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RESEARCH ARTICLE

Is temperature effective against spreading of the 2019-nCoV (Novel Coronavirus)?

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Numerous contagious diseases affected many people worldwide and caused many deaths. In last century, Spanish flue affected 500 million people and 17-50 million people died globally. SARS-CoV and MERS-CoV affected hundreds and thousands of people in 2002 and 2012 respectively. The novel corona virus, 2019-nCoV has emerged as pandemic causing, COVID-19 in more than 219 countries globally. SARSCoV-2 affected millions of people and thousands died. The viruses are constant at lower temperatures, therefore their spreading is at peak in winter season, and they show inactivity at higher temperatures; but the current COVID-19 epidemic is increasing with increase in temperature up to 30°C. It has been speculated, especially in underdeveloped countries, that rise in temperature might be affective for disintegration of structural proteins of the corona virus. However, we did not find any decrease in corona-affected individuals at higher temperature. Overall effect of temperature in spread of the virus is reviewed in this paper

Keywords: COVID-19, Epidemic curve, SARS-CoV-2, Temperature, Humidity

INTRODUCTION

1.0 Emergence

Many epidemic diseases have affected the people in last centuries. Spanish virus consisting of HINI influenza virus was emerged in 1918 which affected 500 million people around the world and 17-50 million people died (Schwartz, 2020). Coronaviruses are a dissimilar family of viruses; these affect birds and mammals and cause a number of diseases in pigs and cows and also cause respiratory disorders in chickens which are potentially harmful for humans. In 2002, SARS (severe acute respiratory syndrome) was exposed for the first time in the Southeast region of China and was named as human CoV (Du et al. 2009). After 10 years from the appearance of SARS-CoV, a different emergent coronavirus was appeared and caused MERS-CoV (Middle East Respiratory Syndrome) which affected the people in Middle east and caused a significant number of deaths. In 2009, the world was again infected by HINI Swine and 6.8 million people were affected where 5 million people died. But the emergence of a new coronavirus, SARS-CoV-2 became life-threating respirational disease globally and has quickly spread throughout the world (Schwartz, 2020). Coronaviruses are named due to the crown-like viral particles having dots on the surface. After current discovery of COVID-19, there are 7 types of coronaviruses: 229E (HCoV-229E), OC43 (HCoV-OC43), NL63 (HCoV-NL63), HKU1, SARS-CoV, MERS-CoV and Novel coronavirus (SARS-CoV-2) (Du et al. 2009). The pneumonia like cases were diagnosed in China on 31st December 2019, announced by WHO. It was believed that at the end of 2019, SARS-CoV-2 virus was transferred from bats to humans in Wuhan market, China (Mukhtar et al. 2020). On 7th January 2020, this novel virus was isolated and was named as 2019-nCoV and on 11th February 2020, the disease by this virus was named as COVID-19 by World Health Organization. International Committee on Taxonomy of Viruses gave it the name SARS-CoV-2 due to its resemblance with SARS coronavirus. China has faced a great loss due to this epidemic disease with 1772 deaths (Mukhtar et al. 2020). COVID-19 has been transmitted from human to human and extended from country to country (Yao et al. 2020).

After a few weeks, many cases were reported in several countries with asymptomatic, symptomatic and even deaths **(Figure 1)** This epidemic disease effected many countries around the world.

