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The Possible Relationship between the Atmospheric Electric Field and High Energy Charged Particles and the COVID-19 Cases in the Central Arabian Peninsula

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Abstract

Background: Since the beginning of the global COVID-19 pandemic, several studies have been carried out to investigate its spread, with a wide range of factors to understand the influence of the factors that contribute to its spread and to reduce the ongoing threat of COVID-19 pandemic. **Methods:** In this study, the relationships between the Earth's electric field and cosmic ray charged particles of different energy ranges and the daily confirmed COVID-19 infections in Riyadh, Saudi Arabia have been investigated using non-parametric statistical tests. The data covered the period between 3 April 2020 and 1st August 2021 and were obtained from the King Abdulaziz City for Science and Technology (KACST) CARPET detector, Riyadh, Saudi Arabia. The electric fields data were obtained from electric field monitor (EFM) deployed on the rooftop of the KACST laboratory. The data of the daily COVID-19 cases were obtained from the official webpage of the Saudi Arabian Ministry of Health (MOH). **Results:** The results revealed that that the number of COVID-19 cases is correlated with cosmic ray charged particles and anti-correlated with the Earth's electric field. **Conclusion:** While the exact mechanism explaining the influence of Earth's electric field and cosmic rays variations on the reported number of COVID-19 cases is not yet established, the results presented in this study can add additional knowledge to our understanding of the effects of additional factors on influenza activities.

Keywords

Infectious Diseases, Electric Field, Charged Particles, COVID-19

1. Introduction

On 31 December 2019, the Chinese government uncovered a scene of a COVID disease (COVID-19) in Wuhan, which was quickly spread from there into all provinces of China and then to the whole world. The current COVID-19 pandemic, the largest the world is facing in more than a century, is considered one of the most significant threats since World War II [1].

Immediately after the spread of COVID-19 from Wuhan, several research studies have been conducted to investigate the factors that caused the spread of the virus and to understand its nature and transmissibility. These include individual, social, economic and immunological factors, environmental influences such as meteorological factors, increased human interactions with animals, and poverty (e.g., [2]-[9]). Terrestrial and extraterrestrial factors such as the weather variations, environmental conditions, fluctuation of the Earth's magnetic field (earth-ionosphere cavity/Schumann resonances), geomagnetic activity, variation of cosmic ray intensity, and electromagnetic changes contribute to the appearance, severity, and spread of infectious disease outbreaks (e.g., [10] and references therein). These factors somehow play direct or indirect roles in influencing the nature of the virus, acquired hosts, virus-host interactions, and infectious diseases viruses' stability and transmissibility (e.g., [11]-[20]). While the exact mechanism explaining this relationship is unclear, several pieces of research have shown that solar variations and subsequent effects on the interplanetary space and Earth's atmosphere may affect the spread and outbreak of infectious diseases through its influence on the environment or through its direct effect on the human body [18]-[26].

Despite extensive scientific research, the relative influence and multiple risks these factors affect on infectious diseases remain poorly defined and unpredictable, particularly with the increasing frequency of infectious disease outbreaks.

Hence, extensive research is needed to understand the interaction between these factors before relying on any early warning system to assess the risk factors of the disease.

To the best knowledge of the authors, there is no study that examines the relationship between the Earth's electric field and cosmic ray charged particles and the spread of COVID-19. Therefore, this paper aims to investigate the possible influences of the variations of the Earth's electric field and cosmic rays on the COVID-19 cases.

2. Material and Method

2.1. Data

The data used in this study cover the period from April 3rd, 2020 to 1st August, 2021 and comprise a number of the confirmed COVID-19 cases, electric field, and cosmic rays (CR) observations.

The data of COVID-19 cases were taken from reports on the official website of the Saudi Ministry of Health.

Pressure-corrected CR observations for charged particles with different energies were obtained from the KACST CARPET detector installed at the KACST detector lab building (latitude: 24˚43'; longitude: 46˚40'; altitude: 613 m; vertical cut-off, Rc = 14.4 GV), Riyadh, Saudi Arabia.

