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New COVID-19 variant (B.1.1.7): Forecasting the occasion of virus and the related meteorological factors

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A B S T R A C T

Background: World Health Organization has reported fifty countries have now detected the new coronavirus (B.1.1.7 variant) since a couple of months ago. In Indonesia, the B.1.1.7 cases have been found in several provinces since January 2021, although they are still in a lower number than the old variant of COVID-19. Therefore, this study aims to create a forecast analysis regarding the occasions of COVID-19 and B.1.1.7 cases based on data from the 1st January to 18th March 2021, and also analyze the association between meteorological factors with B.1.1.7 incidences in three different provinces of Indonesia such as the West Java, South Sumatra and East Kalimantan.

Methods: We used the Autoregressive Moving Average Models (ARIMA) to forecast the number of cases in the upcoming 14 days and the Spearman correlation analysis to analyze the relationship between B.1.1.7 cases and meteorological variables such as temperature, humidity, rainfall, sunshine, and wind speed.

Results: The results of the study showed the fitted ARIMA models forecasted there was an increase in the daily cases in three provinces. The total cases in three provinces would increase by 36% (West Java), 13.5% (South Sumatra), and 30% (East Kalimantan) as compared with actual cases until the end of 14 days later. The temperature, rainfall and sunshine factors were the main contributors for B.1.1.7 cases with each correlation coefficients; r = −0.230; p < 0.05, r = 0.211; p < 0.05 and r = −0.418; p < 0.01, respectively.

Conclusions: We recapitulated that this investigation was the first preliminary study to analyze a short-term forecast regarding COVID-19 and B.1.1.7 cases as well as to determine the associated meteorological factors that become primary contributors to the virus spread.

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Introduction

In the early year 2021, a new variant of coronavirus was detected in more than 50 countries around the world. This new virus variant, called B.1.1.7, which was firstly identified in the United Kingdom in September 2020 [1]. In the United Kingdom, there were 50,000 new cases were found since that date which then makes the authority takes a large-scale social restriction in the city. Based on the recent study, how the emergence of B.1.1.7 was still unknown, but some researchers estimated it because of an immune-compromised person [2]. The European Centre for Disease Prevention and Control also revealed a new variant of B.1.1.7 was very more transmissible about 70% than the old variant of coronavirus. The mutation in the coronavirus especially in spike protein might have modified the B.1.1.7 strains, thus it increased the capability of grabbing and infecting into the human cell [2]. In addition, Volz et al. [3] assumed because of the mutation, the new B.1.1.7 could increase the possibility of risk of mortality.

Although in the current report 2021 by the World Health Organization (WHO) stated the trend of COVID-19 in the Southeast Asian region was now showing decreased activity compared with other regions all over the world. However in Indonesia, the COVID-19 cases still showed a high occasion, even the first case of B.1.1.7 in this country has been reported in the Kalimantan province on 6th January 2021 and then rapidly spread to other areas. Until 18th March 2021, a total of seven B.1.1.7 cases has been recorded by the official authority report. Because of the novel nature of the B.1.1.7 variant, there was still more mystery regarding the occasion of the virus and the related environmental factors that affected the transmission pattern of the virus. Therefore, the short-term forecasting study was prominent for estimating the occasion of B.1.1.7...
in the upcoming days for deciding the best provisions to control the spread of the virus. In last year studies, many researchers have successfully evaluated in time-series forecasting with the COVID-19 trend using some famous predicting models such as Autoregressive Moving Average Models (ARIMA) [4,5], deep learning approaches [6,7], and artificial intelligence techniques [8].

Based on their estimation, the COVID-19 would continue growing in all over the world till the end year of 2020 if no control measures were applied. Furthermore, in all previous studies, they used the COVID-19 data in the early middle of pandemic 2020, but the forecasting of COVID-19 cases at the new normal situation in 2021 was still sparse. In addition, the current investigation regarding the forecasting of the occasion of B.1.1.7 even in slight hint and its associated environmental factors such as meteorological variables was indispensable. Because the forecasting results would assist to determine better management in order to control the spread of B.1.1.7 cases since it just barely detected in Indonesia. Therefore, in this present study, we used the current data from 1st January to 18th March 2021 to forecast the daily number of COVID-19 and B.1.1.7 cases in three different provinces of Indonesia for the upcoming 14 days (19th March – 1st April 2021).

