Relationship between climate variables and new daily COVID-19 cases in Dhaka, Bangladesh

M. Mofijur[1],*, I.M. Rizwanul Fattah[1], A. B. M. Saiful Islam[2], S.M. Ashrafur Rahman[3], M.A. Chowdhury[4]

[1]Faculty of Engineering and IT, University of Technology Sydney, NSW 2007, Australia

[2]College of Engineering, Imam Abdulrahman Bin Faisal University, Dammam 31451, Saudi Arabia

[3]Biofuel Engine Research Facility, Queensland University of Technology (QUT), Brisbane, QLD 4000, Australia

[4]Department of Mechanical Engineering, Dhaka University of Engineering and Technology (DUET), Gazipur 1707, Bangladesh

*Correspondence: MdMofijur.Rahman@uts.edu.au

Abstract

The present study investigates the relationship between the transmission of COVID-19 infections and climate indicators in Dhaka City, Bangladesh, using coronavirus infections data available from the Institute of Epidemiology, Disease Control and Research (IEDCR), Bangladesh. The Spearman-ranked correlation test was carried out to study the association of seven climate indicators, including humidity, air quality, minimum temperature, precipitation, maximum temperature, mean temperature and wind speed with the COVID-19 outbreak in Dhaka City, Bangladesh. The study found that, among the seven indicators, only three indicators (air quality, minimum temperature and average temperature) have a significant relationship with new COVID-19 cases. The results of this paper will give health regulators and policymakers valuable information to lessen the COVID-19 infection in Dhaka and other countries around the world.

Highlights

- Correlation of seven climate indicators with new daily COVID-19 cases in Bangladesh
- Higher correlation is observed for air quality
- The climate factor is one of the factors that influence the fast spread of COVID-19

Keywords: COVID-19; Climate indicators; Air Quality; Environment; Pandemic; Coronavirus

1. Introduction

Coronavirus is a major pathogen affecting the respiratory system of humans [1]. On December 31, 2019, an unspecified etiological outbreak from Wuhan, Hubei, China was reported to the World Health Organization (WHO) [2]. The novel virus, later named as COVID-19, spread quickly to other countries around the globe. In light of the rising danger, WHO declared COVID-19 as an international public health emergency (PHEIC) [3]. COVID-19 has already infected people in most countries around the world. As of 25th July 2020, the incidence of COVID-19 infections reached the figure of 8 million, with more than 205 countries and regions being affected by the pandemic [4]. COVID-19 clinical trials indicate that almost all patients have trouble breathing and pneumonia [5]. Clinical diagnosis has identified that COVID-19 patients have similar indications to other coronavirus affected patients, e.g. MERS and SARS [6]. The initial indication of COVID-19 infection is cough, fever, and short breath, and in the late stage, it can damage the kidney, cause pneumonia, and unexpected death. The vulnerability of the elderly (>80 years of age) is high, with a fatality rate of ~22% of cases infected by COVID-19 [1]. In Bangladesh, the first coronavirus cases were identified on March 8, 2020, in three young patients (two male and one female). The two male patients had returned from Italy and the female was ta family member of one of the two males [7]. Bangladesh's infections remained low until the end of March but increased steeply in April. Bangladesh cases reached 100 on April 9 and exceeded 200 cases in two days, so the time for the caseload to double was two days which later slowed to three and then five days. On June 1, 2020, the time required for the caseload in Bangladesh to double remained at five days. The spread of infection was similar to that of Italy, France, and South Korea, which resulted in WHO announcing COVID-19 a pandemic [8]. Between March 8 and June 1, 2020, there were 49,534 COVID-19 cases in Bangladesh confirmed by rt-PCR, including 672 related fatalities (CFR 1.36%) according to the IEDCR. Figure 1 shows the COVID-19 case distribution up until June 1, 2020 in Bangladesh [9]. As of June 1, 2020, the geographical distribution of confirmed reported COVID-19 cases was available on 65% of all cases (32,120 of 49,534). Of these cases, 70.3% (22,576) were from Dhaka Division, 16.7%

