Effect of Temperature and Humidity on Covid-19 spread in Bhopal.

[1]Sanjula Chaturvedi, [2] Pragya Sourabh, [3]Sharad Gautam

[1]Ph.D. Scholar, [2]Associate Professor, [3]Associate Professor
[1]Department of Environmental Science,
[1]Mansarovar Global University, Bilkisganj Sehore, India

***Abstract*— An attempt was made to evaluate the effect of temperature and humidity on the cases of covid-19 in Bhopal. During the study it was found that there does not exist any correlation between the temperature and the covid cases, likewise humidity also does not show any significant effect with covid spread. Weather conditions such as humidity, precipitations, radiation, temperature, and wind speed could play a secondary role in the transmission of the disease. There are too many contradictory findings to believe the opposite, although a great number of studies suggest that higher temperatures may help to stop the pandemic.**

***Keywords*— Bhopal, Covid-19, Humidity, Temperature.**

I. INTRODUCTION

Corona virus disease 2019 popularly known as (COVID-19) is an infectious disease caused by severe acute respiratory syndrome corona virus 2 (SARS-CoV-2). It was first identified in December 2019 in Wuhan, China, and resulted in pandemic. It is most contagious during the first three days after the onset of symptoms, although spread is possible before the appearance of symptoms. Although the feco-oral route is also a possibility, the novel SARS CoV- 2 appears to spread largely by respiratory droplets, aerosols, and fomites [1]. Environmental elements like humidity and temperature have an impact on how quickly corona viruses propagate [2]. The Middle East respiratory syndrome corona virus (MERS-CoV) and SARS CoV-1, two further members of the corona virus family, displayed temporal associations with temperature and humidity [3], [4]. According to earlier Chinese studies, temperature and the SARS CoV-1 virus are positively correlated while relative humidity and temperature are negatively correlated [5]. However, a Saudi Arabian investigation on the MERS-CoV virus discovered a substantial positive correlation between cases and low humidity and temperature [6]. However, another study found that MERS-CoV infection was significantly influenced by high temperatures and low humidity [7]. As a result, temperature and humidity are crucial factors in the spread of the SARS-1 and MERS-CoV infections. According to recent research, COVID-19 infections are more prevalent in cold and temperate climates than in warm climates, much as how the influenza virus tends to vanish when the temperature is warm. A groundbreaking Chinese study on COVID-19 and environmental factors revealed a strong inverse relationship between COVID-19 instances and temperature and humidity [8].

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II. STUDY AREA

The data relates to the numbers of patients who were suffering from COVID 19 virus in the studied location. The city of Bhopal is the capital of Madhya Pradesh and is situated across latitude and longitude 23.250 North and 77.420 East respectively. The city is divided into rural and urban areas which were selected for the study.

III. DATA COLLECTION

The data was collected from Bhopal Meteorological Department and Office of the District Epidemiologist, Jai Prakash District Hospital Bhopal Madhya Pradesh for first wave of Covid-19 pandemic which ranged from March 2020 to March 2021.

IV. RESULT AND DISCUSSION

In the present study the temperature ranged between 6.6 - 44.5 ^{0}C and the minimum 6.6 ^{0}C. Throughout the present study it was found that highest number of the cases were reported during the late march 2021 (**Fig. 1**) and the lowest number of cases were recorded during the early spread of the pandemic in the march 2020. The highest number of cases reported during the period was 4563 during the last week of march 2021 which accounted for the nearly 8 % (**Fig. 2**) to the total infected cases recorded during the present investigation. It was generally noticed that the number of cases increased with the rising temperature, inspite of the abrupt increase during Late November (**Fig. 3**).

Furthermore, we choose some random values and plotted them with the cases during the temperatures it was found that there exists a relation between the temperature and the spread of covid cases, although found significant to some extent (**Fig.4**). Our results are in concordance with few of the earlier findings [9], [10]. However, several other researchers have reported different relationships with covid spread [11], [12], [13].

In the present study the humidity ranged between 18 gm/m^3 - 96gm/m^3. Throughout the present study it was found that highest number of the cases were reported during the late march 2021 when the humidity values were reported as 31gm/m^3 and 44 gm/m^{3}at morning and evening respectively, on the other hand the lowest number of cases were recorded during the early spread of the pandemic in the march 2020 with morning and evening humidity values as 20 gm/m^3 and 53 gm/m^3 respectively (**Table 1**).

