The role of Temperature on the Spread of COVID-19 worldwide and urgent Solutions

Indrani Roy

University College London

November 21, 2022

Abstract

This study explored whether the global temperature had any role in the spread and vulnerability to COVID-19 and how that knowledge can be used to arrest the fast spreading disease. It highlighted that for transmitting the virus, global temperature played an important role and a moderately cool environment was the most favourable state. Whereas, the risk from the virus was reduced significantly for warm places and countries. Based on the temperature of March and April, various degree of vulnerability was identified and countries were specified. The maximum reported case, as well as death, was noted when the temperature was in the range of around 275°K(2°C) to 290°K(17°C). Countries like the USA, UK, Italy and Spain belonged to this category. The vulnerability was moderate when the temperature was less than around 275°K(2°C) e.g., Russia, parts of Canada and a few Scandinavian countries. For temperature 300°K(27°C) and above, a significantly lesser degree of vulnerability was noted. Countries from South Asian Association for Regional Cooperation, South East Asia, the African continent and Australia fell in that category. This work discussed that based on the variability of temperature, countries can switch from one vulnerability state to another. That influence of temperature on the virus and results of previous clinical trials with similar viruses provided a useful insight that regulating the level of temperature can offer remarkable results to arrest and stop the outbreak. Based on that knowledge, some urgent and simple solutions are proposed, which are practically without side effects and very cost-effective too.
Solutions: General Measures

- **Using Sauna facilities**: Usually hotels, gyms, leisure centres contain existing Sauna facilities. Also, mobile and Caravan Sauna facilities can be thought of in future. After Sauna, if surfaces in public places are touched, hand washing is advisable.

- **Portable Convector Room Heater**: Stay close to a convector room heater and inhale hot air at least two times a day for around half an hour each time (keeping comfort level). It would be very useful at the initial stages of the disease.

- **Disinfect any place using High Temperature**: Before start of office, school or business, temperature of premises may be kept very high (say, 60°C) for half an hour. For airports, train and bus, the same method of disinfecting could be thought of. Optimum temperature and duration can be tested easily. For any external object or material, disinfecting using high temperature could be a useful solution.

- **Using Blow Dryer/ Hair Dryer**: For minor symptoms, inhaling hot air intermittently through the nose (keeping comfort level) even for five minutes, say two/three times a day, will also be useful to kill virus in the nasal cavity.

- **Hot Drinks**: For very mild symptoms, take hot drinks (could be tea, coffee, warm milk, hot water with lemon etc.) few times a day to destroy virus in the mouth and throat. Gargle with warm salt water at least three/four times a day will be very beneficial. Hot soup will also be useful.

**Why**: The virus is very sensitive to Temperature. It mainly enters through the Nose (WHO). Testing is done with swabs from the nasal cavity and the back of the Mouth.

**Important**: Only even Convector Room Heater and Hot Salt Water gargle, Hot Drinks can serve the main purpose.

Indrani Roy
The Role of Temperature on the Global Spread of COVID-19 and Urgent Solutions

Indrani Roy
University College London (UCL), UK
(indrani.roy@ucl.ac.uk)

Article in: International Journal of Environmental Science and Technology
Publisher: Springer Nature
More than 530,000 people died till 4th of July 2020.

- Economy and mental health suffered tremendously.
- No proven cure for the disease is found yet.
- Popular known methods to treat disease are Plasma therapy, Vaccine development, Medication etc. But those are not yet comprehensively tested. In addition, time consuming and with potential side effects.

- With that **Emergency Situation** in mind some **Urgent, Simple Solutions** were proposed on 17th March (Roy, 2020a) purely based on **Science**.

- These are without side effects, no funding required, no vested interest, can be practiced in own home.
This family of viruses is very sensitive to Temperature.

- True for this virus SARS-CoV-2 responsible for COVID-19: Scafetta N., (2020); Paulo M et al., (2020); Roy I., (2020).

