

The Rise and Fall of Covid -19

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Received 25 March 2021

Abstract: COVID - 19 is a disease which has become pandemic because of transmission of the tiny, single stranded virus, called SARS-CoV-2 or SARS-2. It has infected 111 million people with a death toll of 2.1 million in 217 countries in a span of 13 months (Dec 19 - Jan 21). It is the most widespread disease in the whole of human history quite probably due to the global travels. It may be truly regarded as the first world war because it has been staged by the tiny semi-organism on the entire mankind. There are wide variations in the infection among the 217 countries of the world.

A variety of vaccines has been developed and being put into trials in different parts of the world. Yet, surprisingly the Covid wave has started waning in half the world even without any vaccine; in glaring contrast, medically advanced countries like the USA and the UK are groaning and reeling under the waxing, second and third waves.

This report strongly suggests that (a) the median age of the population and (b) climate condition such as temperature are most likely underlying causes for such marked differences.

Key words: Covid -19; pathogenesis; global picture; trends of corona wave; influences of the median age and temperature.

1 Introduction

A variety of diseases are caused by the micro-organisms such as mold, spore, fungi, bacteria and viruses, with the last two in the lower rungs of the ladder. The bacterium is a single-cell organism and exists all by itself without entering into the

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human cell. So an antibiotic can be employed to kill a bacterium without any serious collateral damage to the adjoining human cell.

This is not possible with the viruses as they are just RNA or DNA “virions” or “particles”, which can replicate only inside a cell feeding on the intra-cellular substances (Zhu N et al 2020, Park SE, 2020) Any attempt to eliminate a virus entails serious implication on the host cell.

The variety of viruses can be broadly classified as single strand RNA (SSR). Double stranded RNA (DSR), single stranded DNA (SSD), double stranded DNA (DSD). Out of these the recent ravages caused by SARS - 2 and the forerunners SARS - 1 and MERS 1 all belong to SSR category. All three virulent strains are transmissible between humans. (Susan R. Weiss et al 2005, Tang, X. et al, 2009)

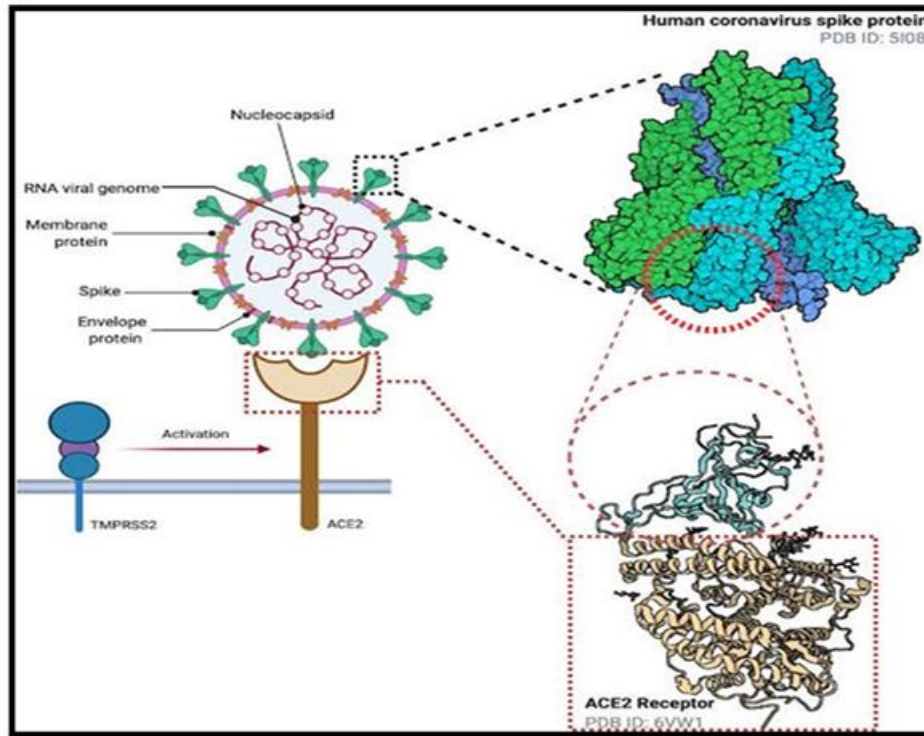


Fig. 1: The lock and key mechanism between the S protein of the corona virus and the ACE2 receptor