Based on the morning and evening shifts the maximum and minimum humidity values during the morning shifts ranged from 33 gm/m^3-96 gm/m^3 with minimum in April and maximum in August. While in the evening shift the humidity varied from 18 - 78 gm/m^3 where maximum and minimum values were reported during September and April months respectively (**Table 1**). It thus is evident from the data that there exists no significant relationship between humidity and covid spread (**Fig. 5 &6**). One of the reasons behind this may be during higher humidity less number of testing may have been done at covid centres. Due to weather conditions, people may or may not decide to seek medical attention thus affecting the number of patients going to the hospital with COVID-19 [14]. Further the hospital capacity and the workload of medical staff is affected by weather conditions, with potential implications on the number of tests conducted [15], [16].

Correlation with temperature

During the present study it was found that there is no correlation between the temperature and the covid cases as the p -value is higher than 0.05 as revealed from ANOVA (**Table 2&Fig 7**). There has been a lot of debate regarding the effect of temperature on COVID-19 transmissions while predicting the spread of the disease in certain warm countries. It has been suggested that the hot and humid climates in India might have been the cause of relatively low transmission rate of COVID-19 cases. However, it has also argued that strict lockdown plays an essential role in the low transmissions of COVID-19 cases [17]. There has been a debate about the negative effect of temperature on COVID-19 transmissions. In this context Researchers have argued for both the negative and positive effects of temperature on COVID-19 transmissions [18], [19] the virus is highly stable at 4°C, but sensitive to heat. At 4 °C, there was only around a 0·7 log-unit reduction of infectious titre on day 14. With the incubation temperature increased to 70 °C, the time for virus inactivation was reduced to 5 min."

Various researchers across the globe suggest a negative correlation between COVID-19 and temperature. A negative correlation was found in worldwide studies at different places like California, Japan, Ghana, Spain, Italy and China [20-37]. Further there exists a Negative relationship between temperature and COVID-19 transmission [38], [39]. A significant negative influence of temperature on daily cases of COVID-19 is vigorous [40].

However, other studies came to the opposite conclusion reporting a positive correlation between COVID-19 and temperature in Jakarta [41] and New York [42], or no association in countries such as Spain [43], Iran [44], [45] Nigeria [46] and in a worldwide study [47]. Further Two worldwide analyses [48] and another one in China [49] found an unclear association between temperature and COVID-19, or an association depending on the temperature range in countries such as Brazil [50], [51], China [52] and India [53]. All these studies considered thus obtained controversial results and none found clear evidence that a temperature rise reduces case counts of COVID-19.

Regarding the covid pandemic transmission various researchers have put forth different views. A higher temperature reduces the spread of the virus and Precipitation shows low influence on COVID-19 spread while higher relative humidity is the protection factor for the control of covid 19 transmissions [54]. At the same time another opinion suggested that absolute humidity and temperature are associated with local exponential growth of COVID-19 across provinces in China and other affected countries [55]. Further the absolute humidity and temperature yielded a positive relationship and a slight negative relationship respectively. In contrary to this one of the findings revealed that the doubling time in cases correlates positively with temperature and inversely with humidity, suggesting that a decrease in the rate of progression of COVID-19 is likely with the arrival of spring and summer in the north hemisphere [56]. These findings are further supported by one study which revealed that COVID-19 has a greater impact in drier and colder weather conditions than in places where the weather is wetter and warmer [57]. Further it has been observed that temperature and humidity contribute to a maximum of 18% of the progression of covid cases and the remaining 82 % being related to other factors such as containment measures, general health policies, population density, transportation, cultural aspects [58]. As per further study changes in weather alone does not lead to declines in case count of covid - 19 but the implementation of extensive public health interventions also behaves as a significant factor [59]. In this respect quality of air along with Average and minimum temperature has been found to significantly influence the transmission of COVID-19 [60-62]. However, a relationship with mortality due to covid and humidity and temperature is also prevalent [63].

