

# Atmospheric factors and the incidence of novel coronavirus pneumonia

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## Research Article

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# Abstract

The novel coronavirus-infected pneumonia (NCIP) was first recognized in December 2019 in Wuhan, China and then spread successively around the world. The epidemic has spread rapidly and aroused widespread concern and panic in China with more than 80 thousand recorded infections and over 3 thousand deaths by March 2020. We have examined the effects of atmospheric conditions on the incidence of NCIP in Wuhan, Hubei province. Our results indicate a significant correlation between the new confirmed NCIP case and maximum wind velocity ( $r^2=0.713$ ). Both mean temperature ( $r^2=-0.691$ ) and air pressure ( $r^2=-0.503$ ) have negative associations with daily new cases. The regression equation  $y = 4590.899 - 1.239x_t - 0.442x_p + 0.579x_w$  was derived to define the optimal climatic conditions for the NCIP epidemic. To verify these results, further investigations in other regions are necessary.

## Introduction

At the end of 2019, the novel coronavirus-infected pneumonia (NCIP) was firstly discovered in Wuhan, China and then broke out successively around the world, which has aroused widespread concern and panic<sup>[1,2]</sup>. About the survival and transmission conditions of 2019-nCoV, many scholars have carried out research investigate<sup>[3,4]</sup>. It was reported that the 2019-novel-coronavirus (2019-nCoV) was detected in the self-collected saliva of 91.7%<sup>[5]</sup>, besides, Chinese government announced that 2019-nCoV can be transmitted through aerosols, specifically saliva mixed in the air, forming aerosols that can cause infection when inhaled. However, the spread of 2019-nCov among humans was uncontrolled and it has been not figured out that how 2019-nCov spread until now.

It's considered that 2019-nCov is one of coronavirus, it might be able to have similar characteristics with SARS virus. Previous researches have suggested that the SARS outbreaks were significantly associated with the temperature and its variations<sup>[6,7]</sup>. Reported findings also showed that there was an association between relative humidity and SARS outbreak<sup>[8-10]</sup>. One ecologic study conducted in China illustrated that SARS patients from regions with high-level air pollution were twice as likely to die from SARS compared to those from regions with low-level air pollution<sup>[11]</sup>. Several researches pointed out that air pollution, ambient temperature and relative humidity had an adverse effect on respiratory symptoms<sup>[12-14]</sup>. Wuhan city belongs to the north subtropical monsoon (humid) climate, with abundant perennial rainfall, sufficient heat, rain, and heat in the same season, light and heat in the same season, cold in winter and hot in summer. The academic literature on air quality in Wuhan has revealed that air quality here was not pretty good<sup>[15,16]</sup>.

Considering these factors, we think that there might be an association between the spread of 2019-nCov and temperature, relative humidity and other atmospheric factors. The purpose of this study was to explore the relationship between the spread of 2019-nCov and atmospheric factors, and try to provide the basis for the novel coronavirus pneumonia countermeasures.

# Methods

## Data source

Since the novel coronavirus-infected pneumonia (NCIP) was firstly discovered in Wuhan, and it's the worst affected area, so we select the data of Wuhan to make the analysis. We got the NCIP data from National Health Commission of the People's Republic of China, Health Commission of Hubei Province and Wuhan Municipal Health Commission(the data is publicly available). At the same time, the data on temperature, air pressure, relative humidity, and wind speed were obtained from the National Meteorological Center of CMA(<http://data.cma.cn/>).

## Statistical analysis

The daily new confirmed cases in Wuhan from 26 December 2019 to 16 March 2020 are presented in Figure 1. We found that the new confirmed cases on February 12 had a sudden sharp increase, that's because it contains 12364 cases clinical diagnosis(with the deepening of the understanding of COVID-19, and according to the characteristics of the outbreak, the national health committee general office and the office of the state administration of traditional Chinese medicine issued "*Novel coronavirus infection pneumonia diagnosis and treatment scheme (trial fifth edition)* ", which added "clinical diagnosis" in the case diagnosis category. In this way, patients can receive standard treatment as the confirmed cases as early as possible, and improve the treatment success rate. The number of clinically diagnosed cases have been included in the number of confirmed cases in Hubei province from February 12).