- Paulo M. et al. (2020) in a review work presented seventeen recent papers on COVID-19 and almost all found strong connections of temperature.

- True for similar generic category Coronavirus SARS and MARS (Van Doremalen N., 2013; Chan et al., 2011).

- True for other similar Seasonal air-borne Flu viruses (Lowen et al., 2007).
Temperature Sensitivity: Clinical Trials

- **Seasonally dependent endemic virus** (Lowen et al., 2007): Temperature of 5 °C and Relative Humidity (RH) 35% to 50%, infection rate was very high (75-100%). Whereas, when RH was still kept at 35%, but only temperature was increased to 30°C, infection rate surprisingly reduced to zero.

- **True for similar Coronavirus genus SARS and MARS**: Virus remain active for a long time in low temperature (Van Doremalen N., 2013). Low temperature significantly contributes to the survival and transmission of the virus (Casanova et al., 2010; Chan et al., 2011; Seung et al., 2007).

- **Typical Air-Conditioning Temperature**: SARS could be active for at least five days in typical airconditioned environments which has relative humidity 40-50 % and room temperature 22 -25°C (Chan et al., 2011).

- **Similar generic Coronavirus (viz. SARS-CoV) using a variable Temperature (Casanova et al., 2010)**: Inactivation of virus was faster at all humidity level if temperature was simply raised to 20°C from 4°C, more rapid if the temperature was further increased to 40°C from 20°C.
COVID-19 is extremely contagious and invaded most of the globe in less than two months.

**Attention:** Understand nature of its transmission under variable temperature condition.

- Lab experiment with Guinea Pigs (Lowen et al., 2007):

Using similar seasonal air-borne virus, it studied effect of temperature on *Airborne Transmission as well as Contact Transmission*. Increasing temperature prevented airborne transmission but not contact transmission. When guinea pigs were kept in separate cages at temperature of 30°C for 1 week, no recipient guinea pigs were infected. But if those were kept in same cage to simulate contact transmission, between 75% and 100% became infected. No role of humidity is found in these experiments.

**Hence Contact Transmission plays role in all Temperature.**
Monthly average air temperature (°K) from mid-February to April 2020.

(Plot generated: [https://psl.noaa.gov/data/composites/day/] )

[Source: Roy, (2020)]
Global Temperature analyses: till 1st May
Vulnerability measured in: Deaths per Million

- **Moderately cool** [275°K(2°C) to 290°K(17°C)] environment was the most favourable state for susceptibility of virus. Countries like USA, UK, Spain, Italy etc.

- Countries with **very cold temperature** [\(< 275°K(2°C)\)] were moderately affected in March-April (e.g. Canada, Russia, Scandinavian countries).

- **Warm countries** and places [\(> 300°K(27°C)\)] were likely to be less vulnerable. e.g., SAARC, South East Asian countries, African continents and Australia.

- **Risks from the virus were reduced** significantly in very **high temperature** environment [\(>305°K(32°C)\)]. Parts of African continents and Australia.
Vulnerability measured in: Deaths per Million (till 1st May)

Difference among Category 1 (Moderate Cold), Category 2 (Very Cold) and Category 3 (warm) were Statistically Significant.

Moderately Cold: USA, UK, Italy, Spain, France
Very Cold: Canada, Russia, Finland, Iceland
Warm: SAARC, South East Asian Countries, African Continents, Australia.

[Source: Roy, (2020)]
Varied characteristics: popular tourist spots, international business hubs with more foreign travellers, level of testing, infrastructural facility, population density, different degree of lockdown restrictions.

In spite of all dissimilarities still one common factor: Death per Million for all those countries from SAARC and SEAC were much less and the pattern is still maintained. It was lesser than 8 till 1st of May, while in Spain it was 531, Italy 467 and UK 405.

Because of large populations, India was one of the highest ranked during August, in overall counts of total Deaths, as well as total Cases.

[Roy, (2020)]
Europe tuned warmer from moderately cold and death rate decreased from March to April 2020. The same pattern is observed till August.