Materials and methods

Description of the study area

The West Java province

The West Java province located in the western part of the island of Java, with a capital city in Bandung (6°45’S, 107°30’E). This province spanned a total area of around 35,377 km². It was one of the most populous provinces of Indonesia with a population of 48,274,160 (2nd rank in Indonesia) with a density of 1400/km². Recently, the total confirmed cases in this area were more than 300 thousand cases and make the area become the 2nd rank of the high COVID-19 cases in Indonesia. It has contributed about 17.1% to the total of national cases in Indonesia. The new COVID-19 variant, B.1.1.7 has also discovered in this province in January 2021. Until March 2021, the official report stated the total of the B.1.1.7 cases in this region was four cases. According to Table 1, the daily confirmed cases showed a fluctuated trend and it ranged from 661 to 4601 cases from January to March 2021. Although this province has implemented the large-scale social restriction policy and it successfully suppressed the COVID-19 transmission but as the lockdown over, the COVID-19 cases started to increase again.

The South Sumatra province

The South Sumatra province located in the Southeast of the island of Sumatra (2°45’S 103°50’E), The province covered a total area of about 91,592 km² and a total population of 8,497,196 (9th rank in Indonesia) with a density of 93/km². The capital of the province was Palembang city. Total confirmed COVID-19 cases in this province during March 2021 were more than 22 thousand cases. This province has added 1.3% to the total of national COVID-19 cases in Indonesia. Furthermore, the official report has also found the first case of the B.1.1.7 variant in this province in early January 2021. During January–March 2021, the daily number of COVID-19 cases has shown total cases ranging from 20 to 134 cases.

The East Kalimantan province

The East Kalimantan Province located in the eastern part of Borneo (1°3’N 116°19’E) which it had a capital city namely Samarinda. The current population of this province was about 3,721,389 with a density of 29/km². This province had a total area of 127,346 km² and was known as the second densely populated province in Kalimantan. Recently, the total confirmed cases of COVID-19 in this province was more than 33 thousand cases. It has contributed 1.9%
Table 1 (Continued)

| Date         | West Java | South Sumatra | East Kalimantan |
|--------------|-----------|---------------|-----------------|
| 15/03/2020   | 1334      | 57            | 204             |
| 16/03/2020   | 1617      | 55            | 244             |
| 17/03/2020   | 1347      | 45            | 240             |
| 18/03/2020   | 1261      | 39            | 328             |


to the total of national cases in Indonesia. Furthermore, the official report has also reported a case of B.1.1.7 variant in this province during mid-February 2021. Table 1 exhibited the daily confirmed cases very fluctuated and it ranged from 142 to 931 cases.

Data collection

We acquired the daily COVID-19 and B.1.1.7 data from 1st January 2021 to 18th March 2021 (Table 1), from the Ministry of Health of Indonesia (www.covid19.go.id). We have collected the data from three provinces in Indonesia such as the West Java, South Sumatra and East Kalimantan. These provinces were chosen based on the occasion of B.1.1.7 within the area. Moreover, each province located on different islands, thus the spread pattern of the virus became an interesting topic to be analyzed. In addition, the meteorological data obtained from the Meteorology, Climatology, and Geophysical Agency of Indonesia. The data included temperature, humidity, rainfall, sunshine hours, and wind speed.

Forecasting analysis with Auto-Regressive Integrated Moving Average (ARIMA) Model

A total number of 77 (from 1st January 2021 to 18th March 2021) days were obtained to construct the ARIMA model. The ARIMA model was a prominent method in time series analysis that could be applied in autocorrelated data analysis. The parameters of the ARIMA model was such as follows: (p, d, q), p was to the order of auto-regression, d was the degree of trend difference, and q was the order of moving average. Before forecasting, time series must become a station according to mean and variance. Thus, the Augmented Dickey–Fuller (ADF) was adopted in identifying a stationary in the mean and Box-Cox test. Log transformation and differences were then used to assign the time series for mean and variance. The ARIMA model was set to a nonseasonal method to obtain the pattern of virus cases over time. The foremost number of the ARIMA model was estimated by looking at the autocorrelation function (ACF) and partial autocorrelation (PACF) plots. All the models that got through the residual tests were fitted using the Akaike information criterion (AIC). The best model that had the lowest AIC was chosen for the analysis. The ARIMA model analysis of our study referred to previous studies by Dehesh et al. [5], and Perone [10]. The analysis of the ARIMA model was carried out using the IBM SPSS Statistics 21 software with a statistical significance level was set at 0.05.