Correlation with humidity

On overall basis during the present investigation we found out that there does not exist any specific correlation between humidity and the covid 19 cases. Our results are further supported by ANOVA (**Table 3&Fig 8**).Various researchers have revealed negative correlation between COVID-19 and humidity, in a worldwide context [64], Mainland China [65] Ghana [66], India [67] and Iraq [68]. However, other studies suggest the opposite association, showing a positive correlation between COVID-19 and humidity (3 out of 27) in China [69], [70] and in a worldwide study [71], or no association (6 out of 27) such as those on New York [72] and Jakarta [73].

Absolute humidity showed a negative relationship, indicating that locations with higher absolute humidity experienced lower transmission [74]. Studies suggested a significant negative influence of humidity on daily cases of COVID-19. Interaction effect of humidity is robust in case of daily COVID-19 cases [75].

V. CONCLUSION

Changes in weather alone will not necessarily lead to declines in case counts without the implementation of extensive public health measures [76]. Moreover, there are certain factors like migrant workers, high density of population, poor health hygiene etc. that might also contribute to an increasing number of cases besides metrological parameters. The important findings in our study were

a statistically significant association of COVID-19 cases with an increase in the total number of tests. This is also being reflected in the country as cases have rampantly increased after increase in COVID-19 testing capacity. Weather conditions such as humidity, precipitations, radiation, temperature, and wind speed could play a secondary role in the transmission of the disease. There are too many contradictory findings to believe the opposite, although a great number of studies suggest that higher temperatures may help to stop the pandemic.

Figures and Tables

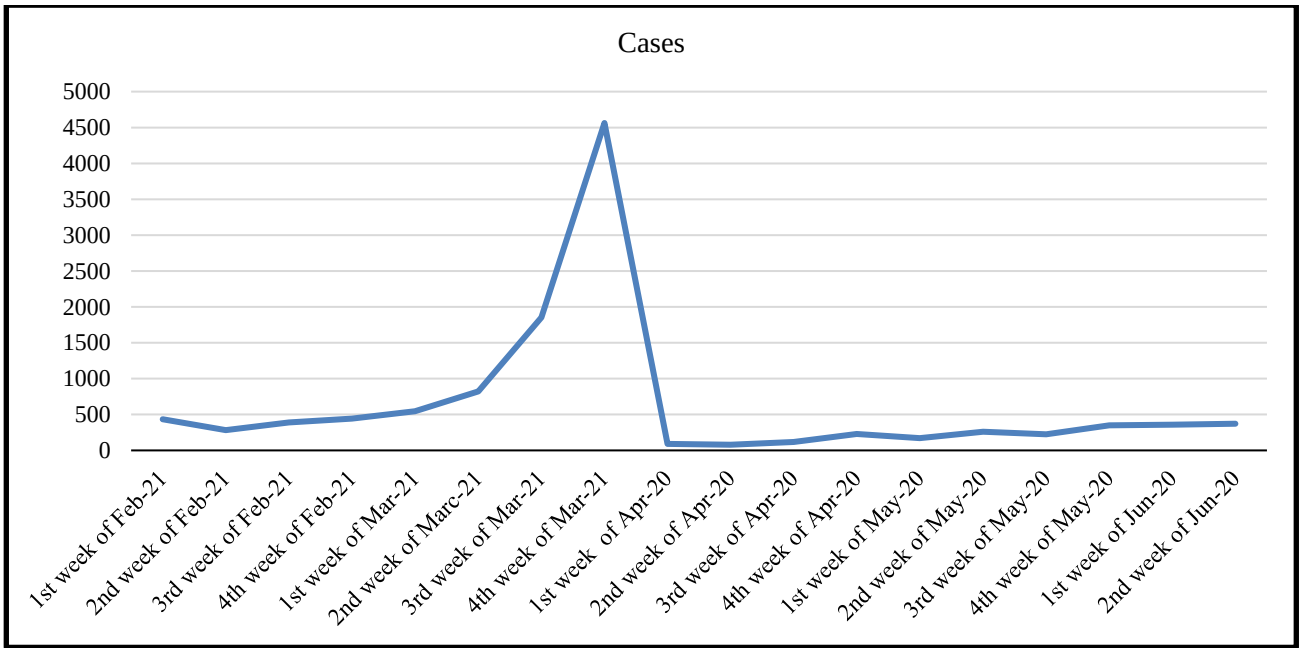

Fig. 1: Shows number of cases recorded during different weeks of study period.