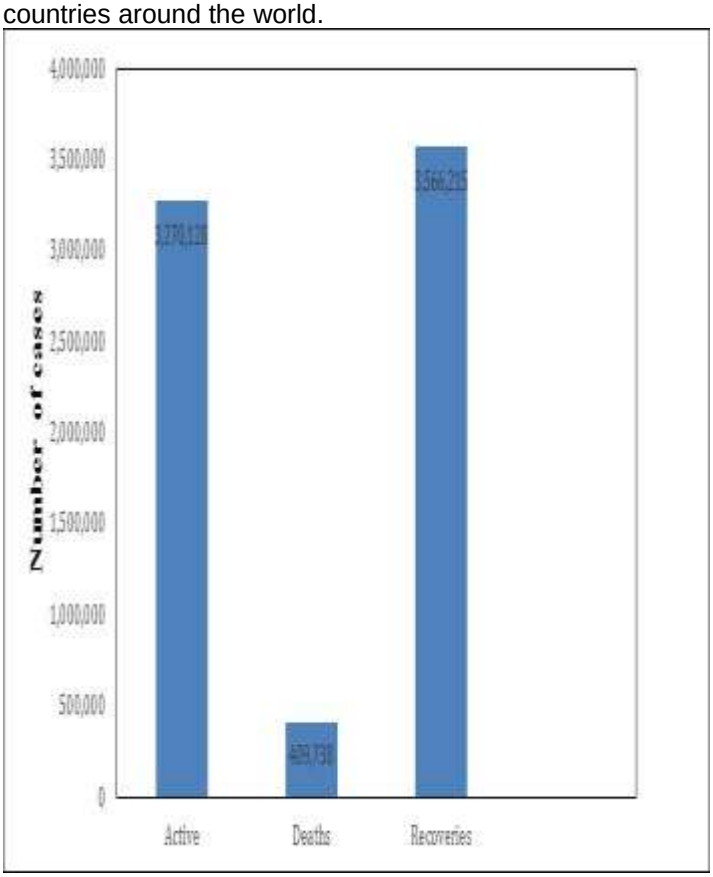


Figure 1; Total affected persons by COVID-19 worldwide, * Data obtained June 9, 2020, 9.00 pm.2.0 Spreading of disease

Several types of symptoms have been found in people infected with COVID-19. Some infected persons show symptoms such as cough, breathing difficulties, tiredness, dyspnea, myalgia, fever, tiredness, multi organ failure and bilateral lung infiltrates (Huang et al. 2020) and others have sour throat, abdominal pain, headache and diarrhea. In severe cases, septic shock, pneumonia, kidney failure, acute respiratory syndrome and death may happen (Wang et al. 2020). COVID-19 virus has 14 days' incubation period and symptoms appear within 2-14 days, once exposed (Prompetchara et al. 2020).

Current evidence suggests that the virus can be spread through respiratory droplets released from mouth and nose of an infected person as they cough or sneeze (A single cough can produce up to 3,000 droplets), between people who are within about 6 feet of each other, and possibly through touching surfaces that have the virus on them, such as handrails, telephones, or doorknobs. Because these particles can stay on these surfaces and persist in air; and stay in fecal material, so without washing hands can pollute everything (Desai and Patel, 2020). This virus can survive on cardboard up to 24 hours and on plastic and stainless-steel surfaces up to 2-3 days. Nevertheless, copper surfaces have a tendency to kill the virus around 4 hours (Covid et al. 2020).

MATERIAL AND METHODS

We collected data about confirmed COVID-19 cases from World Health Organization and collected meteorological data such as average temperature. We collected daily reports of confirmed COVID-19 cases from World Health Organization since early January and sum up as a monthly data of confirmed COVID-19 cases of more than 70 countries, but used data of those countries where COVID-19 emergence duration is at least up to 120 days and have variation in monthly temperature in our study. We compared the increased number of cases with temperature variation. We collected minimum, maximum, day and night time temperature and calculated average temperature of the month.

RESULTS AND DISCUSSION

4.0 Effect of Temperature

Temperature effects the survival of some viruses, as envelope of many viruses is made up of lipids. At low temperature, many other viruses such as influenza virus, affect the people and disrupt the immunity of human. Winter season is the best for the spreading of viruses (Peci et al. 2019). SARS-CoV-2 has been spread all over the world, and exist in temperature range of 0-35°C, such as average temperature in Iran 10°C, Italy 17°C, Jakarta 30°C, Indonesia and Malaysia; 35°C and Germany 25°C **(Table 1).**

After the study of temperature variations in different regions and spreading of COVID-19 cases, it is observed that, viruses are most constant at lower temperature, in winter season mostly people prefer to stay indoors, so chances of spreading viruses by droplets increase from person to person (Tamerius et al. 2011). Attack of viruses was higher at indoor crowding like institutional centers, public places or other work places. Best seasons for the spreading of viruses are end of the winter or early spring because it is time of inter-seasonal and intra-seasonal variability. Spreading of viruses is lower at higher temperature up to 50°C (Peci et al. 2019). HCoV-229E (human coronavirus) can stay on various type of materials for the longer period of time (2hours to 9 days). A high temperature (30-40°C) can affect the perseverance of extremely pathogenic MHV, MERS-CoV and TGEV viruses but at 4°C and below period of perseverance of MHV and TGEV can be increased up to 28 days (Ijaz et al. 1985).