Corona viruses are round enveloped viruses and approximately 80 to 120 nm in size. They contain positive-sense RNA, with the largest genome, approximately of 30 kbp (kilo base pair). A helical capsid within the viral membrane is formed by the RNA complexes with the basic nucleo-capsid (N) protein (Fig. 1) The Corona virus contains three major proteins: Membrane protein (M), Spike protein (S), Envelope protein (E). Spike protein that facilitates the fusion and entry mechanism is

subdivided into S1 and S2 regions, forming crown-like morphology (hence corona) of the virus as seen through the electron microscope.

The entry of corona virus into the host cells is mediated by the trans-membrane spike (S) glycoproteins which are present all over and protrude from the viral surface. The functional receptor for the newly emerged corona virus is the ACE2 receptor protein, (angiotensin-converting enzyme 2). It is proposed that Covid makes a strong imbalance in the action of ACE1- and ACE2-derived peptides, thereby enhancing angiotensin II (Ang II) signaling as the primary driver of COVID-19 pathobiology.

Similar to the other respiratory pathogens such as flu and rhinovirus, the transmission of SARS CoV2 occurs through respiratory droplets (aerosols) from coughing and sneezing by a Covid patient or by being carried to oral cavity or nasal mucosa in a closed space or by hands (fomites) from the virus-infested surfaces. The maximum incubation period from infection to appearance of symptoms is 14 days. The disease caused by SARS CoV2 is called the COVID-19. More often the virus infects the alveolar cells responsible for exchange of O₂ and CO₂, consisting of ACE2 receptor (of alveolar T2 pneumocytes). The damaged ACE2, leads to a series of complications and finally death of alveolar cells; patients die of want of adequate oxygen (Wu, et al 2020)

2 Corona infectivity - A global picture (as on Nov 2020)

2.1 Impact of age gap

There are wide variations in the infectivity and mortality rate among the 217 countries of the world. The corona infectivity rate (CIR) defined as the number of infected people per million population is the figure of merit or the inherent property of a country, something like the specific, electrical conductivity of a metal.

The top 35 countries starting from the USA take the big chunk of (around 85%) the corona brunt (49 million out of 56 million as on 20th November, 2020), when all the countries were aware of the impact and have experienced various level of lockdowns and the whole world was in the “pitch of the battle”. The vaccines have NOT entered into the arena.

The trend in the global daily case load was alarming as shown by the Fig. 2 (from the Worldometer 6). This means the infection had tripled in 100 days, from April to August, and doubled from August to November 110 days.

Note, the corona virus has exhibited second and third waves too in many places like the USA, France, Germany (See Fig. 3); but got “contained” with a single hump, in India , as shown below in (Fig.4).

