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The Effect of Weather Conditions and Some Demographic Data on the Confirmed COVID-19 Cases: Analysis for 12 Statistical Regions of Turkey

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Abstract

COVID-19 has been affecting the world since the beginning of 2020. Although current evidence indicates that the virus spreads through contaminated objects or close contact with infected individuals, there is limited research on under what conditions the virus spreads faster. This study is conducted to reveal the relationship between COVID-19 cases and meteorological conditions and also some demographic characteristics. For this goal, real-feel air temperature, humidity, and wind speed; analyzed as meteorological parameters. The number of individuals over the age of 65, the education level of the individuals, and the population density are also considered as demographical parameters. The analyses are conducted based on Spearman's correlation coefficients. The results proved that the positive correlation was calculated for real-feel air temperature, wind speed, population density, and the number of individuals over 65, whereas negatively correlated with humidity.

Keywords: COVID-19, Coronavirus, Real-feel temperature, Wind speed, Humidity, Age, Population density

Hava Koşullarının ve Bazı Demografik Özelliklerin Doğrulanmış COVID-19 Vakaları Üzerine Etkisi: Türkiye'nin 12 İstatistik Bölgesi Analizi

Öz

COVID-19, 2020'nin başından beri tüm dünyayı etkilemektedir. Mevcut kanıtlar, virüsün kontamine nesneler veya enfekte kişilerle yakın temas yoluyla yayıldığını gösterse de, virüsün hangi koşullar altında daha hızlı yayıldığına dair sınırlı araştırma vardır. Bu çalışma, COVID-19 vakaları ile meteorolojik koşullar arasındaki ilişkiyi ve bazı demografik özellikleri ortaya çıkarmak için yapılmıştır. Bu amaçla, gerçek hava sıcaklığı, nem, rüzgâr hızı gibi meteorolojik parametreler ve nüfustaki 65 yaş üstü birey sayısı, bireylerin eğitim düzeyi, nüfus yoğunluğu gibi demografik özeliklerle COVID-19 vakaları arasındaki ilişki analiz edilmiştir. Analizler, Spearman'ın korelasyon katsayılarına göre yapılmıştır. Sonuç olarak, gerçek hissedilen hava sıcaklığı, rüzgar hızı, nüfus yoğunluğu ve 65 yaş üstü birey sayısı ile COVID-19 vakaları arasında pozitif korelasyon, hava nem ile negatif korelasyon tespit edilmiştir.

Anahtar Kelimeler: COVID-19, Koronavirüs, Hissedilen hava sıcaklığı, Rüzgar hızı, Nem, Yaş, Nüfus yoğunluğu

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1. INTRODUCTION

Coronavirus disease (COVID-19) causes by a family of viruses called Coronaviridae and has been causing the infection for more than 50 years [1]. The official first cases of COVID-19 were reported in Wuhan, China in December 2019 [2]. The World Health Organization (WHO) has anounced COVID-19 disease as pandemic on March 11, 2020. As of November 23, 2020, more than 59 million cases have been reported across the world, resulting in more than 1.3 million deaths [3].

The symptoms of COVID-19 are fever, headache, hacking cough, respiratory failure, loss of smell, rash on the skin or discoloration of the fingers or toes, diarrhea, tiredness and sometimes cases are entirely asymptomatic [4]. The first COVID-19 case in Turkey was declared on March 10, 2020, by the Ministry of Health of Turkey. According to many studies, COVID-19 spreads from an infected person to a healthy person direct, indirect, or close contact via droplets [5]. After the first case of Turkey, in order to reduce the rate of transmission of the COVID-19, the government has started to take measures. For instance, people were not allowed to travel to metropolitan cities. Educational institutions, restaurants, cafes, bars, mosques, churches were closed to provide "social distance" in Turkey like many other countries. Prediction of the trend of COVID-19 cases is vital for government measures policy. Person mobility, human-to-human contact rates can affect confirmed case number. Meteorological factors also affect COVID-19 confirmed cases because of the time of survival of viruses changes in different weather conditions.