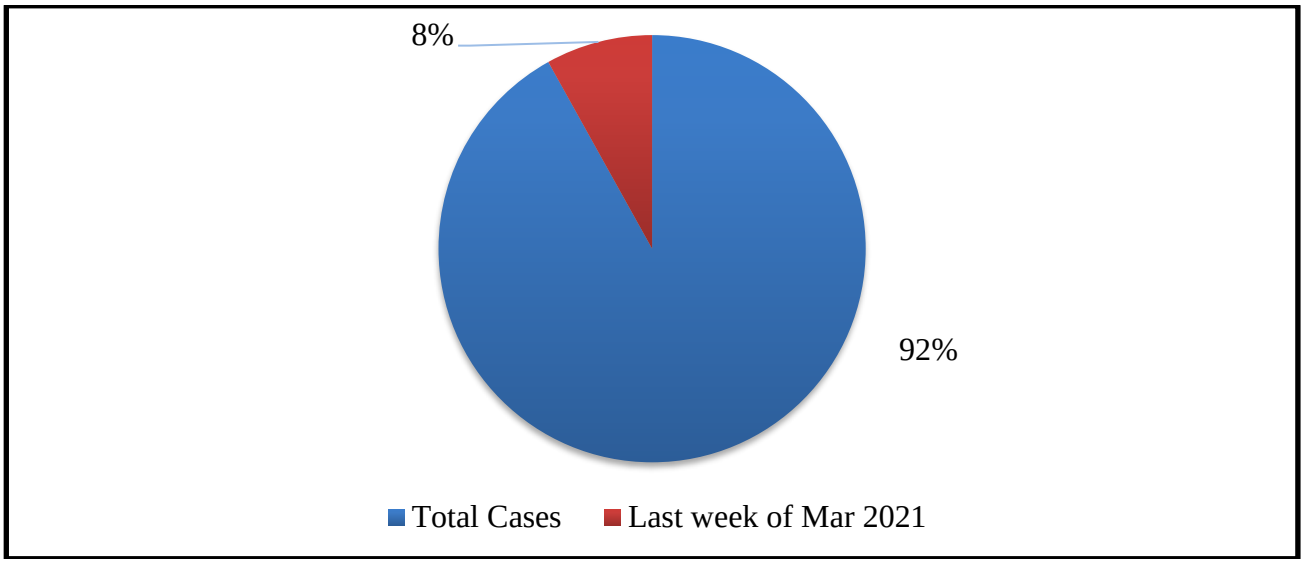

Fig 2: Shows percent contribution of cases recorded during the Last week of March 2021.