The CARPET detector [27] [28] consists of 120 Geiger counters (type STS-6) located on a platform of ~1.5 × 1.5 m. The 120 counters were divided into groups of 60 upper and 60 lower, separated by an aluminum absorber with a thickness of 7 mm. The detector records data from three channels with a time resolution of 1 ms, (Up, Down, and Telescope or Tel). The lower and upper layers are both sensitive to electrons and positrons with energies higher than 200 keV, to protons with energies above 5 MeV, and to muons with energies higher than 1.5 MeV. However, the telescope channel (channel that registers the total number of particles that simultaneously cross the Up and Down layers) detects electrons with energies greater than 5 MeV, protons with energies greater than 30 MeV, and muons with energies greater than 20 MeV [27 and references therein]. An interface unit was developed for logging and storing the data at a resolution of 1 ms.

The daily average data of the electric field for the considered period were collected using an electric field mill EFM 100 (EFM), deployed on the rooftop of the KACST laboratory at Riyadh. The sensor had a time resolution of ~0.1 s.

2.2. Statistical Tests

In this study, the relationships between the variables were examined according to the Spearman rank correlation test and Kendall rank correlation test. Factors were considered to affect COVID-19 if significant differences were observed in both statistical tests (e.g., [7] [8]).

The Spearman's rank correlation coefficient is the nonparametric version of the Pearson product-moment and is used to examine the strength of the association between two variables (monotonic relationship). The formula for the Spearman rank correlation test is as follows:

$$\rho = 1 - 6 \times \frac{\sum d_i^2}{n\left(n^2 - 1\right)}$$

ρ is the Spearman rank correlation coefficient, d_i is the difference between the ranks of corresponding values x_i and y_i, and n is the number of x and y pairs.

Kendall rank correlation, another non-parametric test, was used to assess statistical associations based on the ranks of the data and can be estimated as follows:

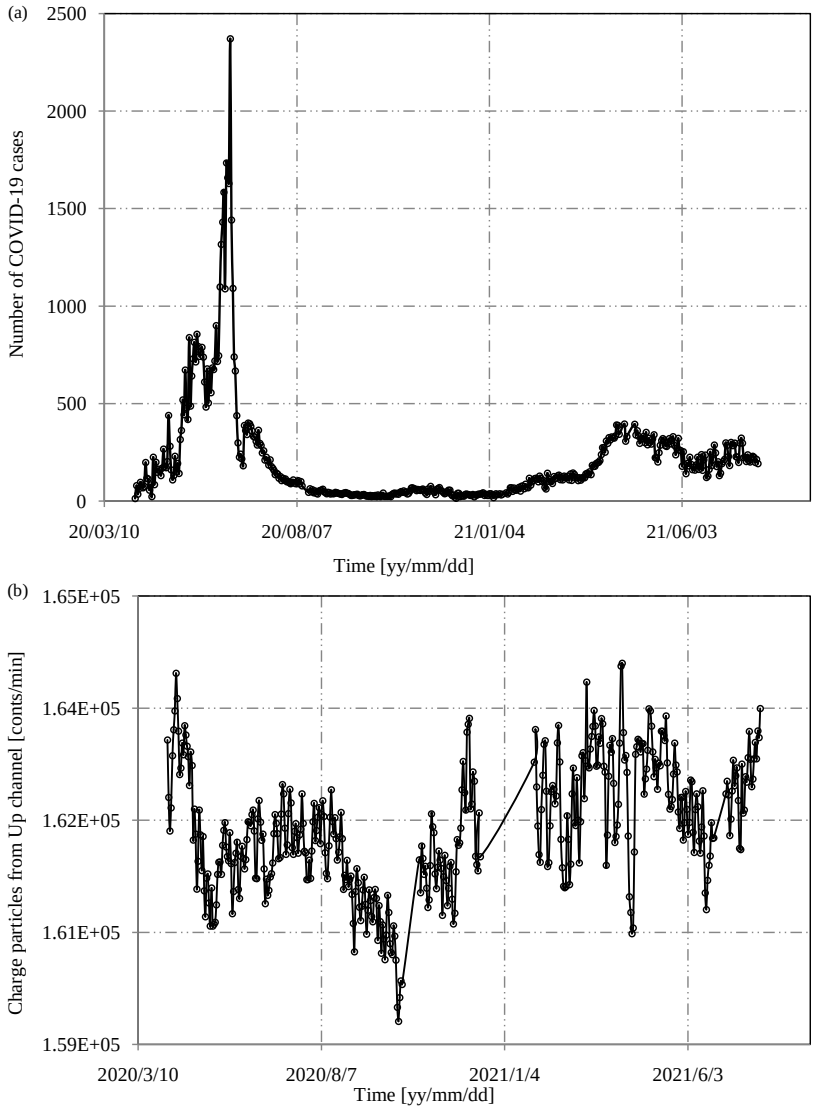
$$\tau = \frac{n_c - n_d}{\frac{1}{2}n\left(n-1\right)}$$

τ is the Kendall rank correlation coefficient, n_c and n_d represent the number of concordant and discordant pairs, respectively. The n represents the number of pairs.