Table 1: Existence of SARS-CoV-2 on various temperature ranges in different regions of the world

Reporting country / Territory/ Area	Total confirmed new cases in February, 2020	Average Temperature (°C) in February	Total confirmed new cases in March, 2020	Average Temperature (°C) In March	Total confirmed new cases in April, 2020	Average Temperature (°C) In April	Total confirmed new cases in May, 2020	Average Temperature (°C) In May	%age of confirmed cases with total population*
China	1313,103	-4	3186	-1.7	1828	14	197	19	0.093%
Republic of Korea	3139	-1	6680	4	979	11.8	703	17.6	0.022%
Australia	15	1.4	4325	1	2387	19	439	15.7	0.028%
Malaysia	16	24	2602	33	3319	33.5	1817	32	0.023%
Japan	216	6	1699	13	12135	14	2763	18.7	0.013%
Philippines	2	26	1559	32	6666	34	9012	34	0.015%
Singapore	85	31	791	31	14762	27	18725	30	0.587%
Italy	886	8	100853	11	101852	13.8	29073	17.7	0.384%
Spain	32	11.5	85163	15	127722	18	26683	15.7	0.512%
Germany	52	5.3	61862	8	97206	8.3	22363	12	0.021%
France	51	4.6	48432	7	83089	9.8	21370	15	0.227%
The United Kingdom	20	9	22125	10.5	143080	11	107605	16	0.401%
Switzerland	10	2	15402	6	13912	12	16933	13	0.355%
Netherlands	2	7	11748	6.6	27052	12	7455	17	0.19%
Belgium	1	3.6	11898	6.7	35960	9	10327	16	0.50%
Austria	5	4.1	9613	5.7	5746	13	1274	13	0.184%
Israel	5	9	4826	16	10951	18	1230	20.6	0.196%
Norway	6	-4.7	4220	-0.8	3441	3.8	744	9.5	0.156%
Sweden	12	-2.8	4016	1.3	16274	4.7	16811	10.7	0.367%
South-East Asia Region									
Thailand	28	28	1496	30	1430	35	127	33.8	0.004%
India	2	18	1069	22	31979	28.6	149093	32	0.013%
Eastern Mediterranean Region									
Iran	388	8	41495	14	52162	20	55293	26	0.177%
Pakistan	2	15	1863	21	13894	27	53737	30.8	0.031%
Iraq	8	12.7	622	16	1373	22	4176	28.8	0.015%
Bahrain	38	19	477	21	2406	30	7872	36	0.63%
United Arab Emirates	15	19	596	23	11318	26	21966	31	0.342%
Kuwait	43	23	223	27	3474	33	22452	31	0.613%
Region of the Americas									
United States of America	56	2.3	140578	5.8	863334	19	712104	28	0.518%
Canada	11	9.3	6303	12.2	44046	12	39378	13	0.237%
African region									
Algeria	1	17.4	510	19.3	3337	21.3	5419	23	0.021%
Nigeria	1	32.7	110	28.5	1421	28	8323	28	0.004%
South Africa	0	23	1326	19	4024	21	25617	17.7	0.052%

***Calculated as percentage of COVID-19 affected people in comparison to total population**

Scatter plot is showing that COVID-19 cases are consistently increasing day by day even at higher temperature **(Figure 2)** due to the transfer of virus from one infected person to other. In case of influenza virus 5 seconds contact can transfer 31.6% virus,[14] while transfer level is low 1.5% with 3-5 seconds contact,[15]. Chances become more, if direct contact of hands with mouth (36%), eyes (31%) and nose (31%) (Kwok et al. 2015).

