

## Review Article

# Epidemiology, pathogenesis, diagnosis and outcome of SARS-COV-2 cases in Uttar Pradesh: descriptive analysis

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## ABSTRACT

Corona virus is one of the major pathogens that primarily target the human respiratory system. Previous outbreaks of corona viruses include the severe acute respiratory syndrome (SARS)-CoV-2 and the Middle East respiratory syndrome (MERS)-CoV which have been previously characterized as agents that are a great public health threat. In late December 2019, a cluster of patients was admitted to hospitals with an initial diagnosis of pneumonia of an unknown etiology. These patients were epidemiologically linked to a sea food and wet animal wholesale market in Wuhan, Hubei Province, China. In India on 30th January 2020 first positive case in a student from Kerala of the SARS-CoV-2 infection, who was studying in Wuhan University and had travelled to India, tested positive by reverse transcriptase polymerase chain reaction (RT-PCR). As of 15th March 2021, in India total confirmed cases 94,61,901 recovery 88,47,600 death 1,37,582 have been reported from 32 states/union territories in U.P. state has 6,05,290 confirmed cases, resulting in 8,746 deaths and 595,637 recoveries. The case fatality rate in Uttar Pradesh was stands at 1.4%. Among different districts of U.P., the Lucknow was listed as first with 82,213 cases, 80,740 recovered and 1,190 deaths. Next states were Kanpur; 33,111 cases, and 839 deaths, Prayagraj 29,436 cases, and 409 deaths, Meerut; 22477 cases, and 442 deaths, Ghaziabad 26902 cases, 26694 recovered, 102 death and Gorakhpur 21510 confirmed case 21115 recovered and 366 deaths till 15th March 2021.

**Keywords:** SARS-CoV-2, COVID-19, Epidemiology, RT-PCR, HRCT, ELISA

## INTRODUCTION

Coronavirus is one of the major pathogens that primarily target the human respiratory system. Previous outbreaks of corona viruses include the severe acute respiratory syndrome (SARS)-CoV-2 and the Middle East respiratory syndrome (MERS)-CoV which have been previously characterized as agents that are a great public health threat. These patients were epidemiologically linked to a seafood and wet animal wholesale market in Wuhan, Hubei Province, China.<sup>1-2</sup> Early reports predicted the onset of a potential Coronavirus outbreak given the estimate of a reproduction number for the 2019 Novel (New) Coronavirus Disease-19 (COVID-19, named by WHO on

February 11, 2020) which was deemed to be significantly larger than 1 (ranges from 2.24 to 3.58).<sup>3</sup> The SARS-CoV-2 belongs to the same corona virus group (Betacoronavirus) as SARS and MERS viruses that caused two of the more severe epidemics in recent years. As with SARS and MERS, this new corona virus, 2019-nCoV, is believed to be of zoonotic origin, but may also be transmitted through the respiratory tract, by direct contact, and possibly via patient's excreta which may contain the living virus.<sup>4</sup>

In India on 30<sup>th</sup> January 2020 first positive case in a student from Kerala of the SARS-CoV-2 infection, who was studying in Wuhan University and had travelled to India,

tested positive by reverse transcriptase polymerase chain reaction (RT-PCR). Soon after this, it became a global concern.<sup>5</sup> The SARS-CoV-2 pandemic in Uttar Pradesh (UP), India was first confirmed on 4<sup>th</sup> March 2020, with the first positive case reported in Ghaziabad. As of 15<sup>th</sup> March 2021, the UP has 6,05,290 confirmed cases, resulting in 8,746 deaths and 595,637 recovered.<sup>6</sup> The case fatality rate (CFR) in Uttar Pradesh stands at 1.4%. The COVID-19 is increasing day by day in India and among different states. In mid of August and first week of September 2020 in India, with over more than 90,000 cases reported per day and have since come down to below 15,000 in mid February and the covid-19 case was increase as of date 15 March India was reported 26386 cases. After consecutive declining for six weeks, COVID-19 cases increased India over for the first time last week. India, highest number of cases (97,399) recorded in the country in a single day on 10th September, 2020 and 8th September 2020 highest number (1,133) of COVID-19 related deaths. The situation of COVID-19 pandemic becomes critical to control day by day the interference of local administrators, state governments and central government as well. The entire world is not only losing their social economical strengths but also lost millions of lives till date in several countries including India.<sup>7</sup> The outbreak of COVID-19 has affected more than 120 million patients, recovered 68.1 million, and 2.66 million deaths were reported as on date 15 March 2021 worlds wide in 208 countries, areas, or territories with a CFR of 3.4% globally.

