**Impact of the coronavirus disease 2019 pandemic on the diversity of notifiable infectious diseases: A case study in Shanghai, China**

Yongfang Zhang\* and Wenli Feng\*

School of Chemistry and Chemical Engineering, Zhoukou Normal University, Zhoukou, Henan, China

Corresponding Author:

Wenli Feng

No.6, Middle Wenchang Avenue, Zhoukou, Henan Province, 466001, China

Email address: wlfeng@zknu.edu.cn

**Section 1. Calculation of weight using the entropy weight method**

As shown in Table S1, our data is a matrix of i rows (48), j columns (2).

a. Data standardization using the method of negative indicators

（1）

b. the weight of indictor j, and month i.

c. Calculate the information entropy of indicator.

d. Redundancy rate of the information entropy

e. The weight of indicators

**Table S1.** The coefficients of weight were derived by using entropy method.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Number of cases** | **Types of diseases** |  | **Xij** | |  | **Yij** | |  | **ej** | |
| 10350 | 30 |  | 0.763 | 0.429 |  | 0.023 | 0.025 |  | 0.99366 | 0.99393 |
| 8332 | 30 |  | 0.826 | 0.429 |  | 0.025 | 0.025 |  |  |  |
| 10199 | 30 |  | 0.767 | 0.429 |  | 0.023 | 0.025 |  | **dj** |  |
| 9193 | 30 |  | 0.799 | 0.429 |  | 0.024 | 0.025 |  | 0.00634 | 0.00607 |
| 11071 | 31 |  | 0.740 | 0.286 |  | 0.023 | 0.017 |  | **Wi** |  |
| 13060 | 31 |  | 0.677 | 0.286 |  | 0.021 | 0.017 |  | 0.511 | 0.489 |
| 13875 | 32 |  | 0.651 | 0.143 |  | 0.020 | 0.008 |  |  |  |
| 12884 | 32 |  | 0.682 | 0.143 |  | 0.021 | 0.008 |  |  |  |
| 13392 | 31 |  | 0.666 | 0.286 |  | 0.020 | 0.017 |  |  |  |
| 15138 | 31 |  | 0.611 | 0.286 |  | 0.019 | 0.017 |  |  |  |
| 13682 | 30 |  | 0.657 | 0.429 |  | 0.020 | 0.025 |  |  |  |
| 14795 | 31 |  | 0.622 | 0.286 |  | 0.019 | 0.017 |  |  |  |
| 11429 | 30 |  | 0.728 | 0.429 |  | 0.022 | 0.025 |  |  |  |
| 7351 | 31 |  | 0.857 | 0.286 |  | 0.026 | 0.017 |  |  |  |
| 8338 | 30 |  | 0.826 | 0.429 |  | 0.025 | 0.025 |  |  |  |
| 9557 | 33 |  | 0.788 | 0.000 |  | 0.024 | 0.010 |  |  |  |
| 16006 | 30 |  | 0.584 | 0.429 |  | 0.018 | 0.025 |  |  |  |
| 25245 | 32 |  | 0.292 | 0.143 |  | 0.009 | 0.008 |  |  |  |
| 28190 | 31 |  | 0.198 | 0.286 |  | 0.006 | 0.017 |  |  |  |
| 21461 | 32 |  | 0.411 | 0.143 |  | 0.013 | 0.008 |  |  |  |
| 26105 | 32 |  | 0.264 | 0.143 |  | 0.008 | 0.008 |  |  |  |
| 15334 | 31 |  | 0.605 | 0.286 |  | 0.019 | 0.017 |  |  |  |
| 10722 | 33 |  | 0.751 | 0.000 |  | 0.023 | 0.010 |  |  |  |
| 11332 | 30 |  | 0.732 | 0.429 |  | 0.022 | 0.025 |  |  |  |
| 19876 | 30 |  | 0.461 | 0.429 |  | 0.014 | 0.025 |  |  |  |
| 15200 | 33 |  | 0.609 | 0.000 |  | 0.019 | 0.010 |  |  |  |
| 16687 | 31 |  | 0.562 | 0.286 |  | 0.017 | 0.017 |  |  |  |
| 13320 | 32 |  | 0.669 | 0.143 |  | 0.020 | 0.008 |  |  |  |
| 13612 | 31 |  | 0.659 | 0.286 |  | 0.020 | 0.017 |  |  |  |
| 14142 | 31 |  | 0.643 | 0.286 |  | 0.020 | 0.017 |  |  |  |
| 14908 | 32 |  | 0.618 | 0.143 |  | 0.019 | 0.008 |  |  |  |
| 12482 | 31 |  | 0.695 | 0.286 |  | 0.021 | 0.017 |  |  |  |
| 15195 | 33 |  | 0.609 | 0.000 |  | 0.019 | 0.010 |  |  |  |
| 12048 | 29 |  | 0.709 | 0.571 |  | 0.022 | 0.034 |  |  |  |
| 10603 | 30 |  | 0.755 | 0.429 |  | 0.023 | 0.025 |  |  |  |
| 31663 | 32 |  | 0.089 | 0.143 |  | 0.003 | 0.008 |  |  |  |
| 34466 | 29 |  | 0.000 | 0.571 |  | 0.010 | 0.034 |  |  |  |
| 3460 | 29 |  | 0.980 | 0.571 |  | 0.030 | 0.034 |  |  |  |
| 2842 | 26 |  | 1.000 | 1.000 |  | 0.031 | 0.059 |  |  |  |
| 3629 | 29 |  | 0.975 | 0.571 |  | 0.030 | 0.034 |  |  |  |
| 3767 | 31 |  | 0.971 | 0.286 |  | 0.030 | 0.017 |  |  |  |
| 4613 | 29 |  | 0.944 | 0.571 |  | 0.029 | 0.034 |  |  |  |
| 5079 | 30 |  | 0.929 | 0.429 |  | 0.028 | 0.025 |  |  |  |
| 5638 | 31 |  | 0.912 | 0.286 |  | 0.028 | 0.017 |  |  |  |
| 7684 | 30 |  | 0.847 | 0.429 |  | 0.026 | 0.025 |  |  |  |
| 7963 | 29 |  | 0.838 | 0.571 |  | 0.026 | 0.034 |  |  |  |
| 7418 | 27 |  | 0.855 | 0.857 |  | 0.026 | 0.051 |  |  |  |
| 7463 | 27 |  | 0.854 | 0.857 |  | 0.026 | 0.051 |  |  |  |