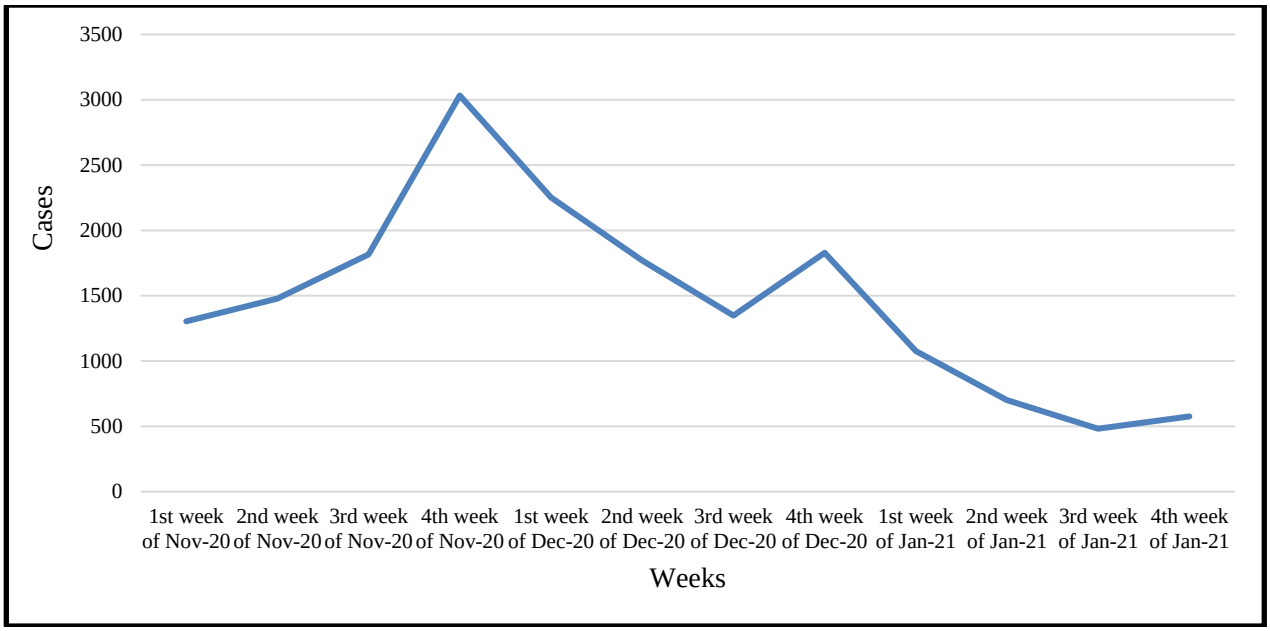

Fig. 3: Shows rise of cases during Late November.

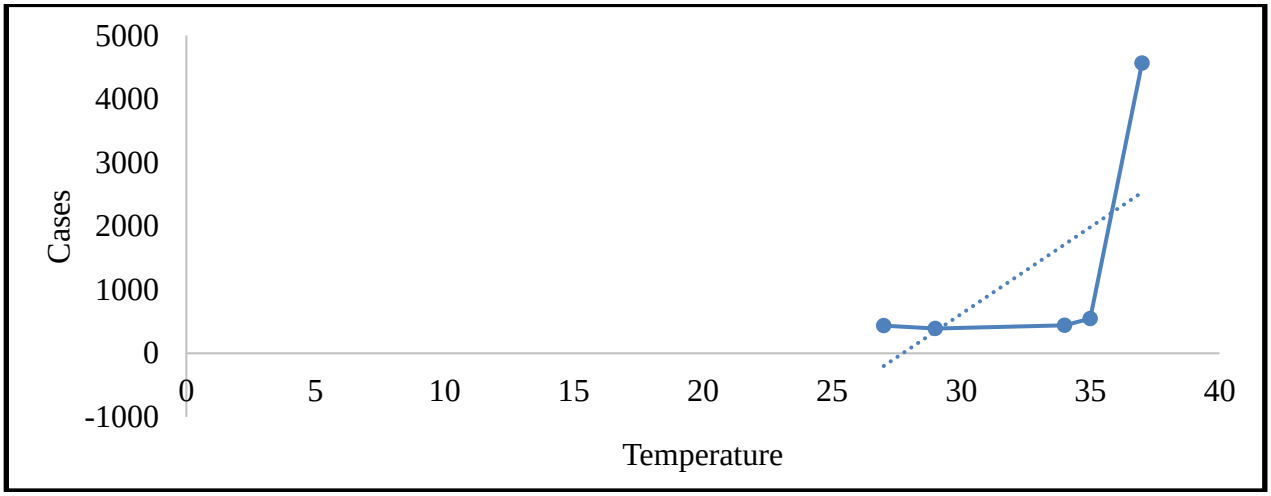

Fig. 4: Depicts relationship between cases and Temperature.