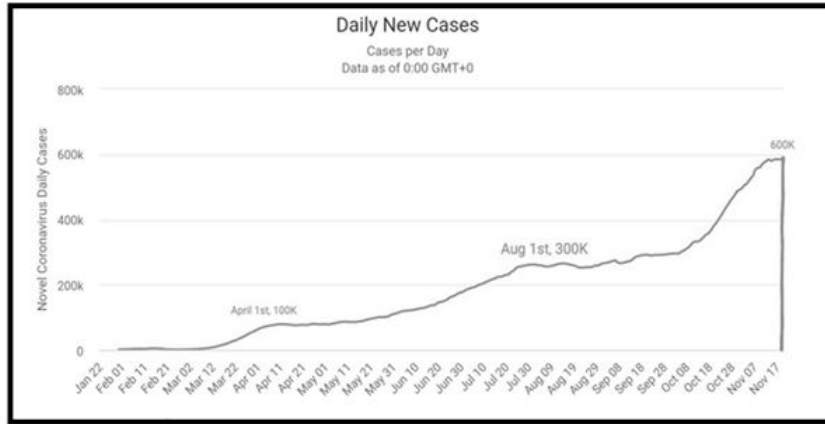


Fig.2: Global daily case load pattern

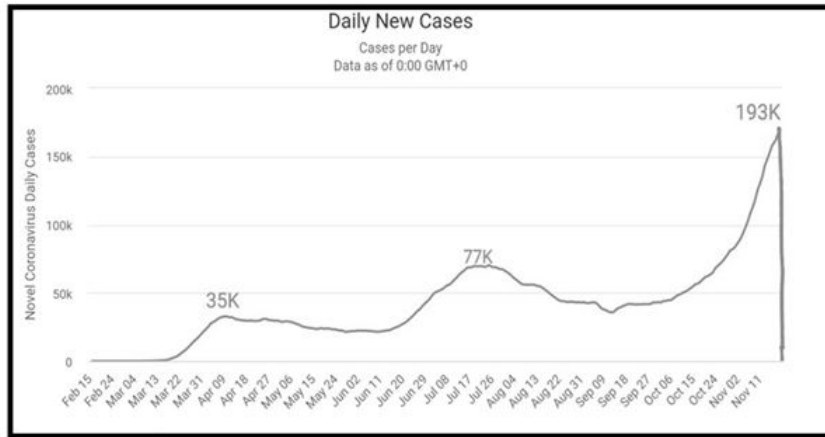


Fig.3: Daily case load in USA

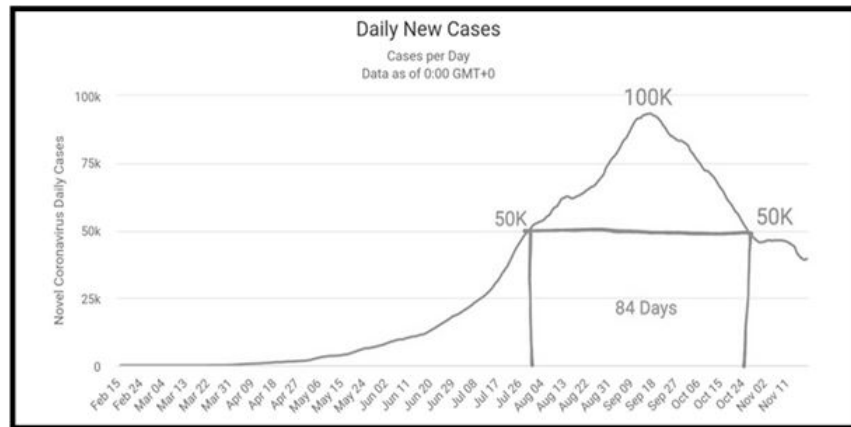


Fig.4: Daily case load in India

Based on the Corona wave patterns the top 24 countries could be classified into two teams; TEAM A (for which there is more than one wave like the USA) and TEAM B (which has just one wave e.g. India). They are listed in Table 1 and Table 2. These tables give the median age of countries of A and B Teams.

Table I: Median ages of European climatic countries groaning under corona: CIR -75000

TEAM A			
COUNTRY	Median AGE	PEAK DATE	TEMPERATURE
USA	38.1	Apr 4	16
BELGIUM	41.4	Apr 12	9
FRANCE	41.4	Apr 4	11
GERMANY	47.1	Apr 2	10
ITALY	45.5	Mar 28	10
UK	40.5	Apr 18	10
RUSSIA	39.6	May 2	2
SPAIN	42.7	Mar20	10
POLAND	40.7	Apr 10	10
UKRAINE	40.5	Apr 30	9
CZECHIA	42.1	-	8
NETHERLAND	43.6	-	10
ROMANIA	42.6	-	10

Median age 42

Table 2: Median ages of countries much less affected by corona: CIR - 10500

TEAM B				
COUNTRY	AGE	BANDWIDTH OF CORONA IN DAYS	PEAK DATE	TEMPERATURE
INDIA	28.1	86	Sep 12	30
BRAZIL	32.4	120	Jul 30	22
ARGENTINA	31.7	90	Oct 10	22
PERU	28	60	Aug 22	22
S.AFRICA	27.3	38	Jul 19	10
CHILE	34.4	170	Sep 10	8
IRAQ	20	60	Oct 06	28
INDONESIA	30.2	50	Jul 3	32
BANGLADESH	26.7	60	Aug 18	30
PHILIPPINES	23.5	50	Jun 14	30
PAKISTAN	23.8	50	Jun 30	35
SAUDI	27.5	50	Sep 23	28
MOROCCO	30.6	50	Sep 20	20

Median age 28.0

A cursory look at the first two columns of the two Tables, alone is enough to reveal the following:

The median age of Team A is 42 while the median age of Team B is only 28 with an age gap of 14 years (something similar to the band gap in semiconductors; see Fig 5). It looks like the corona virus could not penetrate through the age band gap!!