The correlation analysis

The Spearman correlation test was used to assess the association between meteorological factors and the daily number of COVID-19 and B.1.1.7 cases. The data were not normally distributed, thus we used the Spearman test for the correlation analysis. All the statistical analyses were conducted using the IBM SPSS Statistics 21 software.

Results

Forecasting the occasion of COVID-19 and B.1.1.7 cases

Table 2 revealed the ACF and PACF graphs were used for determining the model parameters. The ACF and PACF graphs indicated that total cases of COVID-19 were not affected by the seasonality factors. The parameters of ARIMA models were estimated from these graphs. Then the estimated models were compared based on the AIC value. The models which were depicted in Table 3 had the lowest AIC values based on the forecast analysis. Table 3 showed the forecast graphs of ARIMA models for different provinces with the total cases of COVID-19 and B.1.1.7. In the studied provinces, the daily COVID-19 incidences fluctuated over time (Table 3). The highest COVID-19 cases were observed in the West Java province, while the lowest was at the South Sumatra province. In addition, we also compared our forecast models with other Southeast Asian countries (i.e. Thailand) to avoid the local interest issue. Based on the forecast graph, Thailand successfully controlled the COVID-19 transmission with zero or at least one case per day. As a whole, the comparison of the predicted graph with the actual COVID-19 cases data could be analyzed in these graphs (Table 3). It was used to represent the accuracy of models. Based on the analysis, the selected ARIMA models in Table 3 were considered as the best model in this study, therefore, these models could be used for future studies which would like to create forecasting about COVID-19 and B.1.1.7 cases.

Table 4 showed the forecast data for 14 days (19th of March–1st of April) with 95% CI for different provinces. It obtained that the South Sumatra province might have a constant trend after the 19th of March. It was expected that this trend would remain constant and present a downward trend in near future in this province. In contrast, the West Java and the East Kalimantan provinces did not have a stable trend in these 14 days. The West Java province showed a steep increase from 19th March to 23th March, and after those days, the trend showed a slight increase. Furthermore, the East Kalimantan province represented a little decline on 21st March, 23th March, and 24th March. However, the cases gradually increased after 24th March.

Moreover, if we associated the trend cases in three provinces with B.1.1.7, we assumed the occasion of B.1.1.7 were mostly found at the highest peak point of the trend cases. For instance, in the case of East Kalimantan, the B.1.1.7 cases was found in the highest number of cases on Sunday, at 7th weeks (12th February 2021). So far, a total of four cases of B.1.1.7 have been found in the West Java province. In contrast, for other provinces, there was only one case found from January to March 2021. Our result revealed the daily cases was quite high in three provinces and it was consistent with the output from the forecast model which estimated that it might escalate to about 1971 cases (West Java), 44 cases (South Sumatra), and 426 cases (East Kalimantan) after 14 days later (Table 4). The West Java, South Sumatra, East Kalimantan provinces raised by 36%, 13.5%, and 30%, respectively as compared to the last actual cases till the end of 14 days later.

The association between COVID-19 and B.1.1.7 occasions with meteorological factors

The variation of daily COVID-19 cases in three provinces over time was showed in Table 3. The daily cases were closely related to the meteorological condition in those provinces. Therefore, several meteorological variables have been studied to analyze every possible contributor for COVID-19 and B.1.1.7 incidences. In the case of West Java, the B.1.1.7 incidences were mostly found in the air temperature ranging from 25.2 °C to 25.8 °C (Fig. 1). Meanwhile, in the South Sumatra and East Kalimantan, the temperature was slightly
Table 2
The best ARIMA models for forecasting total cases of COVID-19 and B.1.1.7 based on the ACF and PACF graphs.

| Provinces     | Model     | Graphs |
|---------------|-----------|--------|
| West Java     | ARIMA (1,0,0) | ![Graph](image1.png) |
| South Sumatra | ARIMA (0,1,1) | ![Graph](image2.png) |
| East Kalimantan | ARIMA (1,0,7) | ![Graph](image3.png) |

Fig. 1. Variation of daily COVID-19 and B.1.1.7 cases corresponding to meteorological factors condition in the West Java province.
Table 3
The graphs of COVID-19 and B.1.1.7 cases with the estimation result of ARIMA models in three provinces and other southeast Asian countries.

