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## Effect of temperature and humidity on coronavirus infection in Pakistan

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### ARTICLE INFO

#### Keywords:

COVID-19

SARS

Virus

Pandemic

Pakistan

### ABSTRACT

Ongoing Coronavirus epidemic (COVID-19) identified first in Wuhan, China posed huge impact on public health and economy around the globe. Both cough and sneeze based droplets or aerosols encapsulated COVID-19 particles are responsible for airborne transmission of this virus and caused an unexpected escalation and high mortality worldwide. Current study intends to investigate the correlation of COVID-19 epidemic with meteorological parameters, particularly temperature and humidity. A data set of Epidemiological data of COVID-19 for highly infected provinces of Pakistan was collected from the official website of (<https://www.covid.gov.pk/>) and weather data was collected from (<https://www.timeanddate.com/>) during the time period of 1st March to 30th September 2020. The GrapPad prism 5 Software was used to calculate the mean and standard error of mean (SEM). In the current study the incident of daily covid cases is recorded higher in the month of June while the less number of case were reported in the month of May as compared to the other months (April, May, June, July, September and August) in the four province of Pakistan. We also find out that the incident of Covid19 were high at higher temperature (like the average temperature in the month of June 37 °C) while less cases were reported in May the average temperature was 29.5 °C. Furthermore the incident of covid cases were less reported at low humidity while more intendant with high humidity. Pearson's (r) determine the strength of the relationship between the variables. Pearson's correlation coefficient test employed for data analysis revealed that temperature average (TA) and average humidity is not a significant correlated with COVID-19 pandemic. The results obtained from the current analysis for selected parameters indirect correlation of COVID-19 transmission with temperature variation, and humidity. In the present study association of parameters is not correlated with COVID-19 pandemic, suggested need of more strict actions and control measures for highly populated cities. These findings will be helpful for health regulatory authorities and policy makers to take specific measures to combat COVID-19 epidemic in Pakistan.

### 1. Introduction

The World Health Organization (WHO) declared SARS- CoV-2 a pandemic on 11th March 2020 and as at the 7th August 2020, there have been over 18.8 million confirmed cases with more than 708,000 reported deaths from SARS-CoV-2 [Coronavirus disease (COVID-19) pandemic, n.d.]. Recently the coronavirus was isolated from Wuhan city, China in December 2019, but some other study also reported in

Barcelona during March 2019 (Nikolaenko, 2020). The histories and information gathered from the early patients traced this virus back (and even linked in some ways) to the Wuhan local animal (seafood) market, suggesting a direct food-based spread to human (P. Wu et al., 2020). These observations suggest that animals are the likely origin of this novel coronavirus. For the first time in 2019 the World Health Organization (WHO) named to this disease as coronavirus disease (COVID-19), while unwerd in 20202 the International Committee on Taxonomy of

*Abbreviations:* COVID-19, Coronavirus Disease 2019; SARS, Severe acute respiratory syndrome; SEM, Standard error of mean; TA, Temperature average; WHO, World Health Organization.

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<https://doi.org/10.1016/j.genrep.2021.101441>

Received 7 June 2021; Received in revised form 15 September 2021; Accepted 13 November 2021

