RESEARCH ARTICLE

Nevin Ince[1]
Pinar Yildiz Gulhan[2]
Ege Gulec Balbay[2]
Cihadiye Elif Ozturk[3]
Attila Onmez[4]

[1]Department of Infectious Diseases and Clinical Microbiology, Duzce University Faculty of Medicine, Duzce, Turkey
[2]Department of Chest Diseases, Duzce University Faculty of Medicine, Duzce, Turkey
[3]Department Clinical Microbiology, Duzce University Faculty of Medicine, Duzce, Turkey
[4]Deparment of Internal Disease, Duzce University Faculty of Medicine, Duzce, Turkey

Corresponding Author:
Nevin Ince
Department of Infectious Diseases and Clinical Microbiology, Duzce University Faculty of Medicine, Duzce, Turkey
mail: drnevince@gmail.com
Phone: +90 3805421387

Received: 13.07.2020
Acceptance: 18.09.2020
DOI: 10.18521/ktd.768835

Konuralp Medical Journal
e-ISSN1309–3878
konuralptipdergi@duzce.edu.tr
konuralptipdergisi@gmail.com
www.konuralptipdergi.duzce.edu.tr

The Role of Meteorological Parameters in COVID-19 Infection

ABSTRACT

Objective: The SARS-CoV-2 infection outbreak was given the name Coronavirus Disease 2019 (COVID-19) by the World Health Organization. Meteorological parameters are one of the most important factors affecting infectious diseases. The aim of this study is to analyze the correlation between meteorological parameters and the COVID-19 pandemic.

Methods: One hundred ninety-seven COVID-19 patients diagnosed and treated in the Turkish province of Duzce between 29.03.2020 and 04.05.2020 were included in this study.

Results: We found the relationship between air quality parameters and COVID-19 case numbers revealed significant negative correlation between positive patient number and air temperature, relative humidity, and NO_2, and significant positive correlation with air pressure, but no correlation with PM_{10}, $PM_{2.5}$, SO_2, NO, or CO.

Conclusions: Our findings are important as a preliminary study, since interactions between air pollutants and meteorological factors may be involved in the transmission and pathogenesis of COVID-19, and large-scale studies should now be designed for a better understanding of these interactions.

Keywords: Infection, COVID-19, Meteorological Parameters

COVID-19 Enfeksiyonunda Meteorolojik Parametrelerin Rolü

ÖZET

Amaç: SARS-CoV-2 enfeksiyonu salgınına Dünya Sağlık Örgütü tarafından Coronavirus Hastalığı 2019 (COVID-19) adı verildi. Meteorolojik parametreler bulaşıcı hastalıkları etkileyen en önemli faktörlerdendir. Bu çalışmanın amacı meteorolojik parametreler ile COVID-19 salgını arasındaki ilişkiyi incelemektir.

Gereç ve Yöntem: Türkiye Düzce ilinde 29.03.2020 ve 04.05.2020 tarihleri arasında tanı ve tedavi edilen 197 COVID-19 hastası çalışmaya alındı.

Bulgular: Hava kalitesi parametreleri ile COVID-19 olgu sayıları arasındaki ilişkinin, Pozitif hasta sayısı ile hava sıcaklığı, bağıl nem ve NO2 arasında anlamlı negatif korelasyon olduğu ve hava basıncı ile anlamlı pozitif korelasyon olduğu, ancak PM_{10}, $PM_{2.5}$ SO_2, NO veya CO ile korelasyon olmadığı saptandı.

Sonuç: Bulgularımız bir ön çalışma olarak önemlidir, çünkü hava kirleticileri ile meteorolojik faktörler arasındaki etkileşimler COVID-19'un bulaşması ve patogenezinde rol oynayabilir ve bu etkileşimlerin daha iyi anlaşılması için büyük ölçekli çalışmalar tasarlanmalıdır.