(5,361) Chattogram Division, 3.1% (996) Mymensingh Division, 2.9% (937) Rangpur Division, 2.3% (744) Sylhet Division, 2.2% (700) Rajshahi Division, 1.8% (574) Khulna Division, and 0.7% (232) Barisal Division [4].
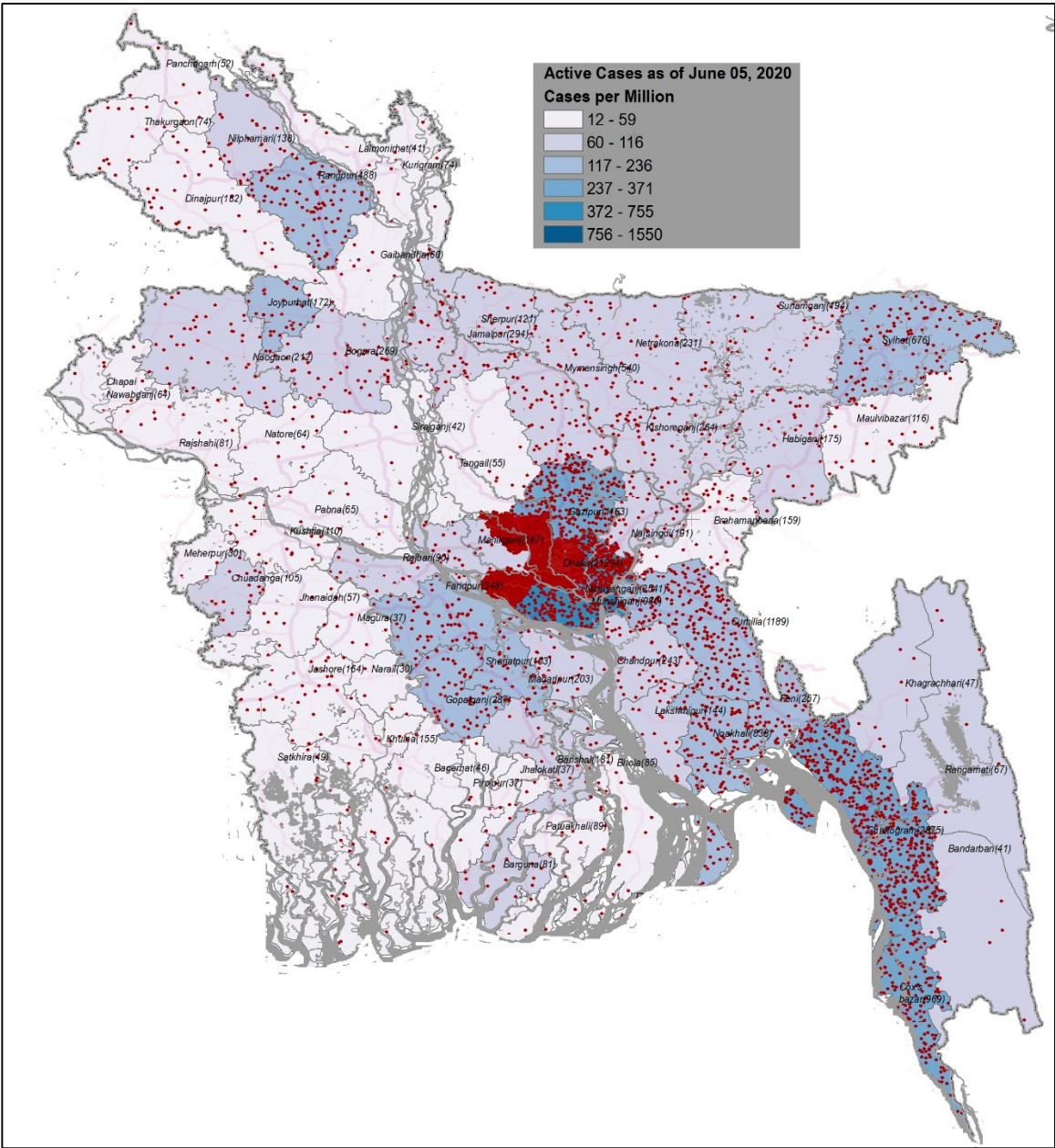

Figure 1: COVID-19 case distribution up until June 1, 2020 in Bangladesh [9].

Recently, Huang et al. [10] reported that COVID-19 was transmitted from bat to human though the transitional host is still unidentified. The transmission of the novel virus is through air droplets from human to human. Bashir et al. [11] reported that the transmission of viruses is influenced by weather

conditions and density of people. Dalziel et al. [12] considered climate indicators as the best predictors because weather conditions play a significant role in the transmission of coronavirus. Researcher [11, 13] has also found that climate indicators significantly affect the death rate due to pneumonia. Tosepu et al. [13] cited that the adverse weather associated with long-term changes in climate made a significant contribution to West Nile virus spreading in the US and Europe. Even though some research has looked into identifying the link between weather variables and the spread of viruses, there is limited research on the relation between them. Most of these studies focused solely on observing the correlation of temperatures, while overlooking the impact of air quality on COVID-19 dynamics. The air quality index of Bangladesh indicates that Dhaka is the most polluted city, which may affect the dynamics of COVID-19 in Bangladesh. Therefore, this work will provide expedient information to the policymaker, which can help to lower the COVID-19 infection rate.