Available online 20 November 2021

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Viruses (ICTV) named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (Hsu et al., 2020; Nazir et al., 2021). The genetic similarities shown 88% homology with bat-derived SARS-CoV and about 50% to the genome is matched with MERS-Cov (Rothan and Byrareddy, 2020). The transmission of SARS-CoV-2 appears to be primarily via aerosols [Stadnytskyi et al., 2020; Zhang et al., 2020] and recent studies have shown that SARS-CoV-2 is able to remain infectious in airborne particles for greater than 3 h [van Doremalen et al., 2020; Smither et al., 2020]. The role of fomites in the current pandemic is yet to be fully determined, although they have been suggested as a potential mode of transmission [Cai et al., 2020] also reflected by the strong focus on hand-washing by WHO and national control schemes. Broadly, viruses have been shown to be readily transferred between contaminated skin and a fomite surface, with high contact surfaces such as touch screens on mobile phones, bank ATMs, airport check-in kiosks and supermarket self-serve kiosks all acting as fomites for the transmission of viruses (Julian et al., 2010). Fomite transmission has previously been shown to be a highly efficient procedure, with transmission efficiencies of 33% for both fomites to hand and fingertip to mouth transfer for bacteria and phages [Rusin et al., 2002]. With the high efficiency of fomite transfer, the persistence of SARS-CoV-2 on environmental surfaces is therefore a critical factor when considering the potential for fomite transmission for this virus. Currently, there are conflicting reports on the survivability of SARS-CoV-2, with data ranging from 3 to 14 days at room temperature for a single surface type, stainless steel [van Doremalen et al., 2020; Kasloff et al., 2020]. Different models were developed to predict the spread of disease. This study aims to provide environmental stability data for SARS-CoV-2 under controlled temperature and humidity conditions for a range of common surfaces.

## 2. Methods

### 2.1. Study area

The four Provinces of Pakistan (Punjab, Sindh, Khyber Pakhtunkhwa and Baluchistan) were selected for the current study. The time period was kept from 1st March to 30th September 2020.

### 2.2. Data collection

Daily basis corona virus cases, temperature and humidity were collected from the official website (<https://www.covid.gov.pk/>), (<https://www.timeanddate.com/>) and the data was calculated to find out monthly average of COVID cases, temperature and humidity.

### 2.3. Statistical analysis

GraphPad prism 5 Software was used to calculate the mean and standard error of mean (SEM). The SPSS software was used to find out the correlation between the numerical variable i.e. average temperatures and average humidity with average number of coronavirus case.

## 3. Results

### 3.1. Effect of temperature and humidity on the number of coronavirus cases in Baluchistan province

In the month of March total record cases of corona virus was (158) the average temperature was (22.4°C) and humidity was (32%). While in the month of April number of cases was (891) average temperature was (27.7 °C) and average humidity was (33.1%). The (3346) cases were recorded in the month of May the average temperature was (34.6 °C) and average humidity was (34.6%). The (6083) case was recorded in June with an average temperature of (35 °C) and average humidity was (34.8%). In the month of July (1267) cases was reported at the average temperature of (36.9 °C) and humidity was (36.7). In the month of

August and September the cases were (1136, 2734) at the average temperature of (32.9 °C, 31.1 °C) and humidity was (46.1 °C, 33.4%) as shown in the (Fig. 1).

### 3.2. Effect of temperature and humidity on the number of corona virus cases in Khyber Pakhtunkhwa province

In the month of March (253) cases were reported the average temperature was (18.3 °C) and the average humidity was (63.5%). While in the month of April (2374) corona cases were reported the average temperature was (24.5 °C) and humidity was (55.3%). In the month of May the total cases of corona virus was (7400) at the average temperature was (30.1 °C) and the humidity was (39.6%). Same for the month of June (16574) cases of corona virus were reported at the average temperature of (32 °C) and humidity was (46.5%). In the month of July (7658) case were recorded at the monthly average temperature of 35.1 °C and the humidity was recorded (50%). The (2062, 1693) cases were reported in the months of August and September at the monthly average temperature of (34.8 °C, 31.6 °C) and the monthly average humidity were recorded (57.3%, 58.1%) as shown in the (Fig. 2).