Anahtar Kelimeler: İnfeksiyon, COVID-19, Hava Parametreleri

INTRODUCTION

The SARS-CoV-2 infection outbreak was given the name Coronavirus Disease 2019 (COVID-19) by the World Health Organization (WHO). COVID-19 then spread rapidly to many countries, and the WHO officially declared it a pandemic on 11 March, 2020 (1).

Viruses do not replicate outside the living cell, but the virus can survive on environmental surfaces it has contaminated, that survival being significantly affected by temperature and moisture (2).

Meteorological parameters are one of the most important factors affecting infectious diseases. Previous studies have suggested that environmental air pollutants make humans more susceptible to pathogens by carrying micro-organisms and are risk factor for respiratory tract diseases by affecting the body’s immunity (3-5).

Various studies have been performed to investigate the factors affecting SARS-CoV-2 transmission in order to control the spread of COVID-19 (6). Several factors affect the transmission, such as the incubation period, the length of infectiousness, the virus load, the incidence and infectiousness of asymptomatic cases, transmission pathways other than droplets, and the length at which the agent can maintain infectivity in external environments (7). Air quality parameters may therefore play a role in the transmission and infectivity of the virus.

Meteorological conditions have been proposed as important factor in predicting epidemic trends, in addition to population mobility and human-to-human contact. Meteorological factors, such as humidity, visibility, and wind speed, can affect droplet stability in the environment, or affect the survival of viruses in the same way as air temperature, thus impacting on epidemic transmission. Air temperature and absolute humidity have been reported to significantly affect the transmission of COVID-19 (8).

Information concerning the survival of SARS coronavirus at different temperature and humidity conditions is of great importance to understanding the transmission of the virus. In addition to human-to-human transmission, both epidemiological and laboratory studies have shown that environmental temperature is an important factor in the transmission and survival of coronaviruses (9,10). The aim of this study is to analyze the correlation between meteorological parameters and the COVID-19 pandemic.

MATERIAL AND METHODS

Study Population: One hundred ninety-seven COVID-19 patients diagnosed and treated in the Turkish province of Duzce between 29.03.2020 and 04.05.2020 were included in this study.

Data Collection: The air monitoring measurement parameters published by the National Air Quality Network [PM10 (particulate matter less than 10 μm), PM2.5 (particulate matter less than 2.5 μm), SO2 (sulfur dioxide), NO2 (nitrogen dioxide), NO (nitrogen oxide), CO (carbon monoxide), air temperature, air pressure, relative humidity] were obtained from the relevant web site (http://laboratory.cevre.gov.tr/Default.ltr.aspx).

The study was conducted in full accordance with the local Good Clinical Practice (GCP) guideline and current legislation, while permission for the use of patient data for publication purposes was obtained from Düzce University Faculty of Medicine Ethics Committee.

Polymerase Chain Reaction (PCR) Method: Combined nasopharyngeal-oropharyngeal swab, sputum or tracheal aspirate samples were collected from suspected cases of COVID-19. These were then sent to the laboratory under appropriate conditions in viral transport medium, where they were processed in the biosafety cabinet. Nucleic acid extractions were performed manually using Bio-speedy viral nucleic acid extraction buffer (Bioeksen R&D Technologies, Turkey). PCR testing was then performed using a SARS-CoV-2 (2019-nCoV) RT-qPCR detection kit (Bioeksen R&D Technologies, Turkey) and Montania® Real-Time PCR instruments (Anatolia Geneworks, Turkey). PCR test results were evaluated and reported by the laboratory manager.

Statistical Analysis: Statistical analysis was performed on SPSS-21 software. Descriptive statistics were calculated as frequency and mean, median, and standard deviation values. Pearson’s correlation analysis was applied to determine correlations between patient numbers at the beginning of each week over the five-week study period and mean air pollution, air temperature, relative humidity, and air pressure values. p values <0.05 were regarded as statistically significant.