2. Methods

2.1 Study Area

Dhaka is the capital of the People's Republic of Bangladesh. Geographically, Dhaka is situated in South Asia, between 20°30' to 26°38' north latitude and 88°01' to 92°41' east longitude. Bangladesh occupies the 95th position in terms of landmass with an area of 148,460 square kilometres (57,320 square miles). The total land and water areas of Bangladesh are 130,170 square kilometres and 18,290 square kilometres, respectively. According to the World Population Dashboard of United Nations Population Fund (UNFPA), in 2019 the total population of Bangladesh was 168.1 million along with an average annual population growth rate of 1.1% (2010-2019) [14].

2.2 Data Collection

The computer-based data on the updates of COVID-19 status in Dhaka from the period of May 1, 2020 - May 31, 2020 were procured from the IEDCR, Bangladesh. Until April 30, there were 6,000 cases recorded in Dhaka and new cases increased steadily from May 1, 2020.The data on climate indicators and atmospheric conditions during May 2020 were collected from the Bangladesh Meteorological

Department (BMD) [15]. The data consists of minimum, maximum, and average temperatures in °C, precipitation in millimetres, and humidity as a percentage. The air quality index (AQI) data was collected from Dhaka US Consulate Air Pollution: Real-time Air Quality Index (Available at http://aqicn.org/city/bangladesh/dhaka/us-consulate/).

2.3 Data analysis

The data distribution is not normal. Therefore, to analyse the data, the Spearman rank correlation (r_s) test was performed to inspect the correlation between new and total infections with environmental indicators. The coefficient is calculated using the following equation [16]:

$$r_s = 1 - 6\frac{\sum d_i^2}{n(n^2-1)} \tag{1}$$

3. Results and Discussion

Figure 2 shows the number of daily new infections and total infections statistics for Dhaka from May 1, 2020 to May 31, 2020. The total confirmed cases increased steadily until the end of the month. On May 1, the confirmed cases in Dhaka were 6,031. By the end of the first week of May, confirmed cases had risen to 8289, by the end of the second week to 11,280, by the end of the third week to 16,528, and by the end of the month to 22,576.
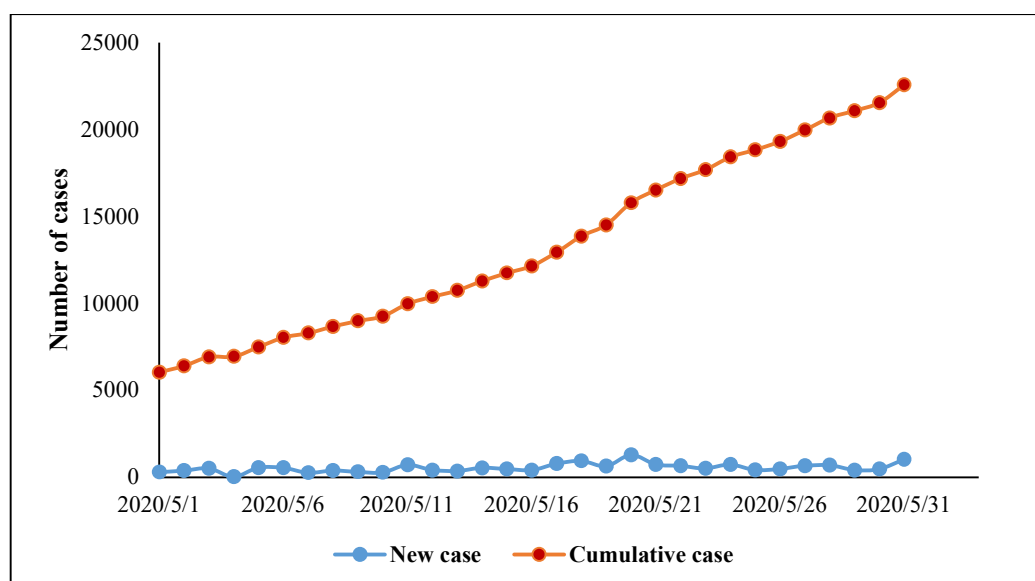

Figure 2: Confirmed cases of COVID-19 in Dhaka, May 2020 [4].