| Provinces                      | Model   | Graph |
|--------------------------------|---------|-------|
| West Java                      | ARIMA (1,0,0) | ![Graph](image1) |
| South Sumatra                  | ARIMA (0,1,1)  | ![Graph](image2) |
| East Kalimantan                | ARIMA (1,0,7)  | ![Graph](image3) |
| Southeast Asian country (Thailand)* | ARIMA (3,1,0)  | ![Graph](image4) |

* Source of data from Dehesh et al. [9].

higher than the West Java at around 26.1–26.8 °C (Figs. 2 and 3). Our result found there was a negative significant correlation between total cases with temperature \((r = -0.230; p < 0.05)\) (Table 5). Furthermore, the relative humidity for B.1.1.7 cases was found around 85–92% in three provinces (Figs. 1–3). The amount of rainfall varied for three provinces ranging from 0.7 mm to 19.1 mm. We obtained a positive correlation between the total cases with rainfall \((r = 0.211; p < 0.05)\) (Table 5). In addition, we found the B.1.1.7 cases related to sunshine duration around 1–6 h (Figs. 1–3). Our correlation analysis showed a strong negative correlation between the total cases with sunshine duration \((r = -0.418; p < 0.01)\) (Table 5). The wind speed in three provinces was ranging from 1 m/s to 2 m/s where the cases of B.1.1.7 were found (Figs. 1–3).

Discussion
The total cases trend in South Sumatra province might become a constant trend in near future. The West Java province would have a steep increase in the first week and then gradually stable till the end date of prediction. The East Kalimantan province had an unstable trend. If we compare these results with Thailand, Thailand’s total cases had a stationary trend. This was because Thailand effectively mitigated the epidemic within their country. Based on our study,
Table 4
Prediction of daily COVID-19 and B.1.1.7 cases for upcoming 14 days based on the ARIMA models with 95% CI.

| Date       | West Java          | South Sumatra          | East Kalimantan     |
|------------|-------------------|------------------------|---------------------|
| 19/03/2021 | 1540.48 (--133.63, 3214.59) | 44.28 (9.75, 78.81) | 320.7 (70.43, 570.97) |
| 20/03/2021 | 1710.12 (--248.25, 3688.49) | 44.28 (8.71, 79.84) | 341.7 (66.19, 617.22) |
| 21/03/2021 | 1813.09 (--240.12, 3866.29) | 44.28 (7.71, 80.84) | 340.05 (59.48, 620.22) |
| 22/03/2021 | 1875.59 (--211.47, 3962.64) | 44.28 (6.73, 81.82) | 380.01 (98.37, 661.64) |
| 23/03/2021 | 1913.52 (--185.87, 4012.91) | 44.28 (5.78, 82.77) | 370.11 (88.25, 651.96) |
| 24/03/2021 | 1936.55 (--167.37, 4040.46) | 44.28 (4.85, 83.70) | 368.41 (86.51, 650.31) |
| 25/03/2021 | 1950.52 (--155.06, 4056.10) | 44.28 (3.94, 84.61) | 392.13 (110.22, 764.05) |
| 26/03/2021 | 1959.01 (--147.19, 4065.20) | 44.28 (3.06, 85.49) | 410.73 (117.78, 709.67) |
| 27/03/2021 | 1964.16 (--142.26, 4070.58) | 44.28 (2.19, 86.36) | 419.29 (116.86, 721.72) |
| 28/03/2021 | 1967.28 (--139.22, 4073.78) | 44.28 (1.34, 87.21) | 423.23 (120.06, 726.39) |
| 29/03/2021 | 1969.18 (--137.35, 4075.71) | 44.28 (0.50, 88.05) | 425.04 (121.72, 728.36) |
| 30/03/2021 | 1970.33 (--136.21, 4076.87) | 44.28 (0.32, 88.87) | 425.88 (122.53, 729.23) |
| 31/03/2021 | 1971.03 (--135.52, 4077.58) | 44.28 (-1.12, 89.67) | 426.26 (122.90, 729.62) |
| 01/04/2021 | 1971.45 (--135.10, 4078.00) | 44.28 (-1.91, 90.46) | 426.44 (123.08, 729.80) |

Fig. 2. Variation of daily COVID-19 and B.1.1.7 cases corresponding to meteorological factors condition in the South Sumatra province.