### CLINICAL CHARACTERISTICS OF COVID-19 CASES

The symptoms of COVID-19 remain very similar to those of the other respiratory epidemics in the past, which include SARS and MERS, but here wide range of symptoms includes mild fever to septic shock. Some intestinal disturbances were reported with the other epidemics, but COVID-19 was devoid of such symptoms. When examined, unilateral or bilateral involvement compatible with viral pneumonia is observed in the patients, and bilateral multiple lobular and sub-segmental consolidation areas were observed in patients hospitalised in the intensive care unit. The co-morbid patients showed a more severe clinical course than predicted from previous epidemic.<sup>5</sup> In patients with COVID-19, the most common clinical symptoms are fever and cough, shortness of breath, and other breathing difficulties in addition to other nonspecific symptoms, including headache, dyspnea, fatigue, and muscle pain.<sup>8</sup> Moreover, some patients also report digestive symptoms such as diarrhea and vomiting.<sup>9</sup> <sup>10</sup> Fever occurred in 98-100% of patients with SARS or MERS, compared to 81.3% of patients with COVID-19.<sup>11</sup> Approximately 18.7% of patients had no fever at admission, suggesting that the absence of fever could not rule out the possibility of COVID-19.<sup>10-11</sup> Although patients initially have fever with or without respiratory symptoms, various degrees of lung abnormalities develop later in all patients, and these can be seen on chest CT (CT).<sup>12</sup> Although diarrhea is present in approximately 20-

25% of patients infected with MERS-CoV or SARS-CoV-2, intestinal symptoms have rarely been reported in patients with COVID-19.<sup>13</sup>

### Pathogenesis

Angiotensin-converting enzyme-2 (ACE2) is used by the coronaviruses as a receptor for entrance to the related cell. These receptors are commonly found not only in lung epithelial cells but are also located in small intestinal enterocyte cells, heart cells, and kidney endothelial cells.<sup>14</sup> It is proved that SARS-CoV-2 binds to ACE2. SARS-CoV-2 primarily targets the lungs, the vasculatures, and the immune system.<sup>15</sup> The initial step of the viral multiplication is the binding to the surface of respiratory cells mediated by the spike (S) viral protein.<sup>16</sup> It had been speculated that SARS-CoV-2 likely utilize angiotensin-converting enzyme 2 (ACE2, EC 3.4.17.23) of various mammals, except murines and a few birds, such as pigeon.<sup>17</sup> The affinity of SARS-CoV-2 for ACE2 is 10–20-higher than that of SARS-CoV.<sup>17-18</sup>

ACE2 is a metalloproteinase and shares about 60% homology with the carboxypeptidase angiotensin-converting enzyme (ACE, EC 3.4.15.1). ACE2, which is made up of 805 amino acids, is type I transmembrane glycoprotein having a single extracellular catalytic domain (Figure 1).<sup>19</sup> Its expression is reported in the lungs, cardiovascular system, gut, kidneys, CNS and adipose tissue. It is the key active peptide of the renin-angiotensin system (RAS) or renin-angiotensin-aldosterone system (RAAS) Angiotensin II (Ang II) is the major effector of the RAAS that advances hypertension partly by decreasing baroreceptor sensitivity to maintain heart rate, and increasing vasoconstriction, sodium retention, oxidative stress, inflammation and fibrosis.

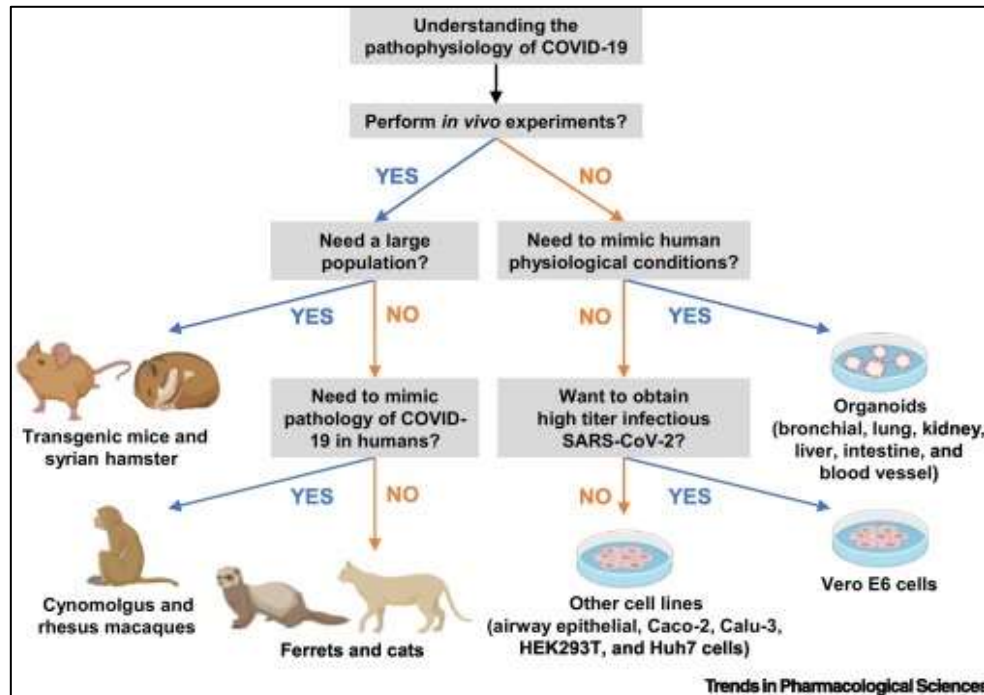
Evidence from various studies favours a crucial function of ACE2 to efficiently degrade Ang II to Ang-(1-7), which antagonizes the effects of Ang II.<sup>20</sup> Ang-(1-7) acts on the Mas receptors that modestly reduce blood pressure through vasodilation, promoting excretion of sodium and water by the kidney, and also attenuate inflammation through the nitric oxide production. On the contrary, ACE converts Ang I into Ang II, which acts at the type 1 angiotensin receptor (AT1R) and increase blood pressure by inducing vasoconstriction, increasing kidney reabsorption of sodium and water by the kidney, and generating oxidative stress to promote inflammation and fibrosis.<sup>20-21</sup>