RESULTS

Women constituted 51.8% (n: 102) of the 197 COVID-positive patients, and men 48.2% (n:95). Mean ages were 44.8 ± 17.8 (min:1, max:88, median 43) for women and 44.8 ± 17.7 (min:2, max: 96, median 43) for men (p=0.990). Five-week mean air parameter and pollution values are shown in Table 1).

Table 1. Five-week mean air parameter and pollution (29 April-5 May 2020)

	First week n=26	2nd week n=55	3rd week n=45	4th week n=28	5th week n=34
Temperature °C	10.6 ± 1.4	12.0 ± 0.9	13.0 ± 1.8	14.7 ± 3.8	17.9 ± 1.8
Relative humidity	90.6 ± 6.2	-	68.2 ± 12.4	74.6 ± 13.3	67.2 ± 6.6
Air pressure	997.1± 2.6	-	1002.3±2.6	999.8± 2.6	995.2±2.8
PM_{10}	46.0 ± 25.9	59.4 ± 22.5	74.9 ± 32.1	58.6 ± 17.7	68.2 ± 8.1
$PM_{2.5}$	24.5 ± 10.7	28.5 ± 9.8	36.4 ± 15.6	28.5 ± 8.6	33.0 ± 3.7
SO_2	2.9 ± 0.7	3.7 ± 0.6	3.6 ± 0.7	4.4 ± 1.3	4.8 ± 0.4
NO	12.5 ± 7.8	11.3 ± 6.5	12.0 ± 5.2	10.3 ± 3.0	13.7 ± 6.3
NO_2	9.7 ± 4.6	8.4 ± 3.8	10.7 ± 3.6	9.4 ± 3.1	15.5 ± 2.3
CO	334.1±235.7	405.9±261.2	558.7±214.5	409.5±182.2	562.7±76.6

PM_{10}: particulate matter less than 10 µm, $PM_{2.5}$: particulate matter less than 2.5 µm, SO_2: Sulfur dioxide, NO: Nitrogen oxide, NO_2: Nitrogen dioxide, CO: Carbon Monoxide

Significant negative correlation was found between positive patient number and air temperature (r= -.247, p= 0.001), relative humidity (r= -.358, p<0.001) and NO2 (r= -.225, p= 0.002) (Figures 1-3). Significant positive correlation was determined between positive patient number and air pressure (r= .444, p<0.001) (Figure 4). No correlation was determined between patient numbers by weeks and PM10, PM2.5, SO2, NO, or CO. (p and r values r=.136 p=.076, r=.047 p=.572, r=-.133 p=.068, r= -.044 p=.549, and r=.040 p= .584, respectively).

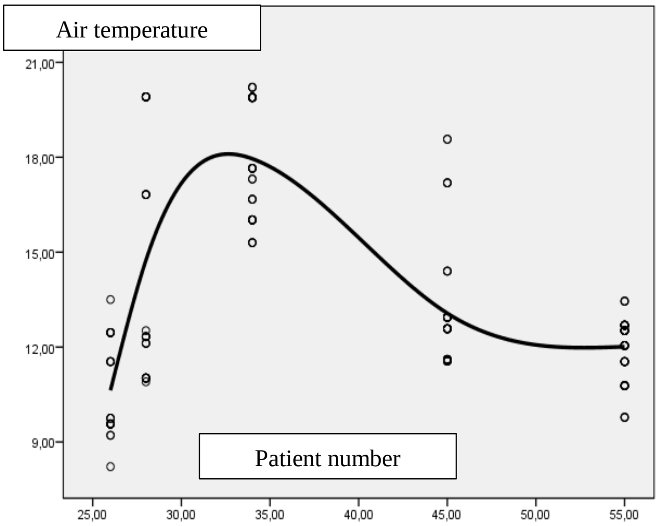

Figure 1. Negative correlation curve between air temperature and COVID-19-positive patient number. Air temperature/patient number (r=-.247, p=.001)