**Fig. S1.** Monthly changes in meteorological factors (a) & (b), air pollutants (c) and socioeconomic indicators (d) from 2017 to 2020 in Shanghai (NASA, 2020; SBS, 2020); (e) Change in monthly confirmed cases of COVID-19 in the 2020 in Shanghai (SMHC, 2020).

**(a)**

**Fig.S2.** The comparison of the predicted values with the observed values.

**Table S2.** Parameters of the results predicted from the Optimized model. The forecasting performance was assessed using error metrics (*Hyndman & Athanasopoulos, 2018*) including mean absolute deviation (MAD), mean absolute percentage error (MAPE), and root mean square error (RMSE).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter type** | **Parameter** | **Cases** | **Types** | **NDOI** |
| Optimized model |  | Autoregression | Autoregression | Season superposing |
| Data statistics | Min | 7,351 | 29 | 0.396 |
|  | Mean | 14,633 | 31 | 0.568 |
|  | Max | 31,663 | 33 | 0.896 |
|  | Std. | 5,641 | 1.05 | 0.126 |
|  | Ljung-Box | 16 | 16.94 | 18.95 |
| Forecast accuracy | RMSE | 2,756 | 0.7 | 0.142 |
|  | MAD | 2,060 | 0.52 | 0.118 |
|  | MAPE | 14.08% | 1.69% | 20.17% |
|  | Durbin-Watson | 2.16 | 2.16 | 1.84 |
|  | Theil‘s U | — | — | 0.836 |
| Regression | Std. | 2,836 | 0.72 | — |
|  | R2 | 0.75 | 0.5435 | — |
|  | Adjust-R2 | 0.75 | 0.5301 | — |
| Smooth factor | Alpha | — | — | 0.139 |
|  | Gamma | — | — | 0.001 |



**Fig. S3.** Monthly changes in number of confirmed cases of notifiable infectious diseases transmitted by (a) direct-contact, (b) water and food, (c) airborne, (d) vector-borne

**Table S3.** Summary of DCA and RDA.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| DCA | Statistic | Axis 1 | Axis 2 | Axis 3 | Axis 4 |
| Eigenvalues | 0.0217 | 0.0107 | 0.0078 | 0.0043 |
| Explained variation (cumulative) | 27.92 | 41.71 | 51.79 | 57.38 |
| Gradient length | 0.5 | 0.48 | 0.48 | 0.37 |
| RDA | Statistic | Axis 1 | Axis 2 | Axis 3 | Axis 4 |
| Eigenvalues | 0.4868 | 0.2104 | 0.1203 | 0.0615 |
| Explained variation (cumulative) | 48.68 | 69.72 | 81.75 | 87.90 |
| Pseudo-canonical correlation | 0.973 | 0.8881 | 0.8306 | 0.8593 |
| Explained fitted variation (cumulative) | 53.21 | 78.02 | 81.16 | 90.36 |
| Permutation Test Results: |  |  |  |  |
| On All Axes | pseudo-F=6.5,  P=0.002 | |  |  |