Previous papers showed that meteorological factors can be impact the number of cases number in infectious diseases such as influenza which, spread with droplets. Nevertheless, only a few studies have discussed the correlation between daily weather conditions and confirmed COVID-19 cases. A positive correlation was found between daily weather temperature range and deaths from COVID-19 [6]. In another paper, using the Loess regression model, a high correlation was found between meteorological conditions and daily COVID-19 epidemic situations. In that research, COVID-19 cases reach the peak points when relative humidity is 64.6% or weather temperature is 8.07 °C, or wind speed is 16.1 miles per hour [7]. In other work, while a positive correlation between daily deaths of COVID-19 and daily temperature range was found, a negative correlation between absolute humidity was found [6]. Mandal and Panwar used univariate analysis to find the relationship between environmental temperature and COVID-19 cases and discovered a negative correlation [8]. Ma and friends explored positive correlation with COVID-19 daily deaths for diurnal temperature range and negative correlation with relative humidity [9]. In another paper, using a generalized additive model, a positive nonlinear relationship was found between mean weather temperature and COVID-19 confirmed cases [10]. In a study conducted in Turkey, the relationship between weather and the number of cases recorded in 9 cities was examined using Spearman's correlation coefficient. Temperature, dew point, humidity and wind speed were used as weather parameters [11]. In Sahin's paper, highly positive correlations were found between cities' population and wind speed.

The main differences from this study, our study takes into account all of Turkey based on statistical regions. In addition to meteorological parameters; demographic parameters, such as the number of people per square kilometer (population density), the number of individuals over 65, and the education level are utilized also in our analysis.

2. MATERIAL AND METHODS

2.1. Study Area

Turkey Nomenclature of Territorial Units for Statistics, used by the European Union Statistical Regional Units of Turkey is the classification. This paper collected the daily confirmed cases in 12 statistical regions of Turkey and real-feel air temperature, wind speed, and humidity of 81 cities to analyze the relationship.

Figure 1 shows the 12 statistical regions in Turkey. Turkey is administratively divided into 81 provinces. This regional distinction has become a frequently used variable in examining the demographic, social, cultural, and economic differences between different country regions.

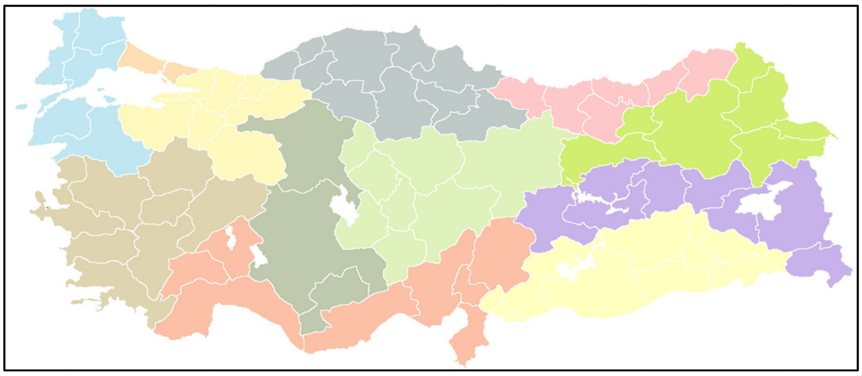

Figure 1. Statistical regions of Turkey

The Ministry of Health announced the daily number of cases for 12 regions of Turkey between July 01 and July 14, 2020. The COVID-19 confirmed cases highly variant for each region were collected throughout time from July 01 to July 14, 2020. In our study, 81 cities covered the Republic of Turkey. Real-feel air temperature, wind speed, and humidity were obtained by calculating the mean of every 3 hours for every day for each of 81 cities from website public.wmo.int. After that, 81 cities were grouped to their statistical region and finally obtained real-feel air temperature, wind speed, and humidity values were obtained by calculating each statistical region's average

2.2. The Data

The data of COVID-19 confirmed cases of 12 statistical regions of Turkey were collected from the official website of the Ministry of Health of the Republic of Turkey. Figure 2 shows the number of daily cases in 12 statistical regions of the first 14 days of July 2020. The highest confirmed cases are observed in Southeastern Anatolia.