**Transition:** Countries can switch from one vulnerability state to another, based on Variability of Temperature

South American countries, like Brazil turned warm to cooler in June, while Canada and Russia from very cold to moderate cold. **Death rate increased in those countries.**

Mean Air temperature in March (left) and April (right) for Europe in NCEP/NCAR Reanalyses. [Source: Roy, (2020)]

(Plot generated: [https://psl.noaa.gov/data/composites/day/](https://psl.noaa.gov/data/composites/day/))

Europe tuned warmer from moderately cold and death rate decreased from March to April 2020. The same pattern is observed till August.
**Solutions : General Measures**

- **Using Sauna facilities:** Usually hotels, gyms, leisure centres contain existing Sauna facilities. Also, mobile and Caravan Sauna facilities can be thought of in future. After Sauna, if surfaces in public places are touched, hand washing is advisable.

- **Portable Convecto Room Heater:** Stay close to a convecto room heater and inhale hot air at least two times a day for around half an hour each time (keeping comfort level). It would be very useful at the initial stages of the disease.

- **Disinfect any place using High Temperature:** Before start of office, school or business, temperature of premises may be kept very high, (say, 60ºC) for half an hour. For airports, train and bus, the same method of disinfecting could be thought of. *Optimum temperature and duration can be tested easily.* For any external object or material, disinfecting using high temperature could be a useful solution.

- **Using Blow Dryer/ Hair Dryer:** For minor symptoms, inhaling hot air intermittently through the nose (keeping comfort level) even for five minutes, say two/three times a day, will also be useful to kill virus in the nasal cavity.

- **Hot Drinks:** For very mild symptoms, take hot drinks (could be tea, coffee, warm milk, hot water with lemon etc.) few times a day to destroy virus in the mouth and throat. Gargle with warm salt water at least three/four times a day will be very beneficial. Hot soup will also be useful.

**Why:** The virus is very sensitive to **Temperature.** It mainly enters through the **Nose** (WHO). Testing is done with swabs from the nasal cavity and the back of the **Mouth.**

**Important:** Only even Convecto Room Heater and Warm Salt Water gargle, Hot Drinks can serve the main purpose.
The virus is very sensitive to Temperature.

- **Green House (glass):** In winter, it would be useful in poor countries and rural places without electricity. During the day, bright sunshine can provide heat by Green House effect (substitute of Sauna). Sufficiently high temperature can be attained and duration can be adjusted to peoples’ comfort level.

- **Outside Raw Fire:** In underdeveloped countries and rural places, people usually sit in a circle round a camp-fire in winter. They use dry leaves and spare woods for a small fire. That heat in winter could be useful.

- **Substitute of Blow Dryer and Room Heater:** While cooking, all members of the household could be, in turn, stay close to the heat source, for, say, half an hour a day. Also, each individual can use separate folded cotton cloths to take heat from the cooking container and use on the nose.
Caution and Additional Points

Caution: If people already developed major symptoms, then all these methods discussed will not be effective and proper medical advice need to be solicited.

Additional Points:

- **Water Shortage**: Whether frequent Hand Washing can be replaced by sensor-based hand dryer (normally found in washroom), temp controlled.

- **Plastic Disposal**: Personal Protective Equipment (PPE) are single use. World is already under stress due to problems of disposing Plastic. If PPE can be disinfected using heat-based solutions and reused. It can be tested in laboratory and could prove very beneficial.

- **Face Shield /Visors**: In busy public places, mass gathering, and cold premise, face shield will give additional protection. The virus can also enter through eyes (ECDC).

- **Contact Transmission**: For warm, highly populated countries, contact transmission can play important role and appropriate measures are required. Hand washing is useful; Air Conditioned (AC) premises, where mass gathering happens need disinfecting on a regular basis.