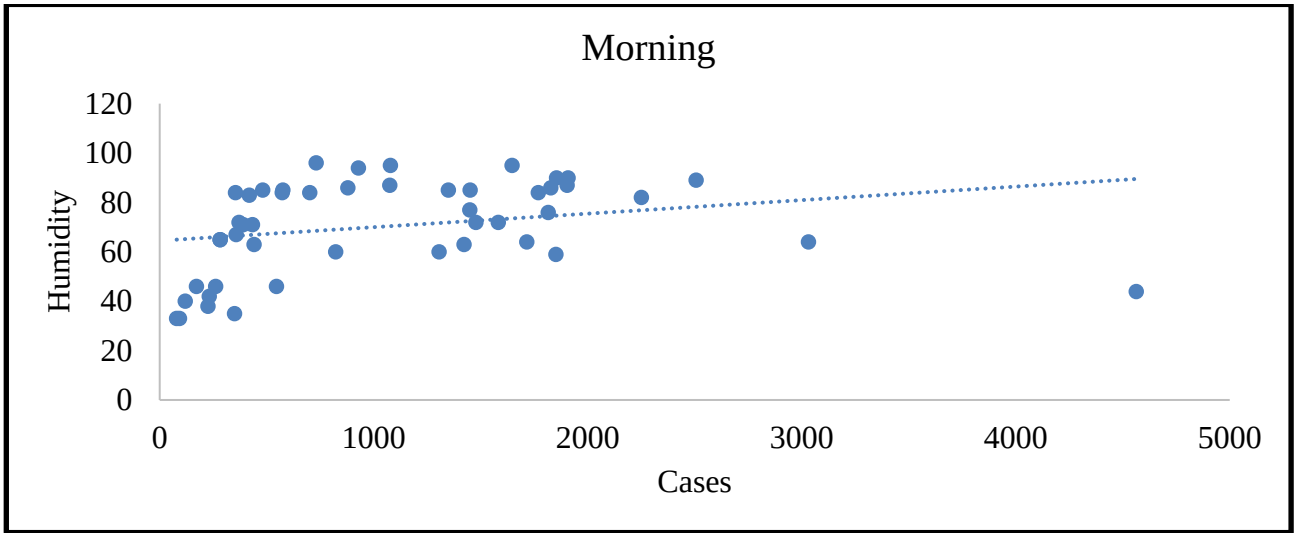

Fig. 5: Depicts relationship between cases and Humidity during Morning.

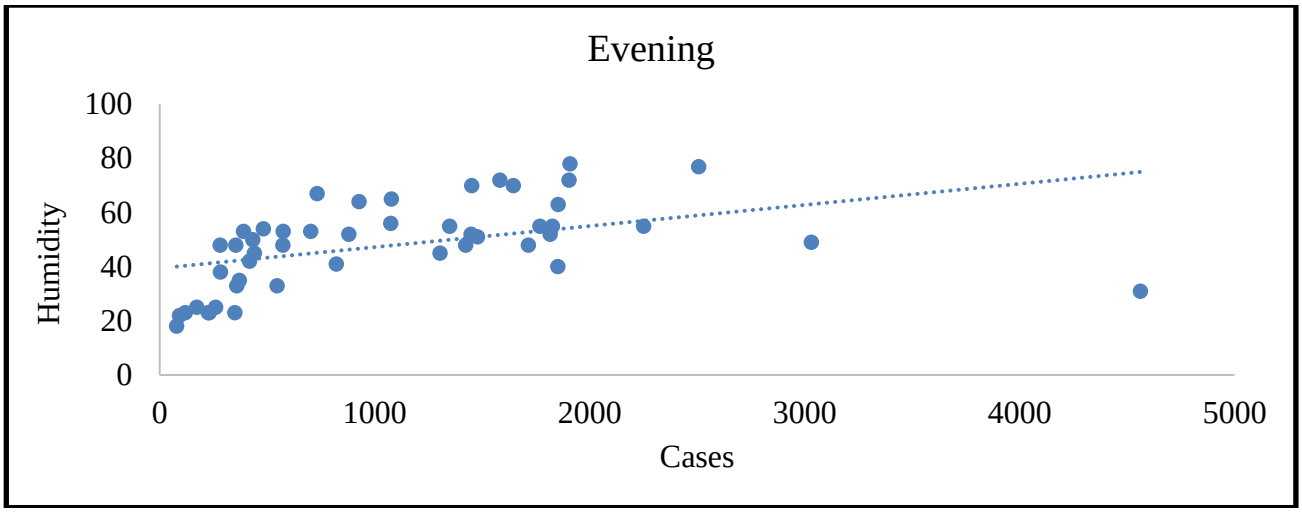

Fig. 6: Depicts relationship between cases and Humidity during evening.