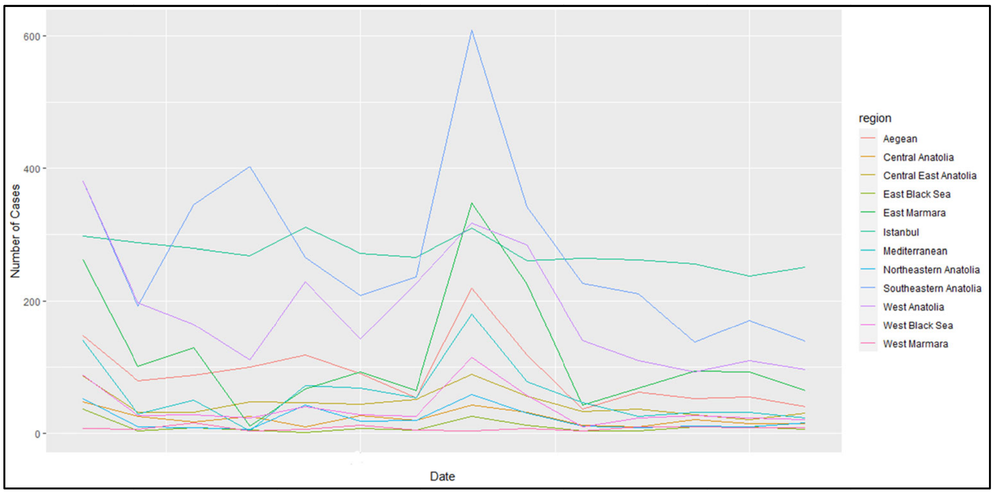

Figure 2. Daily cases in 12 statistical regions for 14 days

Table 1 shows the cumulative confirmed cases in 12 statistical regions. As seen in Table 1, the majority of the confirmed cases are located in Southeastern Anatolia.

Table 1. Total confirmed cases in 12 statistical regions in 14 days

Region	Total Cases
Southeastern Anatolia	3864
Northeastern Anatolia	297
Central East Anatolia	578
Central Anatolia	422
West Anatolia	2267
West Marmara	106
East Marmara	1342
East Black Sea	153
West Black Sea	407
Aegean	972
Mediterranean	826
Istanbul	3824

The reel-feel air temperature, humidity (%) and wind speed (km/h) were collected from https://www.worldweatheronline.com. Figure 3 shows the real-feel air temperature in 12 statistical regions in Turkey for the first 14 days in July 2020.

As seen, almost every day, the highest real-feel temperature is in the Southeastern Anatolia region. Figure 4 shows the humidity (%) for each day in 12 statistical regions. When relative humidity is between 30%-50, people feel comfortable. As seen in Figure 4, almost every region every day, the humidity is above the comfortable level 30%.

Figure 5 illustrates the change of wind speed (km/h) daily in the 12 statistical regions. The highest wind-speed (30.3 km/h) was observed in Istanbul on July 08.

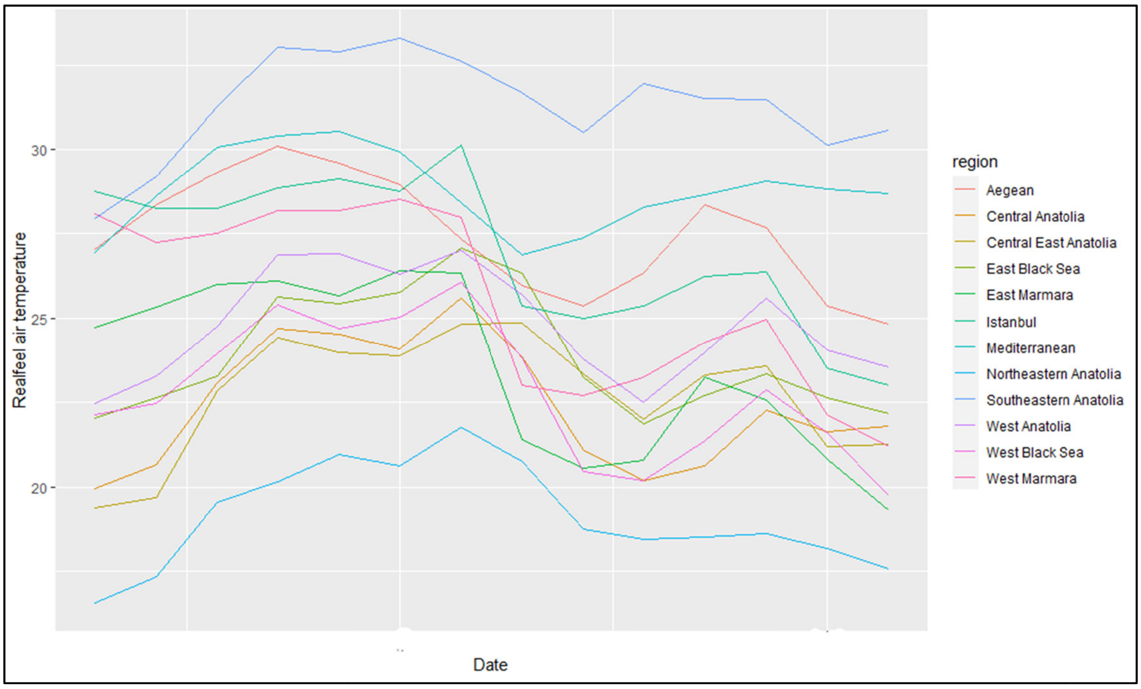

Figure 3. Real-feel air temperature in 12 statistical regions for 14 days

Additionally; data about education level, population density and population above 65 ages were obtained on http://www.turkstat.gov.tr/. Education level was calculated for the population graduating from high school and above.