### 3.3. Effect of temperature and humidity on the number of coronavirus cases in Punjab province

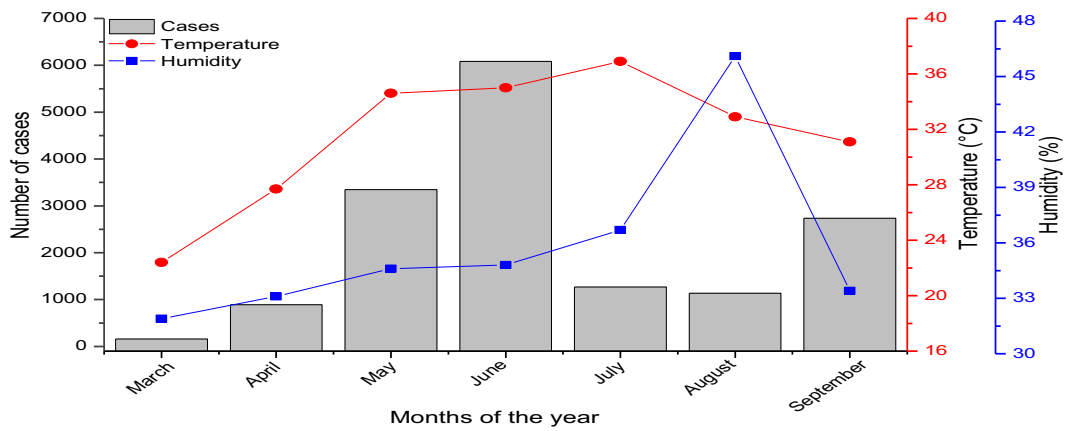
In the month of March (708) cases were recorded with the average temperature of (23.5 °C) and humidity was (55.6). Same for the month of April (5432) cases were recorded with the average monthly temperature of (29.8 °C) and the average humidity was recorded (38.3%). In the month of May (19940) cases were reported with the average temperature of (35.7 °C) and the humidity was recorded (33.8%). In June 56,877 cases were reported and the average temperature was recorded (37.2 °C) and the humidity was (33.8%). In July (16795) corona cases were reported with the average temperature of (37.8 °C) and humidity was recorded (51.4%). In the month of August and September (3875, 2647) corona cases were reported with the average monthly temperature of (35.3 °C, 32 °C) and humidity was (58.5%, 57.6%) as shown in the (Fig. 3).

### 3.4. Effect of temperature and humidity on number of coronavirus cases in Sindh province

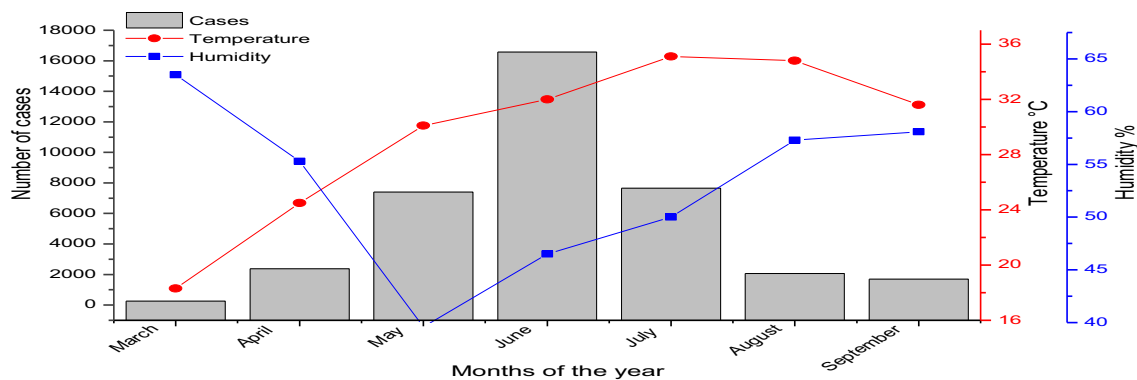
The (907) cases were recorded in the March with average temperature 29.7 °C and average humidity 28.6%. In April (1190) cases were reported with the average temperature of (35.8 °C) and humidity was 30%. In the month of May (22196) cases were recorded the average temperature was (37 °C) and the humidity was (38.7%). In the month of June (56395) cases were recorded with an average temperature (36 °C) and average humidity (44.8%). In July (36699) cases were reported with an average temperature of (35.8 °C) and humidity was (51.5%). In August and September (9229, 7637) cases were reported with an average temperature of (33.2 °C, 33 °C) and humidity for the month August and September were recorded (64.1%, 57.5%) as shown in the (Fig. 4).