3. Results

Since the first confirmed case of COVID-19 in Saudi Arabia on 2 March 2020, a total of 542,000 confirmed cases have been reported as of August 20, 2021. During our study period from 3rd April 2021 to 1st August 2021, a total of 103,729 confirmed locally-transmitted COVID-19 cases were identified in Riyadh. Figure 1 shows the daily mean values of the confirmed COVID-19 cases and the variables considered in this study.

During the study period, the mean number of COVID-19 confirmed cases was 207.54 ± 256.38, with a maximum of 2371 and a minimum of 13. The time series of the reported cases between 3rd April 2020 and 10th August 2020 is characterized by great variations in the number of the reported COVID-19 cases. The number of cases during this period increased rapidly and reached a maximum of 2317 cases. The period between 10th August 2020 and 3rd February 2021 is featured by small variations in the number of cases. The mean number of the reported cases during this period was 42 with a minimum of 14 and a maximum



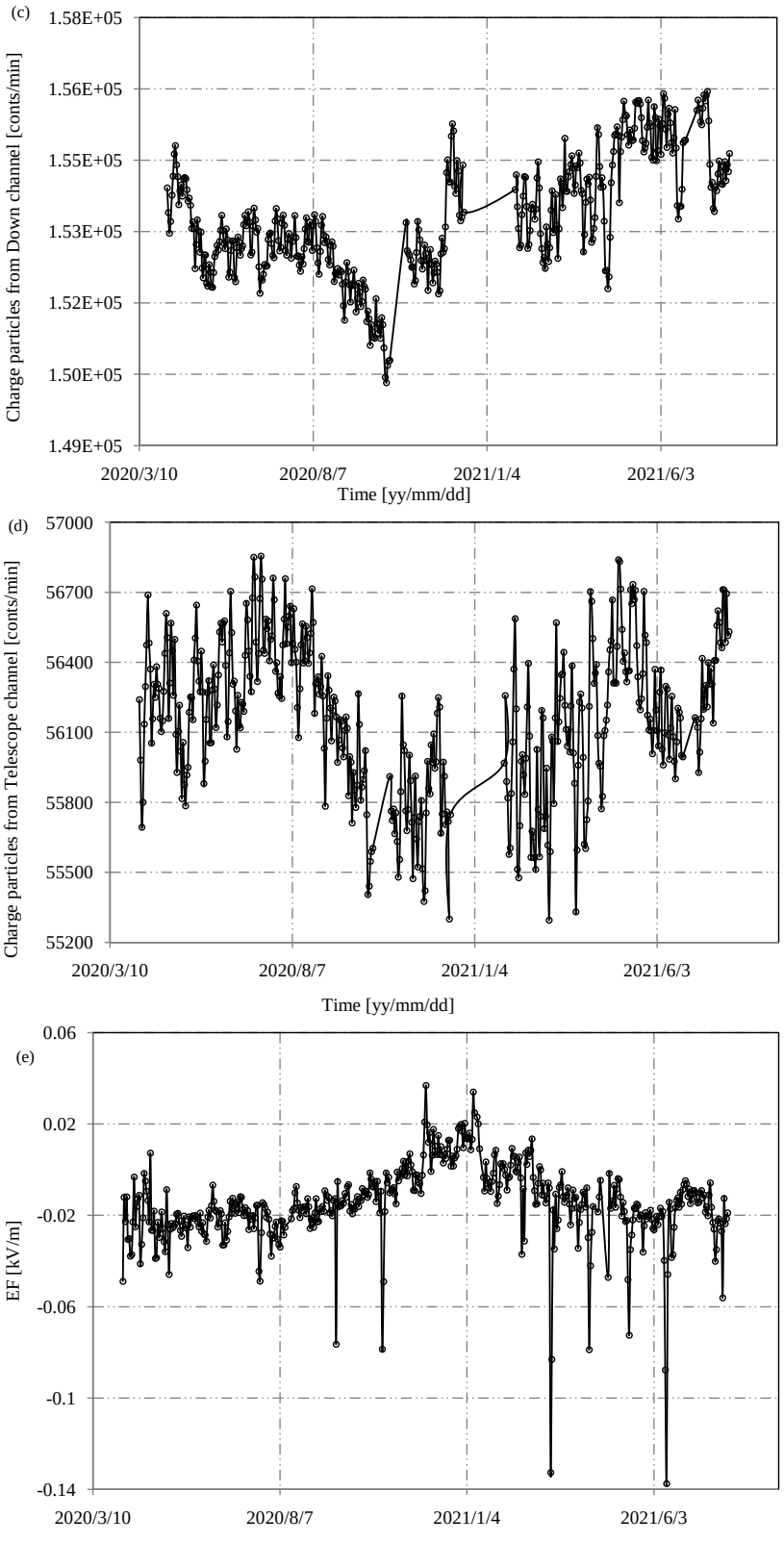


Figure 1. The time series of the daily values of (a) the number of cases of COVID-19; (b) CR charged particles from Up channel; (c) CR charged particles from the down channel; (d) CR charged particles from Telescope channel; and (e) Electric field (EF); in Riyadh during the study period.

of 78 cases. From 3rd February 2021, the number of the reported cases increased slightly until 18th March 2021, during which the number of cases increased dramatically afterward to reach a maximum of about 400 cases on 14th April 2021. For the next two months, the number of cases decreased slightly to reach a mean of about 220 cases and remained around this number for the rest of the period.

The CR data from the three channels follow a cyclic pattern with their maximum around summer and minimum in winter. The Earth's electric field, on the other hand, showed the opposite pattern of variations during the considered period.

Table 1 summarizes the results of the Kendall and Spearman correlation tests on the association of daily COVID-19 cases and the considered variables in Riyadh from 1st April 2020 to 1st 2021. The results showed that the considered variables have a significant relationship with the number of the reported cases of COVID-19, with a confidence level of 99 %. The electric field has a positive correlation with the COVID-19 cases, whereas the cosmic rays showed the opposite. However, the magnitude and type of the association were different from one variable to another.

The Kendall and Spearman correlation coefficients between the EF and the number of cases were −0.315 and −0.470, respectively.