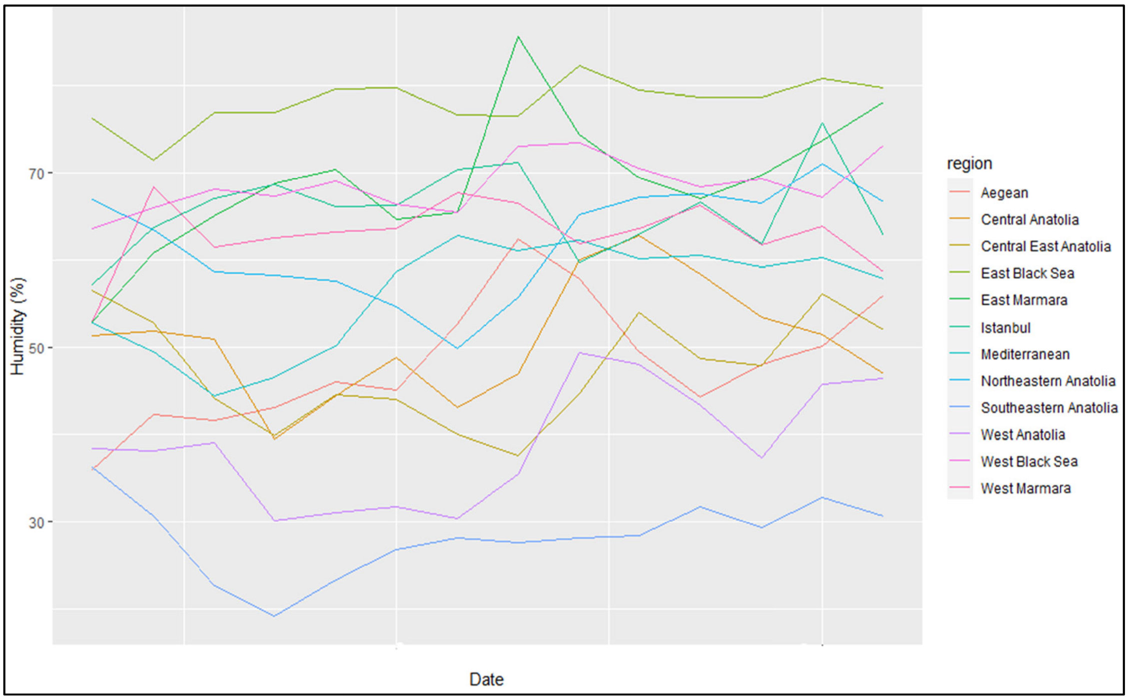

Figure 4. Humidity in 12 statistical regions for 14 days

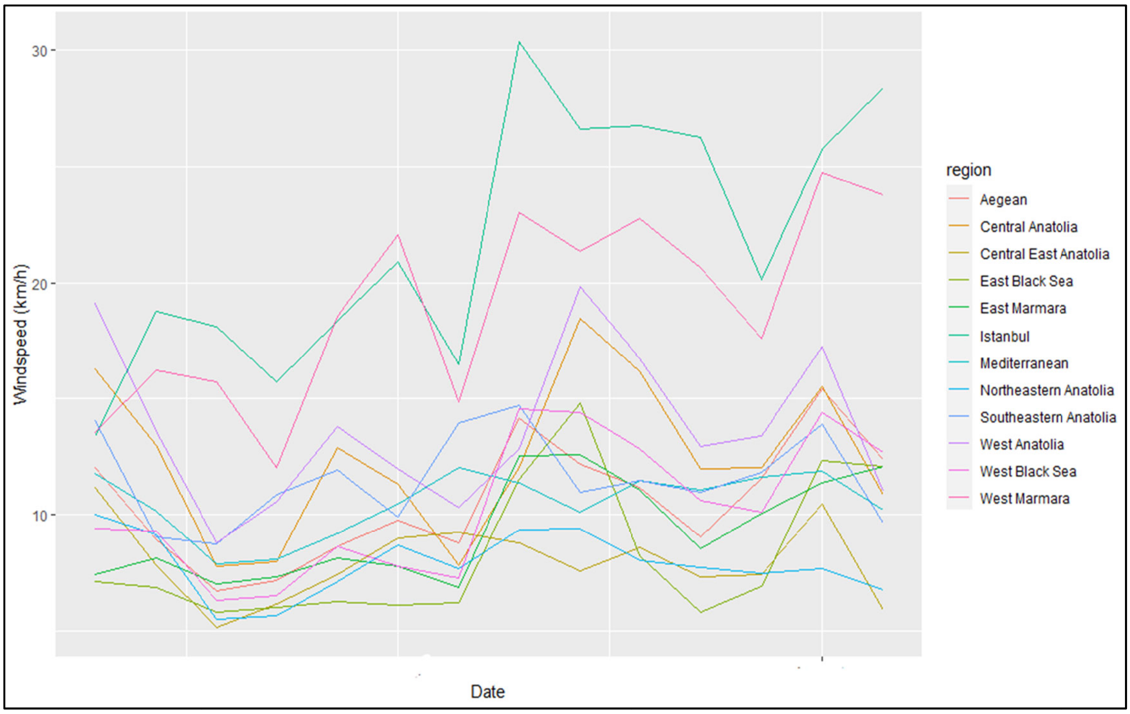

Figure 5. Wind-speed in 12 statistical regions for 14 days

In Table 2, the population density of the 12 statistical regions, the percentage of individuals with high school and above education, and the number of individuals over 65, are given. While the region with the highest number of individuals over the age of 65 is the Aegean region, the region with the least; Northeastern is the Anatolia region. Education level is below 50% in all regions. The highest education level is in West Anatolia, 47.46%, and the lowest education level is in Southeastern Anatolia, 32.14%. The region with the highest population density value, defined as the number of individuals per square kilometer, is Istanbul, 2987 individuals per square kilometer. The region closest to Istanbul in terms of population density is East Marmara, 167 individuals per square kilometer. The large difference in population density between Istanbul and all other regions shows how the population is unevenly distributed in the country.

Table 2. Descriptive statistics for 12 statistical regions in Turkey

Region	Population density	Education level (%)	65+
Southeastern Anatolia	119	32.14	449255
Northeastern Anatolia	31	35.1	178600
Central East Anatolia	51	36.98	265470
Central Anatolia	45	39.13	433541
West Anatolia	112	47.46	725742
West Marmara	84	40.97	469045
East Marmara	167	44.2	765160
East Black Sea	76	41.05	370614
West Black Sea	64	36.56	645589
Aegean	119	41.29	1242292
Mediterranean	120	40.49	926223
Istanbul	2987	45.89	1079196

2.3. Correlation Test