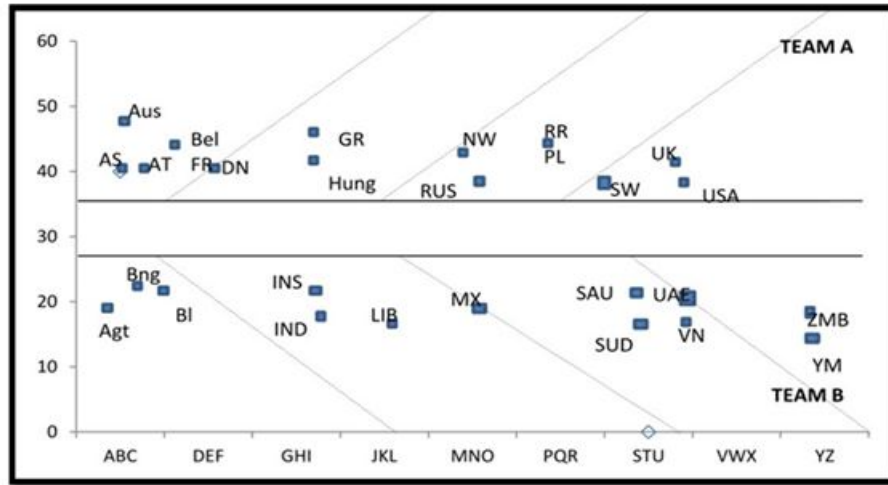


Fig.5: The median age (in Y axis) for a few countries identifiable by three letters: (ind)
for India

Note that Team A consisted mostly Europeans and American countries but Team B in spread is in Asian, South Americans, African countries lying mostly in equatorial and tropical regions. But note, it is not the region but the age that matters, because South Africa and Chile are countries in the Southern hemisphere, far away from the tropics; Indonesian, living under the daily rain is as safe as the Saudis of arid desert.

The second important fact is that the CIR (corona infectivity rate) is thrice higher in Team A than in Team B. Third is that the first peak for all Team A occurred in March to May 2020, the second bigger wave around July - August and the third, the biggest yet, around Nov - Dec 2020. In contrast, for Team B the only peak had occurred in August to October 2020. The most probable reasons for the above distinctly different trends are: SARS-1 and its improved version SARS-2 are single stranded positive sense RNA viruses. Both have more or less same sets of nucleotides in the genetic sequence. Also they both have same types of layers of enclosures and coronalike S protein though the genetic sequence of SARS-2, has undergone a large number of mutations in the intervening period from 2003 to 2019.

For an SSRNA virus like SARS-2 a few millions mutations could have taken place in the intervening period of 16 years since it has been mutating thousand time faster than the next nearest neighbour. During a few such mutations, the spike protein in SARS-2 could have latched very efficiently and specifically to the ACE2 binding protein.

An accidental locking of SARS-2 viruses to the ACE2 receptor of the epithelial cells of lungs of an old man or woman in China got replicated and led to pneumonia and also unsuspected spread to other parts of the world (Italy, Spain UK and USA and then to India etc.) .

2.2 COVID-19 and Comorbidities

According to a carefully studied medical report (Pasquale Pagliaro and Claudia Penna 2020) of Covid impact on 23,188 Italian patients, 3.6% patients had no comorbidities; 14.4% with a single co-morbidity, 21.1% with two, and 60.9% with three or more comorbidities; about 80% were aged above 60. Among these comorbidities, the most represented was the hypertension (69.1%), followed by ischemic heart disease (27.5%), chronic renal failure (21.1%), atrial fibrillation (22%), pulmonary diseases (17.1%), heart failure (16.1%), and some other comorbidities with 15% incidence. Of note was that all these pathologies were characterized by a down-regulation of ACE2 and a high ratio of 12, between ACE/ACE2 (Krishna Sriram , Paul A Insel 2020)

Older people with co-morbidities provide many times higher opportunities than the younger generations for the virus to get latched on. Not only they suffer themselves but become better breeding ground for corona multiplication. This seems to be the characteristics of most of Team A countries.