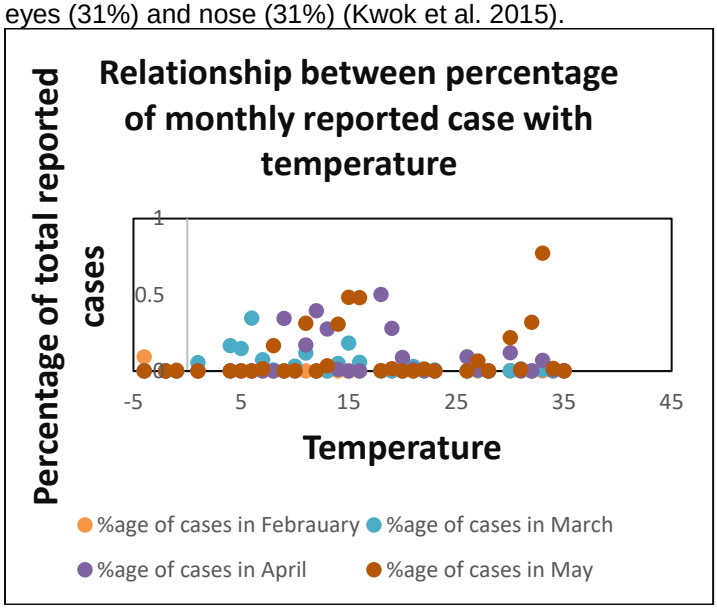
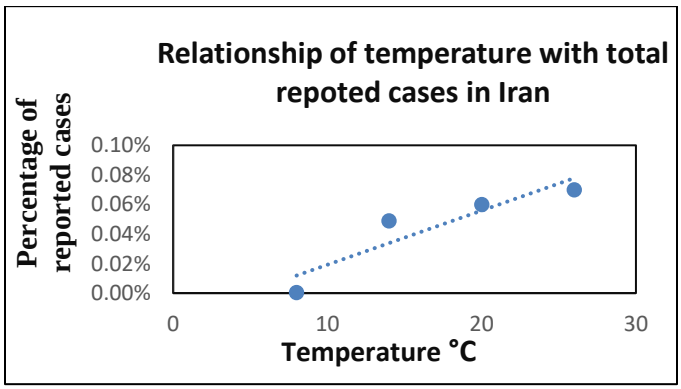


Figure 2: Scatter plot of COVID-19 in different regions of the world at various ranges of temperature.

Study of the graphical presentation of COVID-19 spreading, poses one question, countries affected with higher number of infected cases with increasing temperature has high population growth. Comparison of the average data (ratio of infected individuals with total population) of a few countries with higher number of cases, however, rules out this possibility **(Figure 3 a-g).** The COVID-19 confirmed cases are found at peak with the increase in temperature up to 35°C irrespective of population.



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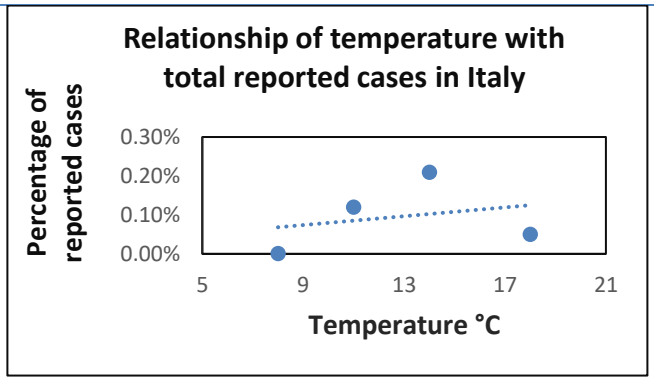

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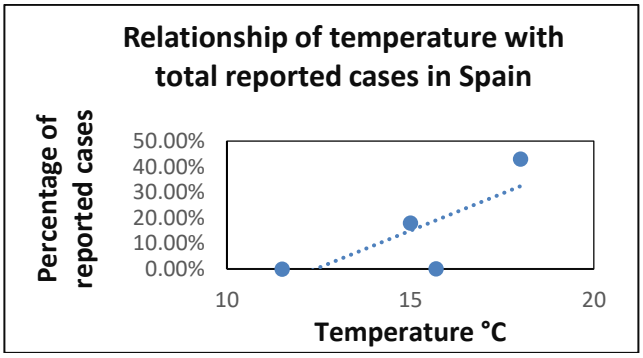

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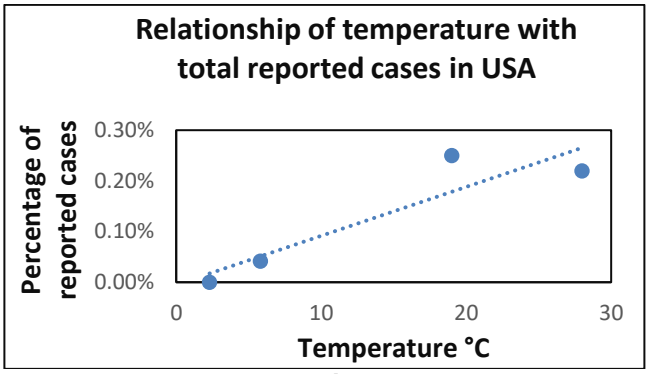