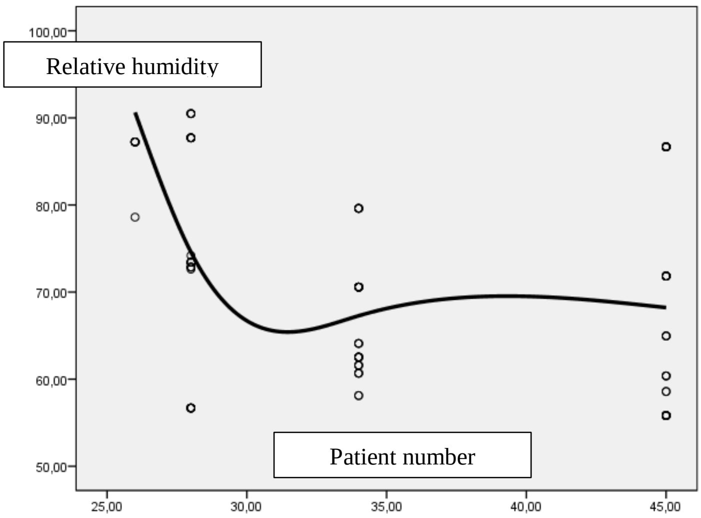

Figure 2. Negative correlation curve between patient number and relative humidity

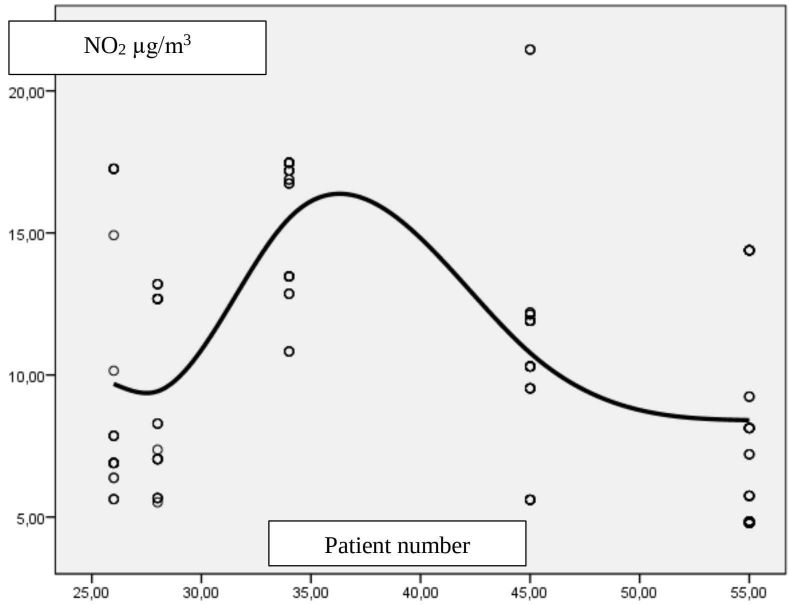

Figure 3. Negative correlation curve between positive patient number and NO2 (r=-.225, p=0.002)