On the other hand, the Kendall correlation coefficients between the number of COVID-19 cases and low energy cosmic rays recorded by Down and Up channels and high energy particles recorded by the telescope channel were 0.192, 0.261, and 0.273, respectively. The Spearman coefficient between the numbers of the COVID-19 cases was 0.272 with the Up channel, 0.354 with the Down channel, and 0.406 with the telescope channel.

4. Discussions and Conclusions

Non-parametric analyses found in this study indicate that the number of COVID-19 cases is affected by variations of the cosmic ray charged particles. On the other hand, the Earth's electric field is anti-correlated with the number of COVID-19 cases.

A challenge in the association between the COVID-19 cases and the considered variables is explaining the exact mechanisms by which the variations in these variables contribute to the number of COVID-19 cases. While several possible mechanisms can be proposed to explain this connection, extensive research is needed to justify the reality of such a relationship.

Table 1. Summary of the nonlinear correlation results between COVID-19 and the considered parameters (3 April 2020-August 1 2021; N = 484) in Riyadh.

Test	EF	UP	Down	Telescope
Kendall τ	−0.315**	0.192**	0.261**	0.273**
Sig. (2 tailed)	0.000	0.000	0.000	0.000
Spearman ρ	−0.470**	0.272**	0.354**	0.406**
Sig. (2 tailed)	0.000	0.000	0.000	0.000

The Earth's electric fields, either of global and/or local components, are related to ionospheric-magnetospheric interactions, solar radiation, cosmic ray ionization, aerosol concentrations, and meteorological conditions. Life on Earth exists under the constant presence of extra-low frequency (ELF) electromagnetic fields and cosmic rays. As such, we cannot exclude the variations on these variables from playing a direct or indirect role in the evolution of biological organisms, and their potential effect on the function of the living organism at a cellular level to a greater or lesser degree cannot be omitted from considerations (e.g., [23] [24] [25]). The variations of the Earth's electric field and cosmic rays' intensities may also have an influence on the genetic mutation of some infectious diseases such as influenza viruses, including COVID-19 [29]-[37]. While the infected cases of COVID-19 might have been impacted by several additional factors, such as social behaviors, immunology, epidemiology, and meteorological factors (e.g., 10 and references therein; [36] [37]), our findings can be useful for the development of influenza surveillance and early warning systems and important for future epidemiological investigations.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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