73-0.98)\* |
| Cumul | 0.55(0.21-1.42) | 0.52(0.26-1.04) | 0.58(0.35-0.97)\* | 0.39(0.26-0.59)\* | 0.11(0.05-0.24)\* | 0.06(0.02-0.17)\* |

Temp : temperature; Cumul: cumulative; \**P*＜0.05

**Table S4** Relative risk (RR) and 95% confidence intervals (*CI*) for HFRS cases (total, male and female) associated with changes in DTR (1, 5, 25, 75, 95 and 99% percentiles) at different lag days and the overall effect with reference at 8.62°C

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 95% *CI* (Confidence Interval) | | | | | |
| **DTR** | ***P1*(3.11℃)** | ***P5*(4.46℃)** | ***P25*(6.69℃)** | ***P75*(10.74℃)** | ***P95*(13.25℃)** | ***P99*(14.53℃)** |
| Total |  |  |  |  |  |  |
| lag0 | 0.86(0.75-0.98)\* | 0.86(0.79-0.94)\* | 0.93(0.89-0.99)\* | 0.91(0.87-0.96)\* | 0.89(0.81-0.97)\* | 1.01(0.88-1.17) |
| lag5 | 0.91(0.87-0.96)\* | 0.96(0.93-1.00)\* | 1.01(0.98-1.03) | 0.97(0.94-0.99)\* | 1.00(0.96-1.04) | 1.07(1.00-1.14)\* |
| lag10 | 0.87(0.84-0.90)\* | 0.95(0.93-0.97)\* | 1.01(1.00-1.03)\* | 0.97(0.95-0.98)\* | 0.98(0.96-1.01) | 1.03(0.99-1.06) |
| lag15 | 0.85(0.81-0.88)\* | 0.94(0.92-0.96)\* | 1.02(1.00-1.04)\* | 0.97(0.95-0.99)\* | 0.98(0.95-1.01) | 1.01(0.97-1.05) |
| lag20 | 0.84(0.82-0.87)\* | 0.94(0.92-0.95)\* | 1.01(1.00-1.03)\* | 0.97(0.95-0.99)\* | 0.98(0.95-1.00)\* | 1.01(0.97-1.05) |
| lag25 | 0.85(0.82-0.89)\* | 0.94(0.92-0.96)\* | 1.01(0.99-1.03) | 0.97(0.95-0.99)\* | 0.98(0.96-1.01) | 1.02(0.98-1.06) |
| lag30 | 0.87(0.82-0.93)\* | 0.94(0.90-0.98)\* | 1.01(0.97-1.04) | 0.98(0.95-1.01) | 0.99(0.95-1.04) | 1.04(0.97-1.12) |
| Cumul | 0.02(0.01-0.03)\* | 0.14(0.09-0.21)\* | 1.17(0.79-1.71) | 0.34(0.24-0.48)\* | 0.50(0.31-0.82)\* | 2.37(1.14-4.94)\* |
| Male |  |  |  |  |  |  |
| lag0 | 0.90(0.78-1.03)\* | 0.88(0.81-0.97)\* | 0.94(0.89-1.00)\* | 0.91(0.86-0.96)\* | 0.86(0.79-0.95)\* | 0.96(0.83-1.12) |
| lag5 | 0.91(0.86-0.97)\* | 0.97(0.93-1.00)\* | 1.01(0.98-1.04) | 0.97(0.94-0.99)\* | 1.01(0.96-1.05) | 1.09(1.02-1.17)\* |
| lag10 | 0.86(0.83-0.90)\* | 0.94(0.92-0.96)\* | 1.01(0.99-1.03) | 0.97(0.95-0.99)\* | 0.98(0.96-1.01) | 1.02(0.98-1.06) |
| lag15 | 0.84(0.81-0.88)\* | 0.93(0.91-0.96)\* | 1.01(0.99-1.03) | 0.97(0.95-1.00)\* | 0.97(0.94-1.00)\* | 0.99(0.94-1.03) |
| lag20 | 0.84(0.81-0.87)\* | 0.93(0.91-0.95)\* | 1.01(0.99-1.03) | 0.97(0.96-0.99)\* | 0.98(0.95-1.00)\* | 0.99(0.95-1.03) |
| lag25 | 0.85(0.82-0.89)\* | 0.94(0.92-0.96)\* | 1.01(0.99-1.03) | 0.97(0.95-0.99)\* | 0.99(0.96-1.02) | 1.02(0.98-1.03) |
| lag30 | 0.88(0.82-0.94)\* | 0.95-0.91-0.99)\* | 1.01(0.98-1.05) | 0.97(0.94-1.01) | 1.00(0.95-1.05) | 1.06(0.98-1.14) |
| Cumul | 0.02(0.01-0.03)\* | 0.14(0.09-0.23)\* | 1.21(0.80-1.84) | 0.36(0.25-0.52)\* | 0.49(0.29-0.84)\* | 1.96(0.87-4.38) |
| Female |  |  |  |  |  |  |
| lag0 | 0.77(0.61-0.96)\* | 0.81(0.70-0.94)\* | 0.92(0.84-1.01) | 0.93(0.85-1.01) | 0.95(0.82-1.11) | 1.15(0.91-1.45） |
| lag5 | 0.92(0.84-1.01) | 0.95(0.90-1.01) | 0.99(0.95-1.04) | 0.97(0.93-1.02) | 0.97(0.90-1.04) | 1.01(0.90-1.12) |
| lag10 | 0.88(0.83-0.94)\* | 0.96(0.93-1.00)\* | 1.02(0.99-1.05) | 0.96(0.93-0.99)\* | 0.98(0.94-1.03) | 1.05(0.99-1.12) |
| lag15 | 0.86(0.81-0.92)\* | 0.96(0.92-1.00)\* | 1.03(1.00-1.07)\* | 0.95(0.92-0.99)\* | 0.99(0.94-1.04) | 1.07(1.00-1.15)\* |
| lag20 | 0.85(0.81-0.90)\* | 0.95(0.92-0.98)\* | 1.02(0.99-1.05) | 0.96(0.93-0.99)\* | 0.99(0.95-1.03) | 1.06(1.00-1.12)\* |
| lag25 | 0.86(0.80-0.91)\* | 0.93(0.90-0.97)\* | 1.00(0.97-1.04) | 0.97(0.94-1.00)\* | 0.98(0.94-1.03) | 1.03(0.96-1.10) |
| lag30 | 0.86(0.77-0.96)\* | 0.91(0.85-0.98)\* | 0.98(0.93-1.03) | 0.99(0.94-1.04) | 0.98(0.90-1.06) | 0.99(0.88-1.12) |
| Cumul | 0.02(0.01-0.04)\* | 0.13(0.06-0.26)\* | 1.09(0.57-2.11) | 0.31(0.17-0.54)\* | 0.53(0.23-1.24) | 3.73(1.12-12.42)\* |

Cumul: cumulative ; \**P*＜0.05