### 3.5. Correlation between number of coronavirus cases and temperature

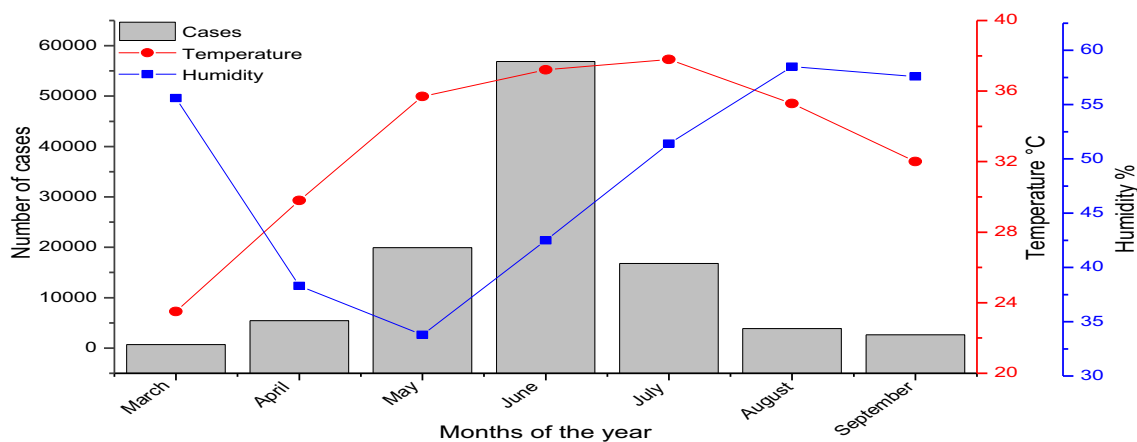
In Baluchistan province Correlation between coronavirus cases and temperature the Pearson (r) value (0.567) P-value (0.1841) and R-squared value (0.332) was reported. Kpk province (0.421, 0.3465 and 0.177) Pearson, P and R- squared value were reported. Same for two other provinces Punjab, Pearson (r) value was (0.580), P-value (0.1722) and R- squared value was (0.336) reported. Pearson (r) value was (0.575), P-value (0.1767) and R- squared value was (0.331) were reported in Sindh province as listed in Table 1.



**Fig. 1.** Effect of temperature and humidity on number of corona virus cases in Baluchistan province. The gray column represents monthly corona virus cases, red symbol (in circle) represents the average temperature of the month and blue symbol (in square) represent the average humidity of the month. The x-axis indicates months of the year and y-axis indicate number of cases, temperature and humidity. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)



**Fig. 2.** Effect of temperature and humidity on number of coronavirus cases in Khyber Pakhtunkhwa province. The gray column represents monthly coronavirus cases, red symbol (in circle) represents the average temperature of the month and blue symbol (in square) represent the average humidity of the month. The x-axis indicates months of the year and y-axis indicates number of cases, temperature and humidity. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