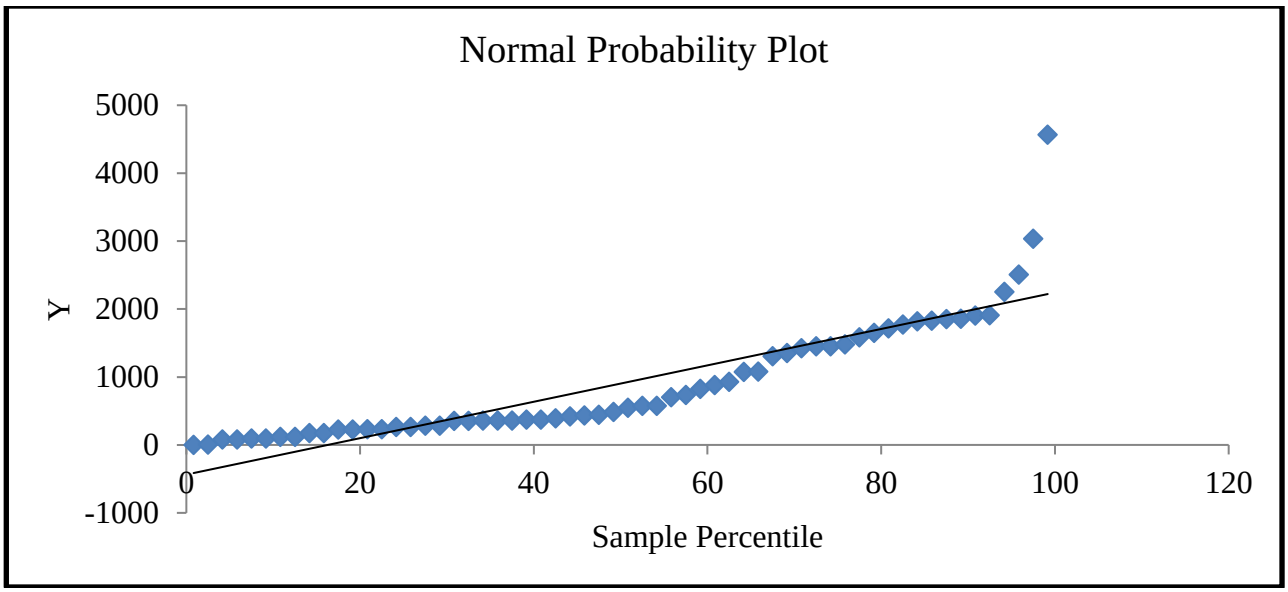

Fig. 7: Shows Normal Probability Plot between overall Temperatures with Covid cases.