**Table S4.** Correlation analysis.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | AP | TE | RH | WS | Prec. | AQI | PM2.5 | PM10 | SO2 | NO2 | CO | O3 | IT | SC | IO | APT | FV |
| **Direct-contact transmitted diseases** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Hand-foot-and-mouth disease | -0.401**\*\*** | 0.484**\*\*** | -0.134 | 0.044 | 0.075 | -0.154 | -0.428**\*\*** | -0.322**\*** | -0.062 | -0.366**\*** | -0.399**\*\*** | 0.146 | 0.439**\*\*** | -0.196 | 0.141 | 0.432**\*\*** | -0.164 |
| Syphilis | -0.457**\*\*** | 0.498**\*\*** | -0.253 | -0.152 | 0.201 | 0.397**\*\*** | -0.139 | 0.033 | 0.169 | -0.022 | -0.013 | 0.395**\*\*** | 0.681**\*\*** | -0.168 | 0.424**\*\*** | 0.663**\*\*** | -0.331**\*** |
| Gonorrhoea | -0.173 | 0.180 | -0.133 | -0.148 | 0.068 | 0.490**\*\*** | 0.127 | 0.244 | 0.545**\*\*** | 0.100 | 0.332**\*** | 0.309**\*** | 0.482**\*\*** | -0.333**\*** | 0.190 | 0.461**\*\*** | -0.512**\*\*** |
| Acquired immune deficiency syndrome | -0.439**\*\*** | 0.574**\*\*** | -0.109 | -0.160 | 0.333**\*** | -0.143 | -0.519**\*\*** | -0.357**\*** | -0.231 | -0.313**\*** | -0.284 | 0.312**\*** | 0.309**\*** | 0.038 | 0.359**\*** | 0.376**\*\*** | 0.008 |
| Measles | -0.253 | 0.165 | -0.034 | -0.015 | 0.040 | 0.124 | -0.014 | -0.032 | -0.068 | -0.104 | -0.176 | 0.299**\*** | 0.458**\*\*** | -0.159 | 0.027 | 0.415**\*\*** | -0.294**\*** |
| **Water and food transmitted diseases** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Infectious diarrhea | -0.220 | 0.213 | -0.074 | -0.175 | 0.249 | 0.274 | 0.036 | 0.034 | 0.257 | -0.024 | 0.199 | 0.066 | 0.521**\*\*** | -0.313**\*** | 0.086 | 0.636**\*\*** | -0.501**\*\*** |
| Hepatitis A | -0.174 | 0.081 | -0.213 | -0.069 | -0.117 | 0.029 | 0.029 | -0.006 | -0.076 | 0.001 | -0.172 | 0.212 | 0.394**\*\*** | -0.233 | -0.045 | 0.361**\*** | -0.218 |
| Hepatitis E | 0.136 | -0.297**\*** | 0.113 | 0.024 | -0.159 | 0.260 | 0.434**\*\*** | 0.411**\*\*** | 0.405**\*\*** | 0.292**\*** | 0.213 | -0.092 | 0.541**\*\*** | -0.380**\*\*** | -0.136 | 0.553**\*\*** | -0.557**\*\*** |
| Hepatitis B | -0.041 | 0.002 | -0.195 | 0.162 | -0.147 | 0.312**\*** | 0.195 | 0.393**\*\*** | 0.713**\*\*** | 0.103 | 0.221 | 0.234 | 0.533**\*\*** | -0.543**\*\*** | 0.008 | 0.398**\*\*** | -0.583**\*\*** |
| Bacillary and amoebic dysentery | -0.421**\*\*** | 0.422**\*\*** | -0.026 | 0.037 | 0.277 | 0.103 | -0.241 | -0.202 | 0.057 | -0.303**\*** | -0.076 | 0.277 | 0.392**\*\*** | -0.399**\*\*** | -0.054 | 0.436**\*\*** | -0.356**\*** |
| Hepatitis C | -0.014 | -0.009 | -0.109 | -0.151 | -0.012 | 0.327**\*** | 0.187 | 0.242 | 0.453**\*\*** | 0.184 | 0.272 | 0.208 | 0.382**\*\*** | -0.364**\*** | 0.042 | 0.311**\*** | -0.442**\*\*** |
| Typhoid and paratyphoid | -0.464**\*\*** | 0.496**\*\*** | -0.069 | -0.059 | 0.305**\*** | 0.187 | -0.333**\*** | -0.200 | -0.089 | -0.301**\*** | -0.053 | 0.474**\*\*** | 0.102 | -0.137 | 0.038 | 0.116 | -0.096 |