In Team B countries like India, Pakistan, or Afghanistan, with too many younger people, active down the street, with too little ACE2 receptor in their respiratory system, the so called “herd immunity” got built within few months ; only a small proportion of old people present in these countries, got caught and inflicted by the corona spike.

What has been presented above is the bird’s eye view of the situation obtained in the whole world when the pandemic was on the hectic rise (around Nov 20) to know the inherent strength and weakness of a set of representative countries in the absence any vaccine. Subsequently the impact of the wave has come down significantly everywhere (with or without the vaccine). For example, as on 10th March 21, the daily infectivity load was 471k, which was about the half the peak of 844k on January 21 which in turn was more than the twice of the second peak of 294k on August 20.

2.3 The impact of temperature on Corona infectivity - A global picture

A careful analysis of COVID-19 infectivity waves in most of above listed countries (which covers 85% of the global incidence) had shown three temperature- dependent

daily new cases patterns, based on which three teams were classified.

1. The USA team consisting of about 20 countries (USA, Italy, France, Germany, Poland, Spain, Russia, Portugal, Austria, Switzerland, Sweden, Canada, Romania, Czech, Netherland, Serbia, Hungary, Monaco, Jordan, Iran, Colombia) which had two or even three corona peaks often with higher and higher amplitudes.

The median age for this team was 40; average temperature:8-14C; and the CIR was 75000 respectively.

2. Indian team (India, Iraq, Philippines, Morocco, KSA, Nepal) which had only one wave in July- September and the corona wave got coiled up fast. The corresponding score for them: 26; 27.5C ; and the CIR 10500.
3. Brazilian Team (Brazil, Mexico, Peru Turkey, Chile,) which had one major wave , with peak in June-July, with less intense secondary wave in December with a corresponding score of 30.8 ; 19.5C ; and the CIR 37050

A careful analysis of the above trends clearly shows the following:

1. The peak infection was reached when temperature is 10C+-4C, irrespective of position and median age. Out of all these, it was the USA that manifested representative, classical example of dependence of corona on climate.

The corona incidence pattern in USA team is given in Fig 4. There were three peaks one in Apr 10 and another July 20 (twice bigger) and in Dec 20 (5 times bigger). For about 80 days(Apr 10 to July 2) the Corona was lying low !!

The temperature in New York of USA during this period was as given in Fig 6. It can be easily seen that when the temperature around was around 12°C in October, the second wave, stronger than the April wave, struck. In June, July, August, during the so-called “summer” in the Corona was hibernating for the second kill.

Coming to the Indian team the Corona wave started rather slowly and got steeped up in Sep 25, when the temperature in most part of India except the Deccan plateau and South Indian part goes to 15-20°C; most of other times it was hovering between 25-35°C. Another supporting example for Indian team was Iraq.

The corona pattern and temperature pattern were very similar in India and Iraq; the difference was only in the magnitude. Note, the hottest New York is colder than coolest New Delhi or Baghdad!