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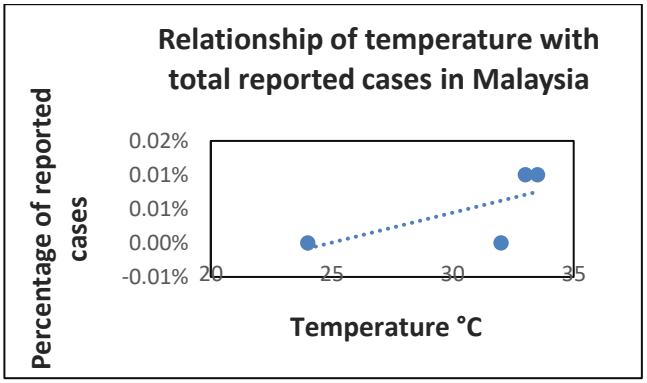

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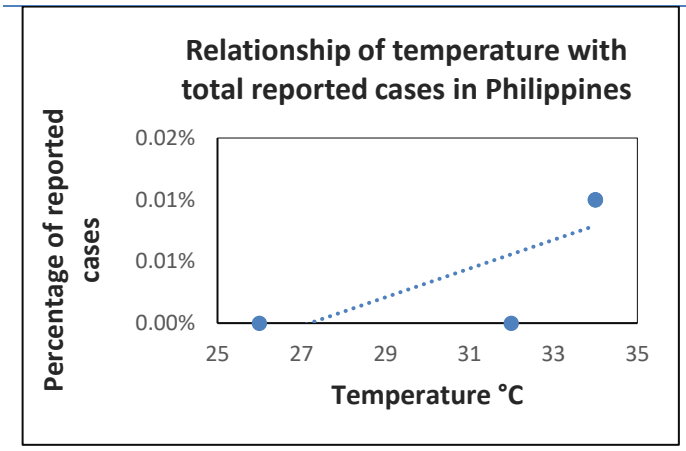

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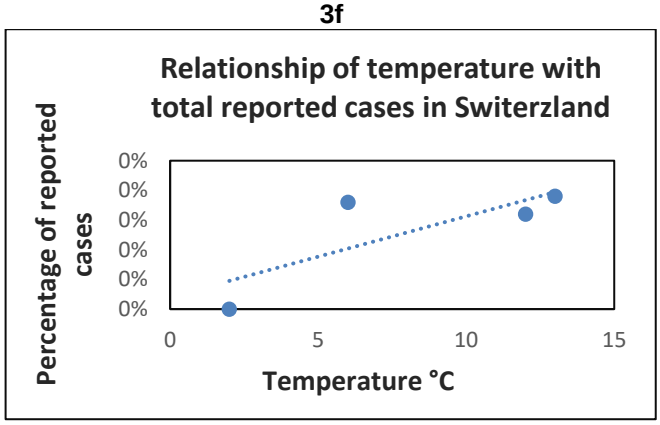

3g

Figure 3; Effect of temperature on spread of COVID-19 in different countries.
a: Iran, b: Italy, c: Spain, d: USA, e: Malaysia, f: Philippines, g: Switzerland

Higher temperature (25-30°C) can be effective for the spreading of COVID-19. SARS-CoV-2 spreading can be compared with Spanish flu (1918-1920) epidemic, that how temperature was effective in the transmission of Spanish flu? It is a respiratory virus which caused major deaths and illnesses for the duration of epidemics and affected thousands of people globally.

Humidity has a significant role in the spreading of similar viruses, such as influenza virus because the size of breathing droplets is affected by humidity. When there is low or no humidity and air is dry, this type of environmental condition is more beneficial for the evaporation of larger droplets and conversion into smaller that are more susceptible to remain in air for longer period of time (Weber and Stilianakis 2008).