The daily temperature changes of Dhaka in May 2020 is depicted in Figure 3. The lowest daily maximum, minimum and average temperature was 24°C, 33°C and 29°C, respectively, whereas the highest daily maximum, minimum and average temperature was 26°C, 34°C and 30°C, respectively. The average daily lowest and highest rainfall was 2mm and 20mm, respectively. The average daily minimum and maximum humidity was 47% and 98%, respectively. The average daily lowest and highest wind speed was 1 km/h and 17 km/h, respectively. The average daily minimum and maximum air quality as per the AQI was 54 and 150, respectively.
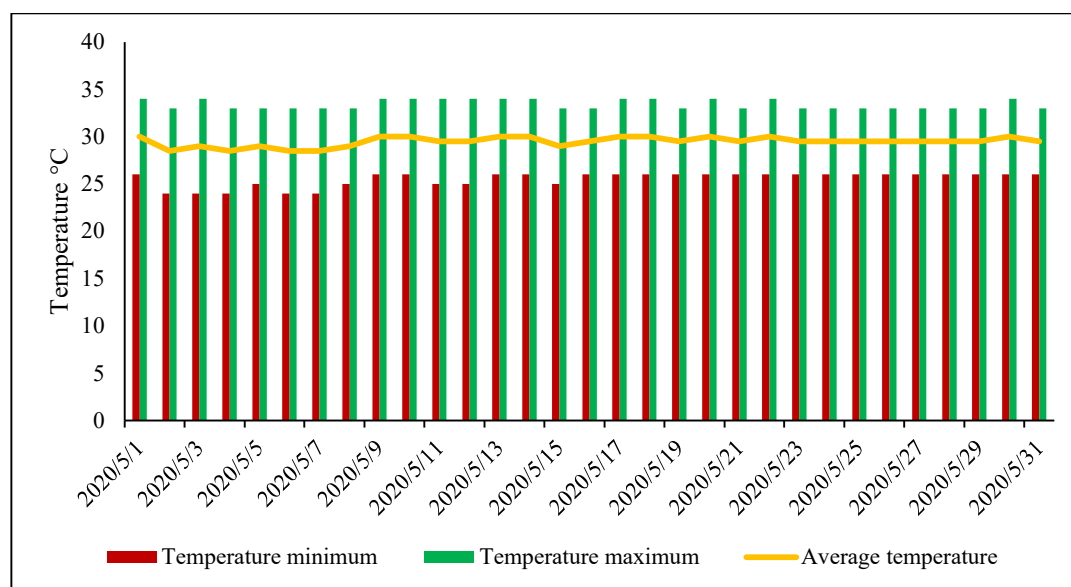

Figure 3. Changes of daily maximum, minimum and average temperatures in Dhaka, May 2020 [14].

Table 1 shows the correlation of these seven climate indicators with daily new infections and total infections of COVID-19 in Dhaka. Among the seven weather variables, only mean temperature (r_s=0.470; p=0.02) and minimum temperature (r_s=0.427; p=0.01) are positively and significantly correlated with daily new infections whereas the data for air quality, mean temperature and minimum temperature indicate a significant relationship with total confirmed infections. Maximum temperature, wind speed, rainfall and humidity were not significantly correlated with the dynamics of coronavirus. For the present study, the link between climate change indicators and the spread of COVID-19 in Dhaka is analysed. Figure 4 shows the most correlation factors on daily new infections and the total number of