Collected data in this study are not distributed normally according to the Shapiro-Wilk normality test. So, the Spearman correlation test is appropriate to use. Spearman's rank correlation coefficient, or Spearman's rho (ρ), is named after the American statistician Charles Spearman who first introduced this statistical method [12]. Spearman's rank correlation coefficient (ρ) is a particular case of Pearson's correlation coefficient. The sample data is arranged in order of the two variables to calculate the ρ value ass seen Equation 1. If there is no tie between the sequence numbers, the following formula is used to find the ρ value. d_i represents the difference between sequence numbers, whereas n total number of observations in a bivariate sample.

$$\rho=1-\frac{6\sum d_i^2}{n^3-n} \qquad (1)$$

The correlation coefficient can take values between -1 and +1. -1 indicates perfect negative correlation, 0 indicates no association, and +1 indicates perfect positive correlation. In this paper, all analyses were conducted using R software. The statistical tests were two-sided, and $p < 0.05$ was considered statistically significant.

3. RESULTS AND DISCUSSION

Figure 6 shows the Spearman correlation coefficient matrix among the collected data. When we examine the meteorological data, the only real-feel temperature had significantly negative correlations with humidity (ρ= -0.41, p<0.05).

In the earlier study about the SARS-CoV virus family, at temperatures of 22–25 °C and relative humidity of 40%–50%, dried SARS-CoV could survive for over five days. However, the viability of the virus reduced rapidly when the temperature or relative humidity increased [13]. Also, cold weather suppresses people's immune systems. Thus, people may be more vulnerable to the virus. Figure 6 suggested that the relationship between real-feel temperature and confirmed cases was a significantly positive correlation (ρ=0.42, p<0.05). That means, as real-feel temperature highs, the confirmed cases of COVID-19 increases.