However, it has been observed that; influenza may be spread and epidemic outbreak through physical contact or droplets means in summer season, when temperature is high,[18]. After the study of Spanish flu and the temperature effect, it has been concluded that temperature has somehow relationship with corona virus (Rota et al. 2008). SARS-CoV is RNA virus with structural proteins, N (nucleocapsid protein), E (envelope protein), M (membrane protein) and S (spike protein) **(Figure 4) (**Lissenberg et al. 2005)

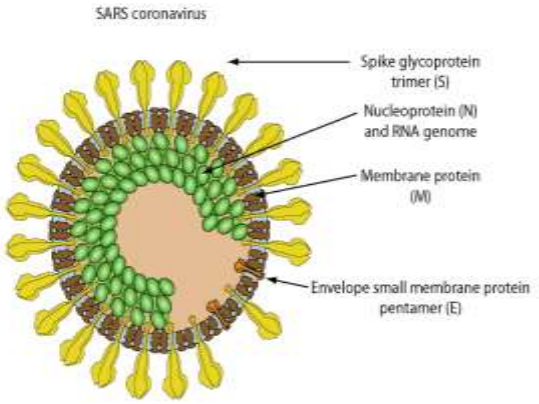

Figure 4: SARS-CoV-2 with structural proteins, N (nucleocapsid protein), E (envelope protein), M (membrane protein) and S (spike protein) (Giwa et al. 2020)**.**

present in envelope which are quite stable as those could be degraded at high temperature (60-65°C) (Rota et al. 2003). Another study demonstrated that the Corona viruses can be active at 4°C, 20°C and 37°C minimum for 2 hours without any significant variation in its contagious capability. The viruses were transformed into non- infectious after 30, 60 and 90 minutes' exposure at 75°C, 67°C and 56°C respectively (Duan et al. 2003).

5.0 Speculations about future spreading of SARS-CoV-2

Maximum number of new reported cases were reported from the countries having temperature 4-17°C. Prior to March 2020, 90% cases were reported in many countries having temperature less than 11 °C; Ten thousand new cases were also reported in countries having temperature 16-18 °C at the end of March; hence, it has been hypothesized that high temperature would prove effective in the activation of SARS-CoV-2 (Bukhari and Jameel 2020). However, on contrary, rise in temperature >20°C in many countries (Pakistan, India, Iran, Iraq and United Arab Emirates) is not effective in reducing the COVID-19 **(Table 1)**. An earlier lab study on the effect of temperature on SARS-CoV showed that enveloped virus could be inactive at 40°C temperature (Casanova et al. 2010). However, such experiments were conducted on two potential surrogate viruses viz. Transmission Gastroenteritis (TGEV)and Mouse Hepatitis Virus (MHV). Moreover, the temperature effect was shown with reference to relative humidity. There could be many reasons for the spread of this in these countries, such as, poor management policies of government regarding lockdown, poor health facilities

and low testing. Many asymptomatic and symptomatic persons without testing became the reason of transmission (Bukhari and Jameel 2020). But it was observed that whatever the cause of the spread, there was no effect of higher temperature on the viral transmission.

Influence of humidity and temperature on viral transmission has also been reported by some other researchers (Dalziel et al. 2018). It has been suggested that a relationship between COVID-19 and temperature was observed in the same way as observed in other contagious viral diseases such as influenza (Ficetola and Rubolini, 2020; Liu. Et al. 2020; Ma et al. 2020; Tosepu et al. 2020) But, recent studies demonstrate contradictory conclusion showing no relationship between climatological conditions and COVID-19 with respect to temperature (Jamil et al. 2020; Xie and Zhu 2020) and relatively humidity (Shi et al. 2019). Similarly, researchers couldn't find any association between temperature and COVID-19 by using meteorological and non-meteorological data in Spain (Briz-Redón et al. 2020).

All these studies strengthen our conclusion that no obvious association exists between temperature and COVID-19.

CONCLUSION

Our study showed no impact of high temperature up to 35°C on reduction of COVID-19 spread. The observation is relatively alike MERS contagious in the Arabian Peninsula, where MERS confirmed cases remain at 45°C temperature. Some other epidemic diseases like influenza shows an irregular pattern. SARS transmission was started in November, 2002, and continued till July, 2003. Therefore, it is concluded that the speculation of reducing COVID-19 at higher temperature does not have hope.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

SS,SA designed and performleed the experiments and also wrote the manuscript. FS, SM, and NK performed treatments, flow cytometry experiments and data analysis. ZA and IS designed experiments AA,FT reviewed the manuscript. All authors read and approved the final version.

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