| Hepatitis (unspecified) | 0.133 | -0.160 | -0.118 | 0.072 | -0.171 | 0.283 | 0.295\* | 0.357\* | 0.686\*\* | 0.245 | 0.267 | -0.019 | 0.650\*\* | -0.568\*\* | -0.061 | 0.561\*\* | -0.669\*\* |
| AHC | -0.450\*\* | 0.437\*\* | -0.106 | -0.266 | 0.224 | 0.190 | -0.226 | -0.260 | -0.138 | -0.369\*\* | -0.190 | 0.487\*\* | 0.171 | -0.206 | -0.094 | 0.152 | -0.134 |
| **Airborne transmitted diseases** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Influenza | 0.350**\*** | -0.407**\*\*** | 0.208 | -0.006 | -0.078 | 0.163 | 0.497**\*\*** | 0.152 | -0.046 | 0.334**\*** | 0.347**\*** | -0.366**\*** | 0.085 | 0.121 | -0.105 | 0.181 | -0.065 |
| Pulmonary tuberculosis | -0.518**\*\*** | 0.566**\*\*** | -0.118 | -0.085 | 0.327**\*** | 0.198 | -0.236 | -0.127 | -0.090 | -0.079 | -0.173 | 0.297**\*** | 0.290**\*** | 0.251 | 0.676**\*\*** | 0.345**\*** | 0.144 |
| Scarlatina | 0.300**\*** | -0.343**\*** | -0.071 | -0.021 | -0.270 | 0.429**\*\*** | 0.526**\*\*** | 0.491**\*\*** | 0.436**\*\*** | 0.561**\*\*** | 0.357**\*** | -0.279 | 0.505**\*\*** | -0.115 | 0.125 | 0.445**\*\*** | -0.363**\*** |
| Mumps | -0.467**\*\*** | 0.581**\*\*** | -0.278 | -0.110 | 0.128 | 0.176 | -0.352**\*** | -0.082 | -0.012 | -0.207 | -0.278 | 0.418**\*\*** | 0.607**\*\*** | -0.090 | 0.401**\*\*** | 0.619**\*\*** | -0.189 |
| Pertussis | -0.470**\*\*** | 0.393**\*\*** | -0.123 | -0.076 | 0.141 | 0.229 | -0.125 | -0.074 | -0.145 | -0.287**\*** | -0.287**\*** | 0.426**\*\*** | 0.614**\*\*** | -0.396**\*\*** | -0.106 | 0.574**\*\*** | -0.391**\*\*** |
| Rubella | -0.137 | 0.061 | -0.195 | -0.130 | -0.153 | 0.041 | 0.008 | 0.055 | -0.302**\*** | -0.009 | -0.177 | 0.159 | 0.275 | -0.043 | -0.114 | 0.259 | -0.061 |
| **Vector-borne transmitted diseases** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Malaria | -0.054 | 0.129 | -0.063 | -0.112 | -0.056 | 0.243 | 0.036 | 0.097 | 0.255 | 0.040 | 0.196 | 0.087 | 0.301**\*** | -0.247 | 0.045 | 0.246 | -0.308**\*** |
| Dengue | -0.432**\*\*** | 0.425**\*\*** | 0.076 | 0.067 | 0.255 | -0.221 | -0.387**\*\*** | -0.444**\*\*** | -0.345**\*** | -0.425**\*\*** | -0.396**\*\*** | 0.111 | 0.268 | -0.127 | -0.054 | 0.343**\*** | -0.108 |
|  | 12 | 13 | 0 | 0 | 3 | 5 | 9 | 6 | 8 | 10 | 6 | 10 | 16 | 7 | 4 | 16 | 11 |

Notes: \* at p < 0.05, \*\* at p < 0.01; AP: Atmosphere pressure, kPa; Precipitation, mm; d; RH: Relative humidity, %; Temperature: oC; WS: Wind speed, m s-1; AQI: Air quality index; SC: Social consumption, billion yuan; IO: Industrial output value, billion yuan; FV: Freight volume, million ton; IT: Inbound travel, million travelers; APT: Airport passenger throughput, million passengers.

**References**

Hyndman, R.J., Athanasopoulos, G., 2018. Forecasting: principles and practice. OTexts, Melbourne, Australia.

NASA. (2020). NASA prediction of worldwide energy resources. https://power.larc.nasa.gov/

SBS. (2020). Data dissemination. https://tjj.sh.gov.cn/

SMHC. (2020). Information on epidemic situation of infectious diseases. https://wsjkw.sh.gov.cn/yqxx/index.html