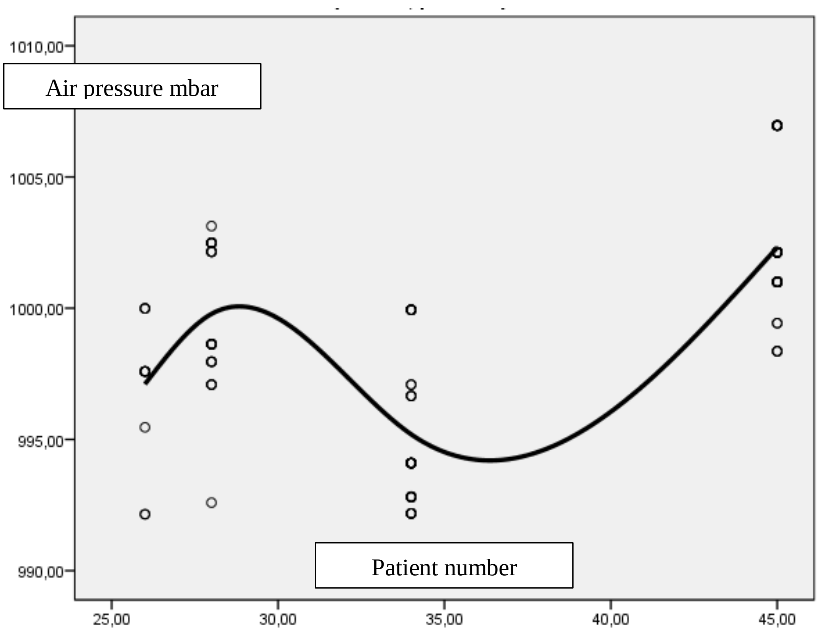

Figure 4. Significant positive correlation curve between positive patient number and air pressure (r=.444, p<0.001)

DISCUSSION

This study investigating the relationship between air quality parameters and COVID-19 case numbers revealed significant negative correlation between positive patient number and air temperature, relative humidity, and NO_2, and significant positive correlation with air pressure, but no correlation with PM_{10}, $PM_{2.5}$, SO_2, NO, or CO.

It is very important to examine the effect of meteorological parameters in outbreaks involving human-to-human transmission. However, the results of studies performed in the field of the COVID-19 pandemic are discrepant. Studies of parameters associated with air pollution have generally involved the effect on COVID-19 infection mortality (11-13). However, mortality outcomes were not evaluated in the present study. In their study of the effect of air pollution of COVID-19 mortality, Xiao Wu et al. (12) reported that a small increase in long-term exposure to $PM_{2.5}$ led to a large increase in the COVID-19 death rate.

Zhu et al. (6) investigated the association between air pollutants and COVID-19 by examining data for 120 cities, and reported significantly positive correlations between $PM_{2.5}$, PM_{10}, CO, NO_2 and O_3 and COVID-19 confirmed cases, while SO_2 exhibited negative correlation with the number of daily confirmed cases. No significant association between PM_{10}, $PM_{2.5}$, SO_2, NO, and CO and case numbers was found in the present study. This may be due to our low case number and to our cases being included only in the Spring, and this is also a limitation of this study.

One study of case numbers and temperature in China reported that every 1 °C increase at a mean temperature of <3 °C led to an increase in case numbers, but that no such relationship was found when the mean temperature exceeded 3 °C (10). Since the increase in case numbers in China was observed in Winter, the inconsistency with our study results is an expected finding. Temperature values in Turkey in March and April were at higher levels.

Chan et al. (2) examined the stability of the SARS CoV virus at different temperatures and relative humidities and reported better stability in a low temperature and low humidity environment.

Oliveiros et al. (14) examined temperature, humidity, rainfall, and wind speed in terms of modulation of the doubling of COVID-19 cases. They reported that the time to doubling was inversely proportional with temperature and humidity. They calculated that these variables explained 18% of the change in the disease doubling time, the remaining 82% possibly being associated with limitation precautions, general health policies, population density, transport, and cultural factors.

One study examining the relationship between weather and COVID-19 in terms of nine cities in Turkey considered the five main factors of temperature, dew point, humidity, wind speed, and population. Similarly to the present study, those authors found a negative correlation between case numbers and temperature, with case numbers rising as temperature decreased (15).

Biqing Chen et al. (16) examined the effect of four meteorological parameters (air temperature, relative humidity, wind speed, and visibility) on COVID-19 infection and reported that the values for the previous 14 days were correlated with case numbers. However, they did not think that changes in a single weather factor such as temperature or humidity could be well linked to case numbers. Based on their study finding, the authors stated that governments could employ these meteorological factors in outbreak control.

The principal limitation of this study is that exposure to air pollution relied on estimation. Home specific exposure assessments could not be performed since exact addresses were unavailable. The monitoring was also limited by the number of observations taken by the National Air Quality Monitoring Network stations.