infections. The analysis determines that the minimum and average temperatures in Dhaka are linked to the spread of COVID-19. This relationship is supported by the work of [16] on the respiratory syncytial virus (RSV) and [17] on SARS viruses. Previous research on the effect of climate indicators on COVID-19 dynamics indicates that temperature served as the key driver for the spread of the coronavirus in China [18], Indonesia [13] and the US [11]. Chen et al. [19] also highlighted that temperature influences the spread of the coronavirus. There are reports of other meteorological indicators affecting the dynamics of the novel coronavirus. It has been reported that humidity and temperature are crucial indicators, which significantly motivate the seasonal transmission of COVID-19 [20]. Similar results for China have been published by Wang [6] which show a strong link between disease propagation and climate variables, predicting that sunny weather may play a crucial role in the reduction of virus transmission. However, weather parameters affect not only the transmission of the novel virus but also mortality [21]. Poole [22] cited that environment latitude also correlates with COVID-19 pandemic.
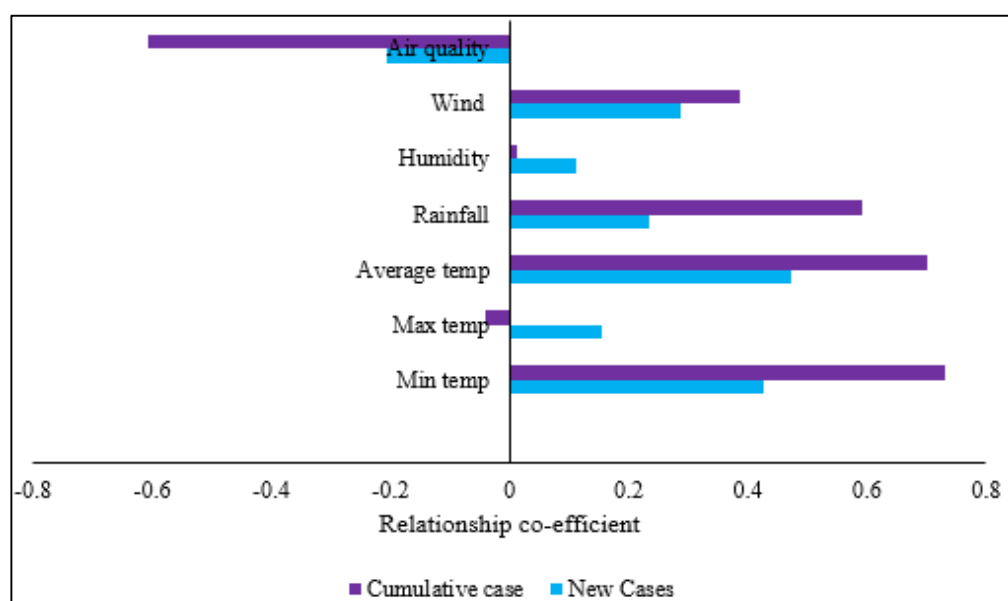

Figure 4: The comparison of r_s among the most indicators.

The findings of this study have been compared with a recent study [13] undertaken in Indonesia which indicated that only mean temperature significantly affected daily cases, with other variables bearing no relationship with the COVID-19 pandemic. In this study, we also found that the average temperature is

7

linked with daily new cases in Bangladesh (r_s=0.472) and that the observed relationship is higher than that found for Indonesia (r_s=0.393). Unlike the Indonesian study [13], this study also considered the effect of air quality on the impact of the outbreak. We found that air quality is strongly related (r_s=0.607; p=0.001)) to total cases in Bangladesh.

In Dhaka, the fast spread of COVID-19 was due to the extremely high level of human mobility, along with the weather. Being the capital city, Dhaka is the centre of commercial, economic and cultural activities of Bangladesh. Many people from regional areas in Bangladesh travel to Dhaka to find a job and develop their financial stability. Another explanation perhaps is that Dhaka has a high population density, allowing very quick transmission of COVID-19. Dhaka has a population of 21 million growing at 3.6% per year and a density of 121,720 residents per square mile, according to census data. Most of the people are involved either in households or unauthorized work and considerable proportion work in the garment industry (approximately 800,000). Such statistics make Dhaka a perfect epicentre for infection compared to other areas of the country. Zhu et al. [23] also reported that population growth is one of the causes for the rapid transmission of COVID-19

Despite important findings on the impact of weather on the COVID-19 pandemic, some limitations remain. For example, the infection of novel coronavirus is influenced by many variables including people's mobility, immunity, hygiene and proximity, the size of gatherings, testing facilities, and health care management. Therefore, further and comprehensive research is necessary to explore data about these variables to give a clearer picture of the dynamics of COVID-19.

4. Conclusions

Climate indicators play an important role in determining the COVID-19 outbreak in Dhaka. This study shows a significant correlation between mean temperature, low temperature, and air quality and rapid transmission of COVID-19 infections. The outcomes of this research will provide useful information to lower the incidence rate. In particular, the significant relationship between air quality and the spread of

COVID-19 infections indicates the importance of implementing clean environment policies within the country. However, further research on daily pollutant emissions such as carbon, particulate matter and nitrogen oxides is important as forced confinement due to the pandemic significantly lowered pollutant emissions.