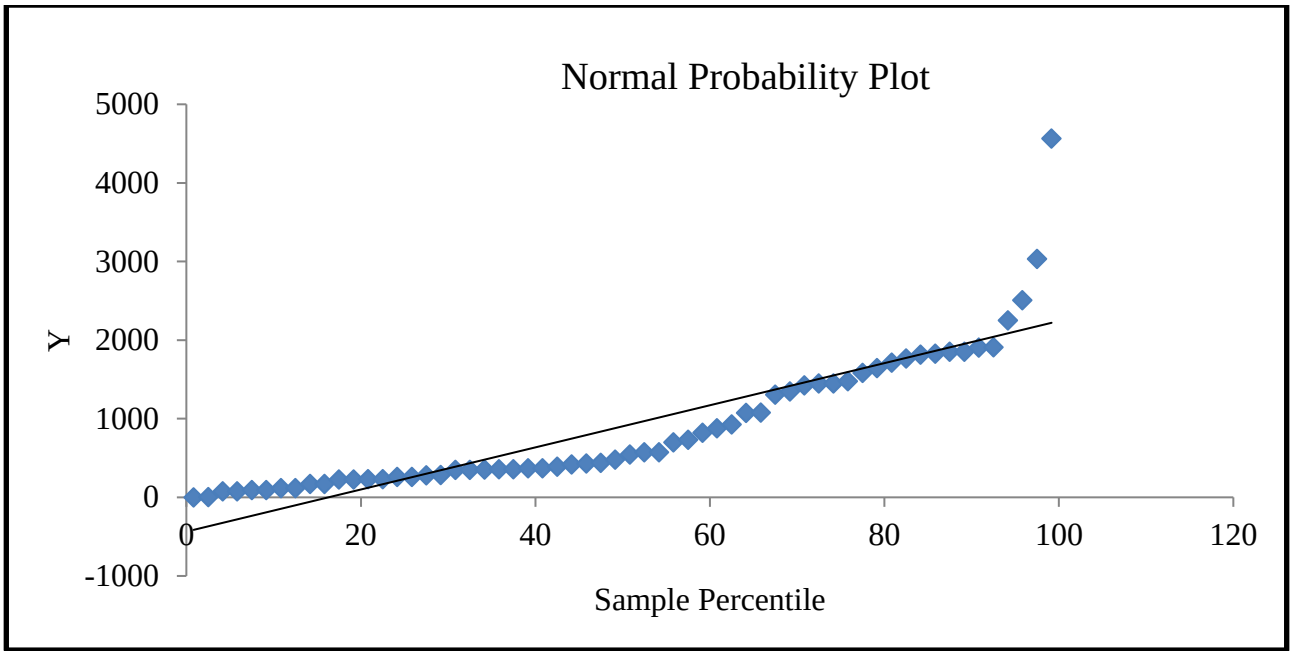

Fig. 8: Shows Normal Probability Plot between overall Humidity and Covid cases.

Table 1: Shows overall Humidity, Rainfall and Temperature during the study period.

	Humidity			Temperature		
Weeks	Morning	Evening	Rainfall	Maximum	Minimum	Cases
3rd week of Jun-20	65	38	38	35	24	283
4th week of Jun-20	84	48	7.73	34	23	355
1st week of Jul-20	83	42	1.5	33	25	418
2nd week of Jul-20	84	48	4.7	32	25	573
3rd week of Jul-20	86	52	2.3	33	25	880
4th week of Jul-20	90	63	7.3	33	24	1854
1st week of Aug-20	95	65	4.96	31	25	1078
2nd week of Aug-20	96	67	7.68	29	24	732
3rd week of Aug-20	94	64	9.41	28	23	928
4th week of Aug-20	95	70	50.93	29	22	1646
1st week of Sep-20	85	70	0	34	26	1451
2nd week of Sep-20	87	72	7.34	33	24	1904
3rd week of Sep-20	90	78	6.77	33	25	1909
4th week of Sep-20	89	77	6.84	31	26	2507
1st week of Oct-20	72	72	0	34	23	1582
2nd week of Oct-20	63	48	0	33	23	1423
3rd week of Oct-20	77	52	3.52	33	22	1449
4th week of Oct-20	64	48	0	32	21	1715
1st week of Nov-20	60	45	0	30	20	1305
2nd week of Nov-20	72	51	0	30	21	1478
3rd week of Nov-20	76	52	0	29	20	1816
4th week of Nov-20	64	49	0.01	30	20	3032
1st week of Dec-20	82	55	0	28	18	2251
2nd week of Dec-20	84	55	1.1	23	10	1769
3rd week of Dec-20	85	55	0	23	10	1349
4th week of Dec-20	86	55	0	25	6.6	1827
1st week of Jan-21	87	56	0.28	27	10	1075
2nd week of Jan-21	84	53	0.7	23	11	702
3rd week of Jan-21	85	54	0	26	11	482
4th week of Jan-21	85	53	0	25	13	575
1st week of Feb-21	71	50	0	27	14	433
2nd week of Feb-21	65	48	0	30	16	282
3rd week of Feb-21	71	53	0	29	16	390
4th week of Feb-21	63	45	0	34	20	441
1st week of Mar-21	46	33	0	35	21	546
2nd week of Mar-21	60	41	0.7	34	21	822
3rd week of Mar-21	59	40	0	34	21	1852
4th week of Mar-21	44	31	0	37	21	4563
1st week of Apr-20	33	22	0	37	20	92
2nd week of Apr-20	33	18	0	38	22	79
3rd week of Apr-20	40	23	0.1	38	23	119
4th week of Apr-20	42	23	0	39	24	231
1st week of May-20	46	25	0.08	41	24	172
2nd week of May-20	46	25	5.43	39	23	261
3rd week of May-20	38	23	0.08	41	25	226
4th week of May-20	35	23	0	43	29	350
1st week of Jun-20	67	33	12.26	34	25	358
2nd week of Jun-20	72	35	2	37	25	371

Table 2: Shows Analysis of variance between overall temperature and Covid Cases.

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	3299502	3299502	4.537192	0.03742
Residual	58	42178317	727212.4		
Total	59	45477819			

Table 3: Shows Analysis of variance between overall Humidity and Covid Cases.

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	10335435	10335435	17.0579	0.000118
Residual	58	35142384	605903.2		
Total	59	45477819			

VI. Acknowledgment

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