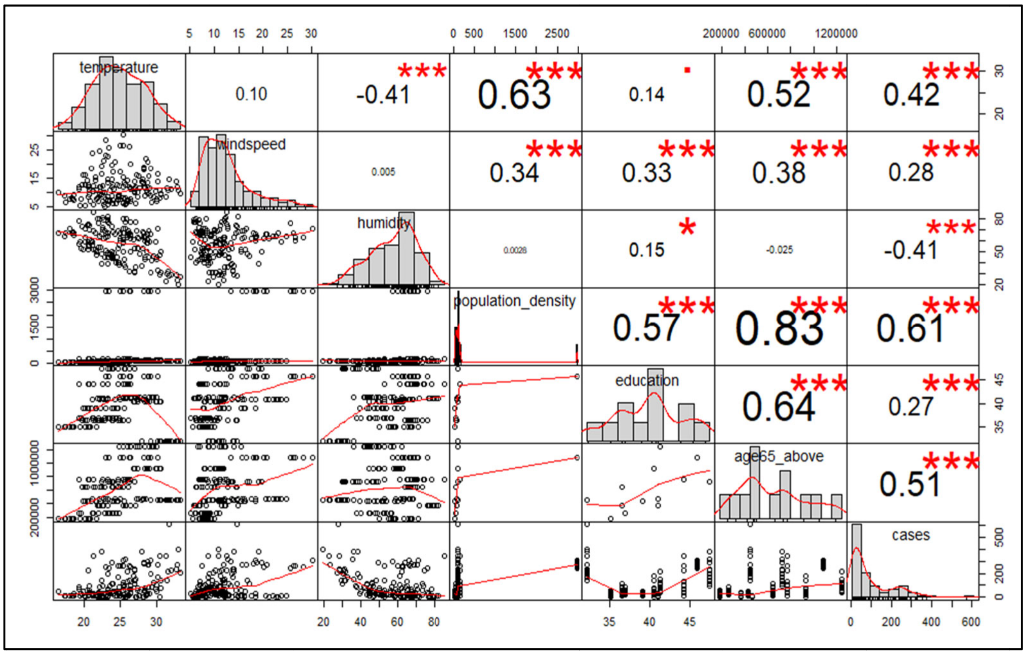

Figure 6. Spearman correlation chart

Furthermore, low humidity reduces the ability to secrete mucus, so hosts the virus easily in human mucus [14]. So, low humidity and low temperatures are perfect environments for viruses to spread. According to Spearman's rank correlation, the relationship was a highly negative correlation between the humidity and confirmed cases, as expected (ρ=-0.41, $p<0.05$). Lastly, according to meteorological data and confirmed cases, the relationship between wind speed and confirmed cases was a positive correlation but not reliable as between real-feel temperature and confirmed COVID-19 cases (ρ=0.28, $p<0.05$).

Hygiene practices, population density, ethnicities, age, or living style may also affect COVID-19 spread [15]. We also try to detect the relationship between some demographical factors and COVID-19 confirmed cases. The expected situation is that the number of cases will decrease as the education level increases.

Based on Spearman's rank correlation coefficient, the highest correlation is between confirmed cases and the statistical region's population density, as expected (ρ=0.61, $p<0.05$). Also, as clearly seen, a positive relationship was also found between the population of people over the age of 65 and the confirmed COVID-19 cases (ρ=0.51, $p<0.05$). It was expected that there would be a negative correlation between the education level and the confirmed cases, but a positive correlation was found as a result (ρ=0.27, $p<0.05$).

This plot study proposes that high real-feel temperature, wind speed, population density, and the population of people over the age of 65 may increase confirmed COVID-19 cases. Real-feel air temperature and wind speed were both positively related to the daily confirmed COVID-19 cases. Population density and the number of individuals over the age of 65 have high impacts on COVID-19 confirmed cases. To the best of our knowledge, this is the limited study to investigate the correlation between weather conditions, demographic data, and confirmed COVID-19 cases. There are no proven studies for the relationship between weather conditions and confirmed COVID-19 cases, despite the belief that warm weather prevents the spread of the virus in studies conducted on previous coronavirus forms. Our findings showed up that temperature and wind speed are positively correlated with daily confirmed COVID-19 cases according to 12 statistical region data for 14 days.

However, this study has been carried out with minimal data and time. Fourteen days may not be enough to observe this relationship. Long-term data can be analyzed in future studies. Weather conditions cannot be the only factor in COVID-19 spread. With more data, we can observe seasonal changes and preexisting health issues of people in future work.

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