References

[1] Abdullah S, Mansor AA, Napi NNLM, Mansor WNW, Ahmed AN, Ismail M, et al. Air quality status during 2020 Malaysia Movement Control Order (MCO) due to 2019 novel coronavirus (2019-nCoV) pandemic. Science of The Total Environment. 2020; 729:139022.

[2] Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. New England Journal of Medicine. 2020; 382:1199-207.

[3] Sohrabi C, Alsafi Z, O'Neill N, Khan M, Kerwan A, Al-Jabir A, et al. World Health Organization declares global emergency: A review of the 2019 novel coronavirus (COVID-19). International Journal of Surgery. 2020; 76:71-6.

[4] WHO. Bangladesh COVID-19 Situation Report #14 2020. Accessed on 5th June 2020.

[5] Holshue ML, DeBolt C, Lindquist S, Lofy KH, Wiesman J, Bruce H, et al. First case of 2019 novel coronavirus in the United States. New England Journal of Medicine. 2020;382:929-36.

[6] Wang YW, Ho SY, Lee SW, Chen CC, Litsu S, Huang WT, et al. Induction chemotherapy improved long term outcomes in stage iv locoregional advanced nasopharyngeal carcinoma. International Journal of Medical Sciences. 2020; 17:568-76.

[7] Paul R. Bangladesh confirms its first three cases of coronavirus. Reuters2020. Accessed on 2nd June 2020.

[8] Cucinotta D, Vanelli M. WHO declares COVID-19 a pandemic. Acta Biomedica. 2020; 91:157-60.

[9] Bengal Institute. COVID19 Active Case Rate in Bangladesh – Interactive Map2020.

[10] Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. The Lancet. 2020; 395:497-506.

[11] Bashir MF, Ma B, Bilal, Komal B, Bashir MA, Tan D, et al. Correlation between climate indicators and COVID-19 pandemic in New York, USA. Science of The Total Environment. 2020; 728:138835.

[12] Dalziel BD, Kissler S, Gog JR, Viboud C, Bjørnstad ON, Metcalf CJE, et al. Urbanization and humidity shape the intensity of influenza epidemics in U.S. cities. Science. 2018; 362:75-9.

[13] Tosepu R, Gunawan J, Effendy DS, Ahmad LOAI, Lestari H, Bahar H, et al. Correlation between weather and Covid-19 pandemic in Jakarta, Indonesia. Science of The Total Environment. 2020; 725:138436.

[14] United Nations Population Fund U. World Population Dashboard Bangladesh. 2019. Accessed on 30th May 2020.

[15] Bangladesh Meteorological Department (BMD). 2020. Accessed on 5th June 2020.

[16] Vandini S, Corvaglia L, Alessandroni R, Aquilano G, Marsico C, Spinelli M, et al. Respiratory syncytial virus infection in infants and correlation with meteorological factors and air pollutants. Ital J Pediatr. 2013; 39:1.

[17] Tan J, Mu L, Huang J, Yu S, Chen B, Yin J. An initial investigation of the association between the SARS outbreak and weather: With the view of the environmental temperature and its variation. Journal of Epidemiology and Community Health. 2005; 59:186-92.

[18] Shi P, Dong Y, Yan H, Li X, Zhao C, Liu W, et al. The impact of temperature and absolute humidity on the coronavirus disease 2019 (COVID-19) outbreak - evidence from China. medRxiv. 2020:2020.03.22.20038919.

[19] Chen B, Liang H, Yuan X, Hu Y, Xu M, Zhao Y, et al. Roles of meteorological conditions in COVID-19 transmission on a worldwide scale. medRxiv. 2020:2020.03.16.20037168.

[20] Sajadi MM, Habibzadeh P, Vintzileos A, Shokouhi S, Miralles-Wilhelm F, Amoroso A. Temperature and Latitude Analysis to Predict Potential Spread and Seasonality for COVID-19. (Available at SSRN 3550308). 2020.

[21] Ma Y, Zhao Y, Liu J, He X, Wang B, Fu S, et al. Effects of temperature variation and humidity on the death of COVID-19 in Wuhan, China. Science of The Total Environment. 2020;724:138226.

[22] Poole L. Seasonal influences on the spread of SARS-CoV-2 (COVID19), causality, and Forecastabililty (3-15-2020). 2020.

[23] Zu ZY, Jiang MD, Xu PP, Chen W, Ni QQ, Lu GM, et al. Coronavirus Disease 2019 (COVID-19): A Perspective from China. Radiology. 2020:200490.