Fig. 3. Variation of daily COVID-19 and B.1.1.7 cases corresponding to meteorological factors condition in the East Kalimantan province.

we found the occasions of B.1.1.7 were mostly found at the highest peak point of total confirmed cases. Therefore, we assumed that the B.1.1.7 occasions might increase if the trend of COVID-19 cases steeply increased.

The West Java province’s total cases revealed a stationary trend after 22nd March. While for the East Kalimantan province’s total cases revealed a stationary trend after 27th March. This might be due to good control and tight social restriction policy that was applied in both provinces. Many studies agreed that the social and movement restriction policies run well to suppress virus transmission [11,12]. In another study on the Southeast Asian data the trend of total cases in Indonesia from 22nd January to 13th April 2020 exponentially increased [13]. This result was in accordance with the result of the current study. We believed that the South Suma-
Table 5
Spearman correlation between meteorological factors and a daily number of COVID-19 and B.1.1.7 cases.

| Meteorological factors | Total cases |
|------------------------|-------------|
| Temperature            | −0.230**    |
| Humidity               | 0.191       |
| Rainfall               | 0.211*      |
| Sunshine               | −0.418**    |
| Wind speed             | −0.025      |

** Correlation is significant at the 0.05 level (2-tailed).
* Correlation is significant at the 0.01 level (2-tailed).

utra province had a decreasing trend that then became stable after the 18th of March. It might be due to the decline in-flight hours and passengers that came from the red zone (high COVID-19 cases areas) such as Jakarta, West Java, East Java, North Sumatra, and West Sumatra provinces. This situation was found in the early year of 2021. Therefore, South Sumatra province was in the movement control period and the stable trend was reasonable.

In this study, we also used meteorological variables to determine every possible contributor for B.1.1.7 incidences. The B.1.1.7 cases were found in low air temperature, in this case, we obtained the air temperature around 25.2–25.8 °C. This assumption has been supported by the correlation analysis which showed a negative correlation between total cases with temperature. A lower temperature, a higher total cases in a certain area. Several studies also obtained the same results where the total cases tended to increase when the air temperature decreased [14,15].

Our study revealed the B.1.1.7 cases would be found higher in larger amounts of rainfall areas. Shabbir et al. [16], explained the spread of disease vectors and viral agents raised in the wet or rainy season. Moreover, the B.1.1.7 cases were found in sunshine duration around 0–1 h. Many studies have also found that the shorter the sunshine duration, the higher cases found in a particular area [17,18]. In addition, Ilie et al. [19] and Rhodes et al. [20] assumed that the regions with high latitudes and winter season tended to have low vitamin D because of low sunshine, which then linked to higher mortality by COVID-19. The wind speed was observed ranging from 1 m/s to 2 m/s where the cases of B.1.1.7 were mostly found. It showed the B.1.1.7 cases tended to spread at the low wind speed value. Our previous study has also found low wind speed could lead to higher COVID-19 cases in Jakarta, Indonesia [21]. Low wind speed yielded stagnation of particulate matters combined with viral agents which attributed to the high accumulation of COVID-19 spread in a particular area [22,23].

Although more data was the best way to check the precision of the forecast model, our proposed models could be useful in estimating future total cases if the trend did not much alter. Because the coronavirus easily mutated and had the capability to be more infected. These factors would govern the prediction models, however, based on our data and current analysis, these models were considered as the best. Then, these models could be used by the authority to arrange the best strategies for controlling and mitigating the spread of COVID-19 and B.1.1.7 in three provinces of Indonesia. Also, these models could be a new insight for future studies that would elaborate the forecast impacted on service planning or provision.

Conclusions

We recapitulated that this was the first preliminary study to analyze a short-term forecast regarding COVID-19 and B.1.1.7 incidences as well as the associated meteorological factors that become primary contributors to the virus spread. This study concluded there could be an increase in the total cases of COVID-19 and B.1.1.7 around 13.5–36% at the upcoming 14 days in three provinces if the current trend did not change. Furthermore, the sunshine, rainfall, and temperature factors could be the main contributors to B.1.1.7 cases. Therefore, we suggested the results of our study could be used by the authority for arranging the precise strategies to avoid further infection of COVID-19 and B.1.1.7.

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Competing interests

None declared.

Ethical approval

Not required.