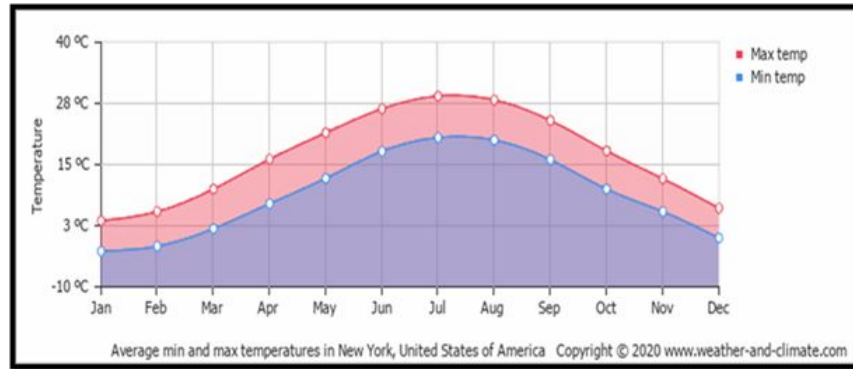


Fig.6: Temperature in New York throughout the year

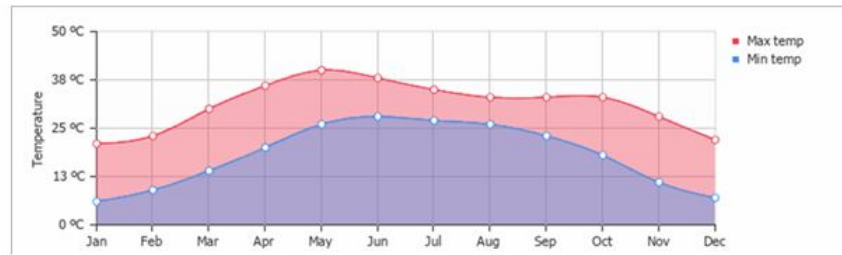


Fig.7: Temperature in New Delhi throughout the year

Note that for the Indian team the average temperature was more than twice and median age was 1.5 less than those of the USA team. Assuming linear dependence on age and temperature a compounded advantage (1.5×2) of more than three had resulted in only one wave with magnitude about 7 times less (mean CIR of 75000 vs 10500). Hence this team is most robust in their resistance against the corona; they had overcome the Covid even without vaccination.

A classic example for the Brazilian team was Chile.

The corona virus incidence had one major wave with a peak in June 2020, when the temperature was around 8°C ; a minimum in October - December, 20 and then a secondary weaker one in Jan 21.

That is because in Chile the winter was in June (8°C) and the summer in November - December (mean temperature 18°C). Note these trends (in peak incidence and temperature) were diametrically opposite to those of Germany because these two were geologically opposite too.

However the Brazilian team is not as lucky as the Indian team because the advantage on median age is 1.3 and on temperature is 1.6. The compounded advantage (1.3×1.6) is only 2. This is reflected in their weaker resistance against the corona and hence these countries experienced the second wave and also the CIR is only half

of the German team. (75000 vs 37050). That is, Team C is somewhere between the two extremes of Team A and B.

There are two out-layers for above trends: they are China, Japan. The corona wave started off seriously in January 2020 but was almost contained in March April, 20, just in three months.

It is interesting to see that how a strong governance could tackle a national medical challenge, despite the vastness of the country and density of the population age, median age (38.4) and average temperature (15°C). The CIR was unbelievably low as much as 620 only; China could just throttle the Covid 19 !

Japan also was also effective in controlling the epidemic but not as efficiently as China. It had a second wave and the CIR was 3310. Perhaps with median age of 48.4 and temperature of 10°C even Japan had to struggle hard to ward of the evil.

3 Corona infectivity - A national picture

What presented was the global picture of impact of temperature on Corona infectivity. The infectivity count depends on the patient search strategy of each country: For example, the health care systems in Pakistan, India, and Bangladesh are not expected to be as effective as the USA and European belt. Under these conditions the CIR as a function of temperature in one single, well developed country like Japan which has a vertical stretch of land mass starting from Hokkaido (in sub-artic) to Okinawa (in sub-tropic) needs special attention. As shown in Table 3 below, there is a negative correlation between the corona infectivity and mean local temperature (Casanova LM et al 2010, Mugen Ujiie et al 2020)

Table 3: Variation of infectivity across different region of single country

PREFACTURE	MEAN TEMP (°C)	COVID incidence
Hokkaido	2.1	26.7
Kyoto	6.9	5.3
Aichi	7.1	15.8
Osaka	8.0	10.2
Tokyo	8.3	6.4
Okinawa	18.7	2.2

It is important to draw attention that corona infectivity is a complex function of population density, median age, international tourism, temperature and humidity. In spite of all these, from the above data one could divide the top three prefectures to have a mean temperature of 4°C and the bottom ones 12°C. Yet the CIR for

the top is 16000, and for bottom 6100. That is, for a three-fold increase in local temperature there is almost three fold decrease in infectivity.

The above picture of infectivity in well-regulated country like Japanese proves that the climatic temperature is overwhelmingly crucial determinant in corona infectivity. It is evident that the temperature factor is stronger than the age factor because the median age for all these Japanese are around 48 and could vary 15% depending upon the prefecture but CIR changes by 250%.

Coming down from the global to the national level and then to the controlled laboratory study, it had been shown that the SARS CoV-2 survives longest at low temperature and extreme level of relative humidity. By a systematic study, they could show the median virus half-life was 24 hours in 10°C and 40% RH (relative humidity), but only 1.5 hours at 27°C and 65% RH. A very similar laboratory study had been reported for SARS Co-V-1 in 2011(Chan et al 2011).