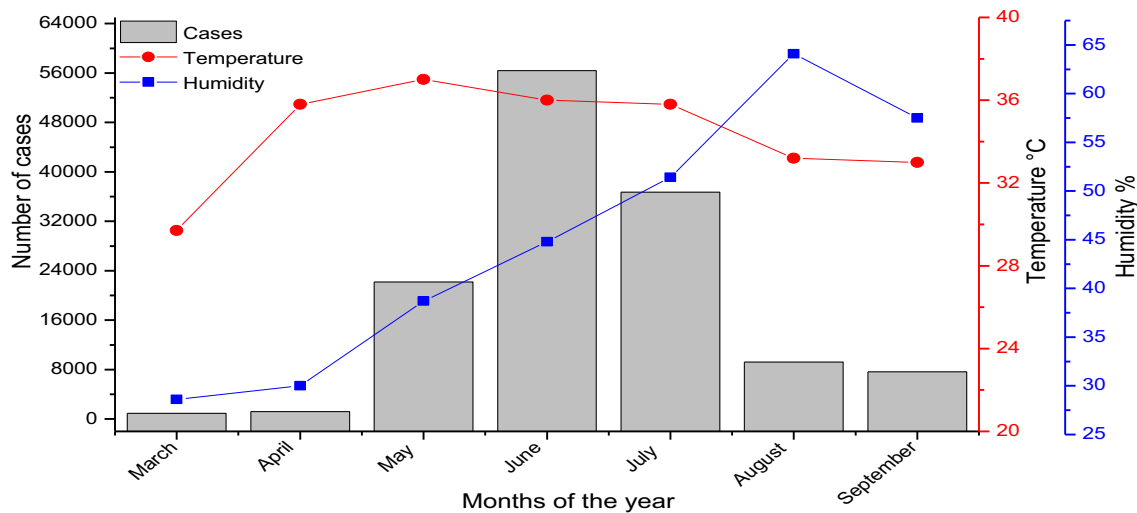


**Fig. 3.** Effect of temperature and humidity on number of corona virus cases in Punjab province. The gray column represents monthly corona virus cases, red symbol (in circle) represents the average temperature of the month and blue symbol (in square) represent the average humidity of the month. The x-axis indicates months of the year and y-axis indicates number of cases, temperature and humidity. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

**3.6. Correlation between number of coronavirus cases and humidity**

In Baluchistan province Correlation between coronavirus case and

humidity the Pearson (r) value (−0.0814) P-value (0.8622) and R-squared value (0.00663) was reported. Kpk province (−0.729, 0.0631 and 0.531) Pearson (r), P and R- squared value were recorded. Same for



**Fig. 4.** Effect of temperature and humidity on number of coronavirus cases in Sindh province. The gray column represents monthly corona virus cases, red symbol (in circle) represents the average temperature of the month and blue symbol (in square) represent the average humidity of the month. The x-axis indicates months of the year and y-axis indicate number of cases, temperature and humidity. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

**Table 1**  
Correlation between number of coronavirus cases and temperature.

Name of province	Pearson (r) value	P-value	R -squared value
Baluchistan	0.567	0.1841	0.322
Khyber Pakhtunkhwa	0.421	0.3465	0.177
Punjab	0.580	0.1722	0.336
Sindh	0.575	0.1767	0.331

two other provinces Punjab, Pearson (r) value was (−0.466), P-value (0.2919) and R- squared value was (0.217) reported. Pearson (r) value was (0.164), P-value (0.7246) and R- squared value was (0.0270) were reported in Sindh province as shown in Table 2.

**4. Discussion**

The coronavirus disease-2019 is a comparatively large virus with a size of about 1–2 nm and is from a class of covered virus ancestors that maintain a positive-sense single-stranded ribonucleic acid, the virus is spread via direct get in touch with infected peoples respiratory drops (sneezing and coughing), also contact with contaminated surfaces. The COVID-19 can stay alive for hours on surfaces, but a simple antiseptic can reduce it (Harmooshi et al., 2020).

Our study examined that the relationship between the number of corona virus cases and meteorological variable such as temperature and humidity, the information is provided for the support of spread of number of corona virus cases in the four provinces of Pakistan. In the present study we checked the relationship between the average number of coronavirus cases with average temperature and humidity. In the current study daily cases of Covid were increased with temperature increased while decreased when the temperature decreased but the statistical result was non-significant among all the four provinces of Pakistan i.e. Baluchistan, Khyber Pakhtunkhwa, Punjab and Sindh. The

**Table 2**  
Correlation between number of coronavirus cases and humidity.

Name of province	Pearson (r) value	P-value	R-squared value
Baluchistan	−0.0814	0.8622	0.00663
Khyber Pakhtunkhwa	−0.729	0.0631	0.531
Punjab	−0.466	0.2919	0.217
Sindh	0.164	0.7246	0.0270

relation of humidity and Covid daily cases were different from temperature and covid daily cases. Whereas increase in the humidity decrease in daily covid cases but non-significant. Both average temperature and average humidity are not significantly correlated with number of coronavirus cases.