- **Very Warm Countries**: Some countries reached temperature more than 40°C in July-August. In that uncomfortable temperature, people use more AC. That low temperature in confined space can increase transmission.
Solutions: The virus is very sensitive to Temperature

**Public**
- Little Higher Temp of Air Condition (AC) (throughout day)
- Fresh Air Circulation: In AC room, half an hour a day. For warm countries, around early afternoon when temp peaks, will be the best.
- High AC Temperature (short period)
- Disinfect PPE and other medical equipment using high temperature.

**Individual**
- Important in Old Care Homes, Health Care Centre, Hospitals.
- Disinfect office, plane, train, bus, airport etc.
- Hot air intake through nose
- Disinfect whole room (for half an hour)

**Sauna**
- Blow / Hair Dryer (Destroy virus in the nose)
- Hot Drinks, warm salt water gargle (Destroy virus in mouth, throat)
- Hot air intake through nose
- Convector Room Heater

Important in Old Care Homes, Health Care Centre, Hospitals.

Indrani Roy
Interested in Details

References


- **Lowen** A. C. et al., (2007). Influenza virus transmission is dependent on relative humidity and temperature. Plos Pathogens, 3 (10), 1470–1476, 10.1371/journal.ppat.0030151


The virus is very sensitive to temperature.

Solar Variability

QBO (Q uasi-Biannual Oscillation)

ENSO (E l-N iño S outhern Oscillation)

Other major modes of Climate Variability

Stratosphere-Troposphere coupling

Atmosphere-Ocean coupling

Climate change

Indian Summer Monsoon

Arctic and Antarctic climate

Paleoclimate, Volcano, Hydrology and Agriculture

Thank You
The Role of Temperature on the Global Spread of COVID-19 and Urgent Solutions

Indrani Roy
University College London (UCL), UK
(indrani.roy@ucl.ac.uk)

Article in: International Journal of Environmental Science and Technology
Publisher: Springer Nature
More than 530,000 people died till 4th of July 2020.

- Economy and mental health suffered tremendously.
- No proven cure for the disease is found yet.
- Popular known methods to treat disease are Plasma therapy, Vaccine development, Medication etc. But those are not yet comprehensively tested. In addition, time consuming and with potential side effects.

- With that **Emergency Situation** in mind some **Urgent, Simple Solutions** were proposed on 17th March (Roy, 2020a) purely based on **Science**.
- These are without side effects, no funding required, no vested interest, can be practiced in own home.
This family of viruses is very sensitive to Temperature.

- True for this virus SARS-CoV-2 responsible for COVID-19: Scafetta N., (2020); Paulo M et al., (2020); Roy I., (2020).

- Paulo M. et al. (2020) in a review work presented seventeen recent papers on COVID-19 and almost all found strong connections of temperature.

- True for similar generic category Coronavirus SARS and MARS (Van Doremalen N., 2013; Chan et al., 2011).

- True for other similar Seasonal air-borne Flu viruses (Lowen et al., 2007).
Temperature Sensitivity: Clinical Trials

- **Seasonally dependent endemic virus (Lowen et al., 2007):** Temperature of 5 °C and Relative Humidity (RH) 35% to 50%, infection rate was very high (75-100%). Whereas, when RH was still kept at 35%, but *only temperature was increased to 30°C, infection rate surprisingly reduced to zero.*

- **True for similar Coronavirus genus SARS and MARS:** Virus remain active for a long time in low temperature (Van Doremalen N., 2013). **Low temperature significantly contributes** to the survival and transmission of the virus (Casanova et al., 2010; Chan et al., 2011; Seung et al., 2007).

- **Typical Air-Conditioning Temperature:** SARS could be active for at least five days in typical airconditioned environments which has relative humidity 40-50 % and room temperature 22 -25°C (Chan et al., 2011).

- **Similar generic Coronavirus (viz. SARS-CoV) using a variable Temperature (Casanova et al., 2010):** Inactivation of virus was faster at all humidity level if temperature was simply raised to 20°C from 4°C, more rapid if the temperature was further *increased to 40°C from 20°C.*
Transmission of Disease and Temperature

COVID-19 is extremely contagious and invaded most of the globe in less than two months.