Now the physical conditions for the above correlation between the infectivity and temperature must be addressed.

SARS Co-V 2 viruses are ejected out into the atmosphere as an aerosol, through a sneeze, cough, speech or yawn. A big colony of viruses, mixed in water vapour, float around for a while.

The tiny drops of aerosol hit among themselves and gets deposited naturally on the nearby surface.

They are very similar to the kinetic motion of molecules in a box, in this case the aerosol cloud. As the temperature increases the average number of collision increases and in each collision the integrity and functionality of the virus is reduced for any microorganism, as they are structurally fragile. This situation is more severe for a virus like SARS CoV-2, which is the frailest of the lot. In addition, as the temperature increases, the protective water vapour with which they were ejected out (from a corona patient), decreases, making the mass of the virus colony smaller and hence increasing the inherent speed. They collide more frequently and also more easily carried away by wind or airflow to any other dislocations.

Another factor often overlooked was the role of UVA (400-350nm) and UVB(350 to 300nm) available in sunlight during day time, more abundantly in Team B countries. (We may assume that UVC is almost completely absorbed by the ozone in the atmosphere).

The above radiations are capable of strongly absorbed by the proteins (membrane, capsid, envelope) of the enclosures of the virus RNA. Further, to bring about a genetic mutations on the viruses, UVC is the best but UVB would just suffice. A cleavage in the H bond is more than enough which could be done fairly well with radiation at 300 nm. Only because of the abundance of UVB in sunlight many mutations of RNA and DNA would have taken place and the surface of earth is replete

with a plethora of mutating species. Skin lesions, wrinkles, aging and melanoma were all attributed to the impact of such UVB of sunlight on human skins.

Considering the relative humidity alone at a given temperature, it can be realized that the air becomes more viscous as RH increases; this could make the virus colony left to settle down on nearby surface than hang around for longer time making it possible for an unwary passer -by get infected. In a condition of medium humidity when they settle down on the floor, or road, they get transported by foot, by people, or by animal or machines. An extension of the argument would be that during monsoon or rainy seasons the aerosols of the corona colony would lose its stability. This would reduce the infectivity rate, as it has been observed in multiple equatorial and tropical countries (assuming the outside movements of people were not significantly reduced by the rain).

There seems to be a range of temperature (10 ± 4 degree C)and humidity (RH 50 to 70%) for the optimal infectivity of viruses. Below 5°C and RH of 90% the corona colony spewed out from the mouth of patient would easily freeze forming a thick cloud and settle down directly on the surface (without hanging around) which might get eventually trampled down. This is perhaps the main reason for all arctic countries (Finland, Greenland, etc.) having negligible corona infectivity.

4 Conclusion

In this short report it has been shown that SARS CoV-2 infectivity rate is a complex factor of many factors both on global or national levels.

Yet, the median age and the climatic conditions such as temperature and humidity are the most important crucial determinants in infectivity (keeping others more or less constant).

The importance of age was explained on the basis of lock and key mechanism between the spike protein of SARS 2 and ACE2 receptor enzyme found higher in older people with comorbidities.

It was also shown that the top 35 most affected countries could be classified into three teams based on corona wave: USA team which had three waves of growing amplitude. Indian team which had only one peak in Sep October 2020 and the luckiest of the lot since CIR is 7 time is less than Team A. Bolivian team which had two peaks but with a smaller secondary wave ; the CIR is half only compared to Team A.

The common denominators for Team A countries were that they had environmental temperature around 10°C , and median age 42; the compounded effect of these two led to the highest infectivity. Apart from the global and national pictures in the controlled laboratory modeling too, the negative correlation between temperature and infectivity could be confirmed. The cause underlying such correlation was qualitatively explained in terms of the kinetic energy modeling of the virus colony. As temperature increases they collide and kill themselves. The abundant UVB ra-

diation available in tropical climate could act as a natural sanitizer. In this water content or relative humidity also plays a finite but less significant role.

Declaration: All authors have made approximately equal share in preparation and analysis and have read the paper.

Conflict of Interest: The authors declare no conflict of interest.

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