Wu et al. study show that humidity and temperature are oppositely correlated with daily number of corona virus cases, for every 1% increase in average temperature the number of corona virus cases reduced by 3.08% and for every 1% increase in average humidity the number of corona virus cases reduced by 0.85%. This study is not consistent to our work because Wu et al. studied 166 countries, compared to our study we just study one state, and they further concluded that the effect of humidity and temperature on number of coronavirus cases may not be obvious in regions where the population spread of corona virus had not occurred because the amount of acceptance cases was high (Y. Wu et al., 2020). Negative relation identified in the event of high humidity, on similar to our study, investigated by Chan et al. recommended inverse correlation between humidity and number of SARS-CoV (Chan et al., 2011). Another study on the viability of SARS and MERS coronavirus show that MERS CoV was hard and fast in vaporize type at low temperature and low humidity, this study not represent our work as we concluded that no significant correlation between number of cases, temperature and humidity. The viability was decreased at low temperature and high humidity, compared to the SARS CoV has been recorded to stay stable for up to 5 days at low temperature and low humidity, and increased in temperature and humidity resulted in rise of reduction in stability (Van Doremalen et al., 2013). Another study examined that viruses may stable for a days at low atmospheric temperature and high humidity involve in reduction of stability, not consistent to our study, as Casanova et al. examined that increased in temperature and humidity play a role in reduction of stability of virus (Casanova et al., 2010). A study by Shehzadi et al. suggested that negative relation determined between number of coronavirus cases and average humidity, compared to our work we recommended that no significant negative relationship between number of coronavirus infection and average humidity, not totally consistent to our result while in infection of temperature and number of coronavirus cases our result is also the same but the two variable is non-significantly positively correlated, and Shezadi et al. study show that average temperature and number of coronavirus show positive correlation (Shahzadi et al., 2020). The results of (Meo et al., 2020) revealed a significant decrease in the number of daily new cases and deaths in countries with high temperature and low humidity,

compared to those countries with low temperature and high humidity. (Ahmad et al., 2020) to investigate the spread of coronavirus in Pakistan, have developed the SEIR time fractional model with newly developed fractional operator of Atangana–Baleanu. The result of the study indicated that the spread of virus is very rapidly.

It is still not clear whether COVID-19 is seasonal like flu. However, its cases have been reported throughout the year with different level of severity among different months. This difference might be probably due to variations in climatic conditions such as temperature, and relative humidity as viability of the virus on surfaces and the air is affected by environmental conditions (Harmooshi et al., 2020). However, the role of societal behavior may also be important which need further investigation. The study areas reported here has some societal differences as the population residing here are observing some religious practices like Eid and Moharram etc. in certain months of the year where masses are gathered. Similarly, people living in more congested areas and working in populated setups vs those in rural areas may also make a difference. However, we believe that it is very interesting to find out the behavior of this virus with respect to climatic conditions of certain geographical zones, because it will help to devise policies regarding societal behavior during highly infection-prone months/seasons and in months/seasons with lower risk of infections.

## 5. Conclusion

Several weather conditions impact upon the coronavirus infection. In our study we examine the relationship between numbers of coronavirus cases and meteorological variable such as temperature and humidity. We concluded that the correlation between number of corona virus cases and average temperature is not significantly positive correlated, similarly the relationship between the number of coronavirus cases and average humidity is not significantly negatively correlated among all four provinces (Baluchistan, Khyber pakhtunkhwa, Punjab and Sindh). Both temperature and humidity was non-significantly correlated with number of corona virus cases. Non significant of covid-19 with humidity and temperature may be due to off and down in temperature very quickly. From the result of existing data, we recommended that the increasing in the number of cases in Pakistan is not clarified by the variation of humidity and temperature. We further recommended that humidity and temperature is not a provident measure for policy maker and preventing the coronavirus epidemic spreading. It is most probable operated by certain other agent of the host associated with epidemiology, various climatic condition and social-economics.

## CRedit authorship contribution statement

1. Thank you for your valuable comments and we agreed to your point regarding our manuscript. In accordance to your comments we modified our manuscript in a more impressive way for the readers. The changes in the manuscript are highlighted in yellow. We also thoroughly reconsidered our manuscript to make it in accordance to the journal format.
2. Now we think that the changes which are made will represent our manuscript in more impressive way.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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