**Attention:** Understand nature of its transmission under variable temperature condition.

- Lab experiment with Guinea Pigs (Lowen et al., 2007):

  Using similar seasonal air-borne virus, it studied effect of temperature on *Airborne Transmission as well as Contact Transmission*. Increasing temperature prevented airborne transmission but not contact transmission. When guinea pigs were kept in separate cages at temperature of 30°C for 1 week, no recipient guinea pigs were infected. But if those were kept in same cage to simulate contact transmission, between 75% and 100% became infected. No role of humidity is found in these experiments.

  **Hence Contact Transmission plays role in all Temperature.**
Global Air Temperature: Mid-February to April 2020

Monthly average air temperature (°K) from mid-February to April 2020.

(Plot generated: https://psl.noaa.gov/data/composites/day/)

[Source: Roy, (2020)]
Global Temperature analyses: till 1\(^{st}\) May
Vulnerability measured in: Deaths per Million

- **Moderately cool** \([275°K(2°C)\text{ to } 290°K(17°C)]\) environment was the most favourable state for susceptibility of virus. Countries like USA, UK, Spain, Italy etc.

- Countries with **very cold temperature** \([< 275°K(2°C)]\) were moderately affected in March-April (e.g. Canada, Russia, Scandinavian countries).

- **Warm countries** and places \([ > 300°K(27°C)]\) were likely to be less vulnerable. e.g., SAARC, South East Asian countries, African continents and Australia.

- **Risks from the virus were reduced** significantly in very **high temperature** environment \([ > 305°K(32°C)]\). Parts of African continents and Australia.
Vulnerability measured in: Deaths per Million (till 1st May)

Total Death per Million (upto 1st May)
Uncertainty: one Standard Deviation

Based on Temperature (Moderate Cold, Very Cold and Warm)

Difference among Category 1 (Moderate Cold), Category 2 (Very Cold) and Category 3 (warm) were Statistically Significant.

Moderately Cold: USA, UK, Italy, Spain, France
Very Cold: Canada, Russia, Finland, Iceland
Warm: SAARC, South East Asian Countries, African Continents, Australia.

[Source: Roy, (2020)]
Varied characteristics: popular tourist spots, international business hubs with more foreign travellers, level of testing, infrastructural facility, population density, different degree of lockdown restrictions.

In spite of all dissimilarities still one common factor: Death per Million for all those countries from SAARC and SEAC were much less and the pattern is still maintained. It was lesser than 8 till 1st of May, while in Spain it was 531, Italy 467 and UK 405.

Because of large populations, India was one of the highest ranked during August, in overall counts of total Deaths, as well as total Cases.

[Roy, (2020)]
Europe tuned warmer from moderately cold and death rate decreased from March to April 2020. The same pattern is observed till August.

Transition: Countries can switch from one vulnerability state to another, based on Variability of Temperature

South American countries, like Brazil turned warm to cooler in June, while Canada and Russia from very cold to moderate cold. Death rate increased in those countries.

Mean Air temperature in March (left) and April (right) for Europe in NCEP/NCAR Reanalyses. [Source: Roy, (2020)]

(Plot generated: https://psl.noaa.gov/data/composites/day/)

Europe tuned warmer from moderately cold and death rate decreased from March to April 2020. The same pattern is observed till August.
Solutions : General Measures

- **Using Sauna facilities:** Usually hotels, gyms, leisure centres contain existing Sauna facilities. Also, mobile and Caravan Sauna facilities can be thought of in future. After Sauna, if surfaces in public places are touched, hand washing is advisable.

- **Portable Convecto Room Heater:** Stay close to a convector room heater and inhale hot air at least two times a day for around half an hour each time (keeping comfort level). It would be very useful at the initial stages of the disease.