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References

[1] Iacobucci G. Covid-19: new UK variant may be linked to increased death rate, early data indicate. BMJ 2021;372(230):n230.
[2] Duong D. What’s important to know about the new COVID-19 variants?: 2021. [Online].
[3] Voltz E, Mishra S, Chand M, Barrett JC, Johnson R, Geddes LG, et al. Assessing transmissibility of SARS-CoV-2 lineage B.1.1.7 in England. Nature 2021;593(7858):266–9.
[4] Ribeiro MHDA, da Silva RG, Mariani VC, dos Santos Coelho L. Short-term forecasting COVID-19 cumulative confirmed cases: perspectives for Brazil. Chaos Solitons Fractals 2020;135:109853.
[5] Yousaf M, Zahir S, Riaz M, Hussain SM, Shah K. Statistical analysis of forecasting COVID-19 for upcoming month in Pakistan. Chaos Solitons Fractals 2020;138:109926.
[6] Chimmula VKR, Zhang L. Time series forecasting of COVID-19 transmission in Canada using LSTM networks. Chaos Solitons Fractals 2020;135:105864.
[7] Zerouali A, Harrou F, Daiari A, Sun Y. Deep learning methods for forecasting COVID-19 time-series data: a comparative study. Chaos Solitons Fractals 2020;140:110121.
[8] Hu Z, Ge Q, Li S, Jin L, Xiong M. Artificial intelligence forecasting of covid-19 in china. arXiv 2020;6(1):71–94.
[9] Dehesh T, Mardani-Fard HA, Dehesh P. Forecasting of covid-19 confirmed cases in different countries with arima models. MedRxiv 2020;1:1–12.
[10] Perone G. An ARIMA model to forecast the spread and the final size of COVID-19 Epidemic in Italy. arXiv 2020, preprint arXiv:2004.00382.
[11] Aziz NA, Othman J, Lugova H, Suleiman A, behalf of the Economy, O. Cluster SW. Malaysia’s approach in handling COVID-19: Reengaged, targeting of Movement Control Order (MCO) and targeted screening to reduce community infection rate and impact on public health and economy. J Infect Public Health 2020;13(12):1823–34.
[12] Tang KHD. Movement control as an effective measure against COVID-19 spread in Malaysia: an overview. J Public Health (Bangkok) 2020;1:4–.
[13] Tandon H, Ranjan P, Chakraborty T, Suhag V. Coronavirus (COVID-19): ARIMA based time-series analysis to forecast near future. arXiv 2020, preprint arXiv:2004.07855.
[14] Shi P, Dong Y, Yan H, Zhao C, Li X, Liu W, et al. Impact of temperature on the dynamics of the COVID-19 outbreak in China. Sci Total Environ 2020;728:136890.
[15] Wang M, Jiang A, Gong L, Luo L, Guo W, Li C, et al. Temperature significant change COVID-19 Transmission in 429 cities. medrxiv 2020;1:1–19.
[16] Shabbir W, Pilz J, Naem A. A spatial-temporal study for the spread of dengue depending on climate factors in Pakistan (2006–2017). BMC Public Health 2020;20(1):1–10.
[17] Sharma R, Vikas V, Singh M, Sharma V, Sharma V, Kumar D. Sunshine and Wind speed effect on COVID-19 cases in mid hill region of Rajouri and Jammu districts of Jammu Kashmir Union Territory, India. Pharma Innov J 2020;9(8):164–6.
[18] Li H, Xu XL, Dai DW, Huang ZY, Ma Z, Guan YJ. Air pollution and temperature are associated with increased COVID-19 incidence: a time series study. Int J Infect Dis 2020;97:278–82.
[19] Ilie PC, Stefanescu S, Smith L. The role of vitamin D in the prevention of coronavirus disease 2019 infection and mortality. Aging Clin Exp Res 2020;32(7):1195–8.
[20] Rhodes JM, Subramanian S, Laird E, Kenny RA. Low population mortality from COVID-19 in countries south of latitude 35 degrees North supports vitamin D as a factor determining severity; 2020.

[21] Rendana M. Impact of the wind conditions on COVID-19 pandemic: a new insight for direction of the spread of the virus. Urban Clim 2020;34:100680.

[22] Coccia M. How do low wind speeds and high levels of air pollution support the spread of COVID-19? Atmos Pollut Res 2021;12(1):437–45.

[23] Rendana M. Air pollutant levels during the large-scale social restriction period and its association with case fatality rate of COVID-19. Aerosol Air Qual Res 2021;21:200630.