Despite these limitations, our findings are important as a preliminary study, since interactions between air pollutants and meteorological factors may be involved in the transmission and pathogenesis of COVID-19, and large-scale studies should now be designed for a better understanding of these interactions.

Conflict of Interest: Authors declared no conflict of interest.

REFERENCES

1. Park SE. Epidemiology, virology, and clinical features of severe acute respiratory syndrome - coronavirus-2 (SARS-CoV-2; Coronavirus Disease-19). Clin Exp Pediatr. 2020;63(4):119-24.
2. Chan KH, Peiris JS, Lam SY, Poon LL, Yuen KY, Seto WH. The Effects of Temperature and Relative Humidity on the Viability of the SARS Coronavirus. Adv Virol. 2011; 2011:734690.
3. Becker S, Soukup JM. Exposure to urban air particulates alters the macrophage-mediated inflammatory response to respiratory viral infection. J Toxicol Environ Health Part A. 1999;57:445–57.
4. Cai QC, Lu J, Xu QF, Guo Q, Xu DZ, Sun QW, et al. Influence of meteorological factors and air pollution on the outbreak of severe acute respiratory syndrome. Public Health. 2007;121:258–65.
5. Horne BD, Joy EA, Hofmann MG, Gesteland PH, Cannon J.B., Lefler JS, et al. Short-term elevation of fine particulate matter air pollution and acute lower respiratory infection. Am J Respir Crit Care Med. 2018;198:759–66.
6. Zhu Y, Xie J, Huang F, Cao L. Association between short-term exposure to air pollution and COVID-19 infection: Evidence from China. Sci Total Environ. 2020 Jul 20;727:138704. doi: 10.1016/j.scitotenv.2020.138704. Epub 2020 Apr 15.
7. McIntosh K. Coronavirus disease 2019 (COVID-19): Epidemiology, virology, clinical fea-tures, diagnosis, and prevention. UpToDate. (https://www.uptodate.com/con-tents/coronavirus-disease-2019-covid-19-epidemiology-virology-clinical-features-di-agnosis-and-prevention) (Accessed 10 April 2020).
8. 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. Med Rxiv. 2020 https://doi.org/10.1101/2020.03.16.20037168
9. Casanova LM, Jeon S, Rutala WA, Weber DJ, Sobsey MD. Effects of air temperature and relative humidity on coronavirus survival on surfaces. Applied and Environmental Microbiology. 2010;76(9):2712–7.
10. Xie J, Zhu Y. Association between ambient temperature and COVID-19 infection in 122 cities from China. Sci Total Environ. 2020;724:138201. doi:10.1016/j.scitotenv.2020.138201
11. Ogen Y. Assessing nitrogen dioxide (NO2) levels as a contributing factor to coronavirus (COVID-19) fatality. Sci Total Environ. 2020;726:138605. doi:10.1016/j.scitotenv.2020.138605

12. Wu X, Nethery RC, Sabath BM, Braun D, Dominici F. Exposure to air pollution and COVID-19 mortality in the United States: A nationwide cross-sectional study. Preprint. medRxiv. 2020;2020.04.05.20054502. Published 2020 Apr 7. doi:10.1101/2020.04.05.20054502
13. Sharma AK, Balyan P. Air pollution and COVID-19: Is the connect worth its weight?. Indian J Public Health. 2020;64(Supplement):S132-S134. doi:10.4103/ijph.IJPH_466_20
14. Oliveiros B, Caramelo L, Ferreira NC, Caramelo F. Role of temperature and humidity in the modulation of the doubling time of COVID-19 cases. doi: https://doi.org/10.1101/2020.03.05.20031872
15. Şahin M. Impact of weather on COVID-19 pandemic in Turkey. Sci Total Environ. 2020;728:138810. doi: 10.1016/j.scitotenv.2020.138810.
16. 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. https://doi.org/10.1101/2020.03.16.20037168.