We also noticed that between 17 January and 26 January 2020, the average daily new cases are 65, but then there were 892 new clinically diagnosed cases on 27 January 2020, and after that day, the daily new cases became much high. Actually before 10 January 2020 the cases were identified as the "pneumonia of unknown etiology", and when its pathogen preliminary was identified as a novel coronavirus, the national, provincial and municipal expert group immediately revised and improved the treatment of viral pneumonia. By 24:00 on January 10, 2020, 41 cases of the novel coronavirus pneumonia were diagnosed. During the 23 days from 26 December 2019 to 17 January 2020, the number of confirmed NCIP cases in the official data rose from 4 to 59, and then fell to 41, with no new cases for 12 days.

We have investigated the association between the spread of NCIP and 9 weather parameters: mean temperature, maximum temperature, minimum temperature, mean relative humidity, mean air pressure, maximum air pressure, mean wind velocity, maximum wind velocity, precipitation.

We calculated the correlation between the daily new cases of NCIP and each meteorological factor. Considering the mean incubation period of 5.2 days, and the meantime of 0 to 3 days from the onset of clinical symptoms of NCIP to hospital admission<sup>[1]</sup>, we investigated for up to 11 days before the date of onset.

The date was further investigated to determine the effect of weather conditions in the 11 days before clinical diagnosis. Parameters producing significant correlations ( $P < 0.5$ ) were then used in multiple stepwise linear regression modeling to identify the meteorological factors most strongly correlated with the spread of NCIP.

$$y = b_0 + b_1x_1 + b_2x_2 + \dots + b_nx_n$$

in which  $y$  is the daily new confirmed number of NCIP cases and  $x_n$  is the  $n^{\text{th}}$  meteorological factor on the selected day or selected period before clinical diagnosis. All analyses were performed using EXCEL2010 and SPSS.

## Result

To study on the relationship between atmospheric factors and the incidence of novel coronavirus pneumonia, we divided the data into two periods: 26 December 2019 to 26 January 2020 as the first period, the cases growth is slow; 27 January to 16 March 2020 as the second period, the cases growth rate is much higher than the first period, there were several hundred and even more than one thousand new cases every day. Considering the situation of the second period is complex with high transmitting speed from people to people, the government's active policies and the change of diagnosis criteria, we only study the relationship between atmospheric factors and NCIP cases in the first period.

Significant positive associations ( $P < 0.05$ ) were obtained for the number of NCIP cases in Wuhan and maximum wind velocity ( $r^2 = 0.713$ ) and mean relative humidity ( $r^2 = 0.185$ ). By comparison, mean temperature ( $r^2 = -0.691$ ), maximum temperature ( $r^2 = -0.276$ ), minimum temperature ( $r^2 = -0.261$ ), mean air pressure ( $r^2 = -0.503$ ), mean wind velocity ( $r^2 = -0.236$ ) and precipitation ( $r^2 = -0.015$ ) showed negative associations.

To determine the optimal climatic conditions for the novel coronavirus pneumonia in Wuhan, a regression equation was derived using the most strongly correlated factors:

$$y = 4590.899 - 1.239x_t - 0.442x_p + 0.579x_w$$

in which  $y$  is the estimated number of NCIP cases, and  $x_t$ ,  $x_p$ ,  $x_w$  are the mean temperature, mean air pressure, and maximum wind velocity, respectively, on the selected day or a selected period during the NCIP epidemic. The daily new confirmed cases and the three atmospheric factors in Wuhan in the first period is shown in Figure 2. And the regression model was tested against rigorous case report data from the Wuhan epidemic and found to fit well with the reported daily number of new NCIP cases ( $r^2 = 0.740$ ; Table 1).

Table 1. Statistical test of the constant and independents in the regression equation

$$y = 4590.899 - 1.239x_t - 0.442x_p + 0.579x_w$$

Variable	Coefficients	Standardized Coefficients	t Stat	P-value
Intercept	4590.899	928.344	4.945	<.001
mean temperature( $x_t$ )	-1.239	0.1467	-8.45	<.001
mean air pressure( $x_p$ )	-0.442	0.091	-4.881	<.001
maximum wind velocity( $x_w$ )	0.579	0.254	2.283	<.005

## Discussion

In this study, we examined the effects of atmospheric conditions on the incidence of NCIP in Wuhan, Hubei province. Our results indicated that there significant positive associations between and maximum wind velocity. Both mean temperature and air pressure have negative associations with daily new cases. These climatic variables may represent the optimal temperature, air pressure, and wind velocity for the survival and transmission of the coronavirus. Conversely, mean relative humidity, precipitation, and daily temperature fluctuations seemed have little impact on coronavirus onset.