- **Disinfect any place using High Temperature:** Before start of office, school or business, temperature of premises may be kept very high, (say, 60ºC) for half an hour. For airports, train and bus, the same method of disinfecting could be thought of. *Optimum temperature and duration can be tested easily.* For any external object or material, disinfecting using high temperature could be a useful solution.

- **Using Blow Dryer/ Hair Dryer:** For minor symptoms, inhaling hot air intermittently through the nose (keeping comfort level) even for five minutes, say two/three times a day, will also be useful to kill virus in the nasal cavity.

- **Hot Drinks:** For very mild symptoms, take hot drinks (could be tea, coffee, warm milk, hot water with lemon etc.) few times a day to destroy virus in the mouth and throat. Gargle with warm salt water at least three/four times a day will be very beneficial. Hot soup will also be useful.

**Why:** The virus is very sensitive to **Temperature.** It mainly enters through the **Nose** (WHO). Testing is done with swabs from the nasal cavity and the back of the **Mouth.**

**Important:** Only even **Convecto Room Heater** and **Warm Salt Water gargle,** **Hot Drinks** can serve the main purpose.
The virus is very sensitive to Temperature.

- **Green House (glass):** In winter, it would be useful in poor countries and rural places without electricity. During the day, bright sunshine can provide heat by Green House effect (substitute of Sauna). Sufficiently high temperature can be attained and duration can be adjusted to peoples’ comfort level.

- **Outside Raw Fire:** In underdeveloped countries and rural places, people usually sit in a circle round a camp-fire in winter. They use dry leaves and spare woods for a small fire. That heat in winter could be useful.

- **Substitute of Blow Dryer and Room Heater:** While cooking, all members of the household could be, in turn, stay close to the heat source, for, say, half an hour a day. Also, each individual can use separate folded cotton cloths to take heat from the cooking container and use on the nose.
Caution and Additional Points

Caution: If people already developed major symptoms, then all these methods discussed will not be effective and proper medical advice need to be solicited.

Additional Points:

- **Water Shortage**: Whether frequent Hand Washing can be replaced by sensor-based hand dryer (normally found in washroom), temp controlled.

- **Plastic Disposal**: Personal Protective Equipment (PPE) are single use. World is already under stress due to problems of disposing Plastic. If PPE can be disinfected using heat-based solutions and reused. It can be tested in laboratory and could prove very beneficial.

- **Face Shield /Visors**: In busy public places, mass gathering, and cold premise, face shield will give additional protection. The virus can also enter through eyes (ECDC).

- **Contact Transmission**: For warm, highly populated countries, contact transmission can play important role and appropriate measures are required. Hand washing is useful; Air Conditioned (AC) premises, where mass gathering happens need disinfecting on a regular basis.

- **Very Warm Countries**: Some countries reached temperature more than 40ºC in July-August. In that uncomfortable temperature, people use more AC. That low temperature in confined space can increase transmission.
Solutions: The virus is very sensitive to Temperature

Public

Little Higher Temp of Air Condition (AC) (throughout day)

Fresh Air Circulation:
In AC room, half an hour a day. For warm countries, around early afternoon when temp peaks, will be the best.

High AC Temperature (short period)

Disinfect PPE and other medical equipment using high temperature.

Individual

Important in Old Care Homes, Health Care Centre, Hospitals.

Disinfect whole room (for half an hour)

Important in Old Care Homes, Health Care Centre, Hospitals.

Important in Old Care Homes, Health Care Centre, Hospitals.

Important in Old Care Homes, Health Care Centre, Hospitals.

Sauna

Blow / Hair Dryer (Destroy virus in the nose)

Hot Drinks, warm salt water gargle (Destroy virus in mouth, throat)

Hot air intake through nose

Convector Room Heater

Disinfect office, plane, train, bus, airport etc.

Indrani Roy
Interested in Details


References


- **Lowen** A. C. et al., (2007). Influenza virus transmission is dependent on relative humidity and temperature. Plos Pathogens, 3 (10), 1470–1476, 10.1371/journal.ppat.0030151


Thank You