However, we didn't analyze the whole NCIP cases from the beginning spread to the outbreak was almost completely continue, considering the situation of the second period is complex with high transmitting speed from people to people, government's active policies and the change of diagnostic criteria. Furthermore, there are still many other factors make it's impossible to predict if the novel coronavirus will reoccur, such as the survival time in vitro, the incubation period, and transmission route (include direct contact, respiratory droplets, and aerosolization). Asymptomatic and unreported cases also limit the analysis since the asymptomatic could denote an important effect if the coronavirus reoccur, and actual cases could be many times higher.

Furthermore, it still can't verify the seasonal nature of the disease with the shot-term change of NCIP, and additional analysis of the underlying climatic conditions is needed. With the various public health measures now in place for prevention, the outbreaks in China will disappear soon, this may be difficult to predict the course of the disease. To verify these results, further investigations in other regions are necessary.

## Declarations

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### Author Contributions

Zhixiang Ma conceived the study, analysed data and wrote the paper. Xiangwei Meng drafted figures. Xiyuan Li, Cai Chen, and Leilei Dong all contributed to scoping and structuring the paper and provided guidance on method development. Wei Li supervised the study. All authors reviewed the manuscript.

### Competing Interests

The authors declare no competing interests.

### Data availability

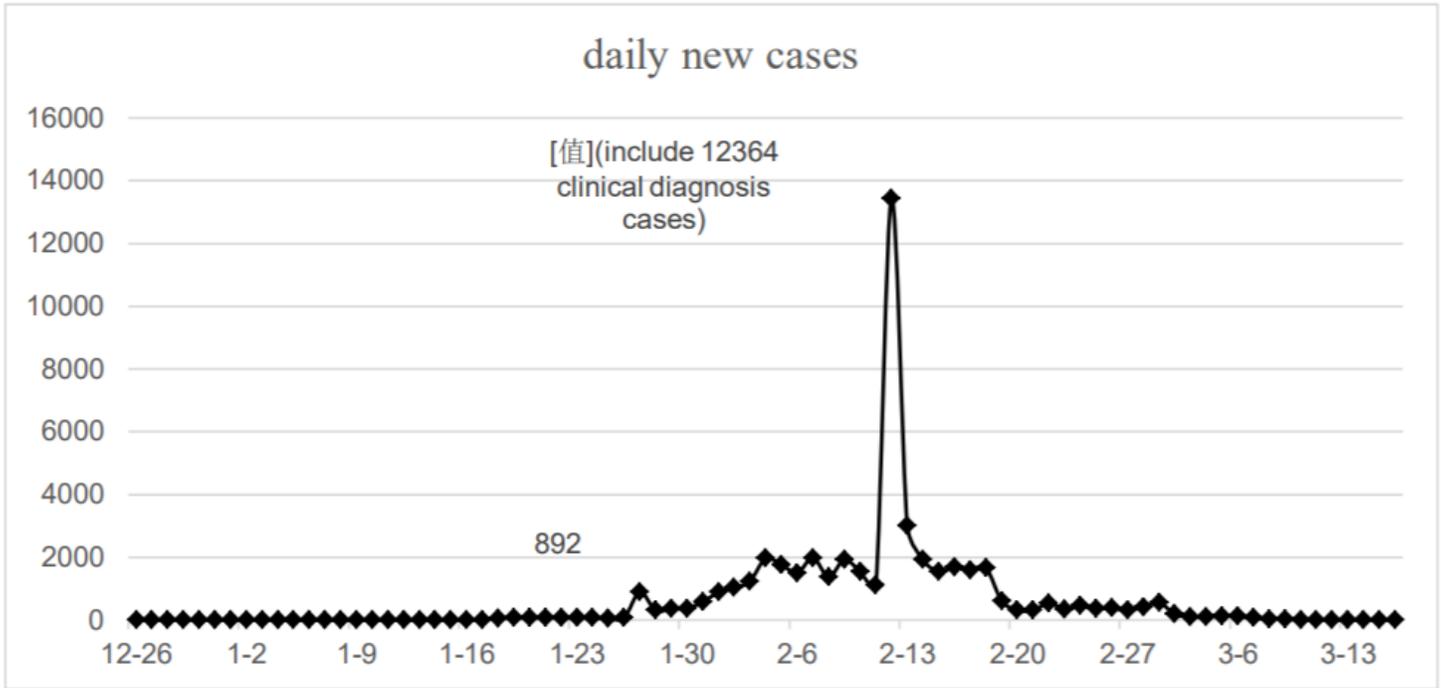
The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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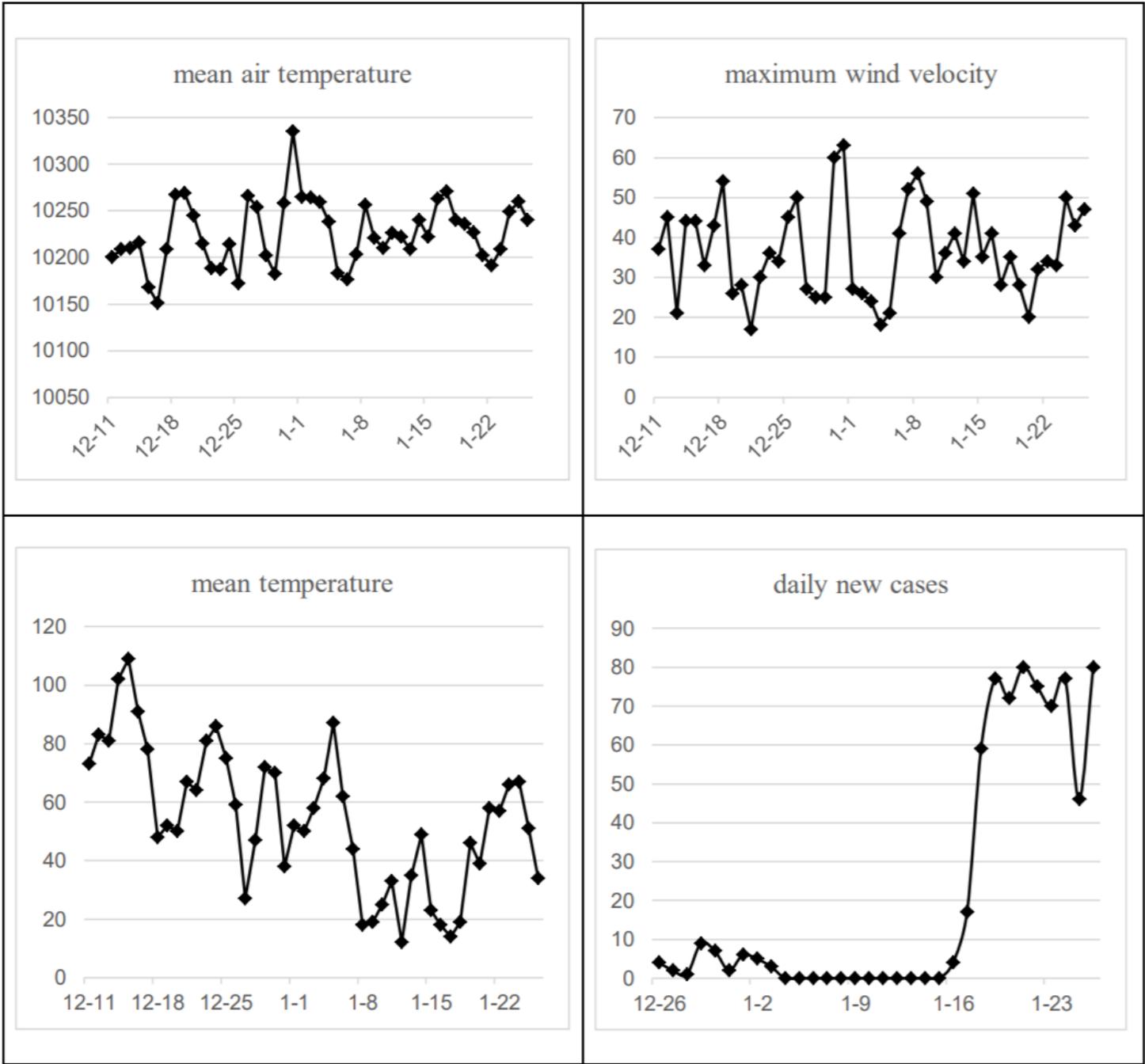
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## Figures



**Figure 1**

The daily new confirmed cases in Wuhan from 26 December 2019 to 16 March 2020.



**Figure 2**

The daily new confirmed cases and three atmospheric factors in Wuhan in the first period.