### COVID-19 virus structure, genome and its variations

COVID-19 is a spherical or pleomorphic enveloped protein particles containing single-stranded (positive-sense) RNA associated with a nucleoprotein within a capsid comprised of matrix protein. The envelope bears club-shaped glycoprotein projections. Some coronaviruses also contain a hem agglutinin-esterase protein (Figure 2).<sup>22</sup> The size is highly variable and generally is an average

diameter of 120 nm. Extreme sizes are known from 50 to 200 nm in diameter.<sup>23</sup> The total molecular weight is on average 40,000 kDa. They are enclosed in an envelope

embedded with a number of protein molecules.<sup>24</sup> The lipid bilayer envelope, membrane proteins, and nucleocapsid protect the virus when it is outside the host cell.<sup>25</sup>

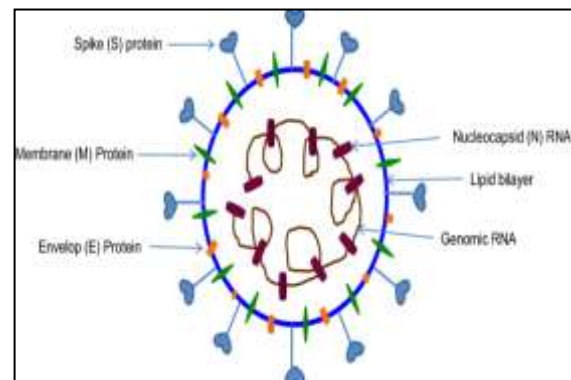


**Figure 1: Pathophysiology of COVID-19.**

Corona viruses contain the largest genomes structure between 26.4 to 31.7 kilo bases among all known RNA viruses, with Guanine and Cytosine contents varying from 32% to 43% of its total overall genomic material. The variable numbers of small ORFs and RDRP gene are present between the various conserved genes (ORF1ab, spike, envelope, membrane and nucleocapsid) and the genome terminal has a 5' methylated cap and a 3' polyadenylated tail downstream to the nucleocapsid gene in different coronavirus lineages. The viral genome contains distinctive features, including a unique N-terminal fragment within the spike [S] protein envelope [E], membrane [M]. Genes for the major structural proteins in all coronaviruses occur in the 5-3 order as S, E, M, and N.<sup>26</sup> The E proteins facilitate assembly and release of the virus but also have other functions. For instance, the ion channel activity in SARS-CoV-2 E protein is not required for viral replication but is required for pathogenesis.<sup>27</sup> The N protein constitutes the only protein present in the nucleocapsid. It is composed of two separate domains, an N-terminal domain (NTD) and a C-terminal domain (CTD), both capable of binding RNA in vitro, but each domain uses different mechanisms to bind RNA. It has been suggested that optimal RNA binding requires contributions from both domains and it also seen N protein is also heavily phosphorylated.<sup>28</sup> Recent SARS-CoV-2 work has also shown that the membrane exopeptidase ACE enzyme (angiotensin-converting enzyme) functions as a COVID-19 receptor to enter the human cell especially through it.

#### Methods of diagnosis

Development of the accurate and rapid diagnostic testing is essential to control virus outbreak. These tests must be sensitive, reliable, and scalable. Medical screening of coronavirus depends on the past infections, clinical demonstration, and nautical tests including the screening of viral nucleic acid by a swab test, CT scan, immune identification technology (IgM/IgG antibody tests), and blood culture.<sup>29</sup>



**Figure 2: Structure of SARS-CoV-2.**

Due to the complexity of coronavirus, it is recommended to use the combined technologies to make a precise diagnosis. Overall, while nucleic acid testing is appropriate for the detection of the coronavirus since, it

helps in the critical episodes. To improve the detection pathways, employing both the gene detections and the serological methods could be a prominent strategy at the situation to improve the accuracy of the corona virus diagnosis. The following sections will discuss the current methods for diagnosis of human coronavirus.

### ***Nucleic acid detection-based methods***

The nucleic acid detection is a genetic molecular diagnostic technique that applies to detect the specific nuclear sequence through which the specific species, organism, or genera can be identified. To diagnose such organisms by targeting the nucleic acid sequences, synthetic amplification method is required. As such, the nucleic acid detection methods are master on amplification using the primers and probes to detect the specific organism for specific diseases.

### ***RT-PCR***

RT-PCR is considered the 'gold standard' method for detection of human coronaviruses due to being quantitative and specific. In a schematic illustration of RT-PCR, PCR works on enzymatic way that replicates a single gene into multiple copies by separating the two strands of DNA where the gene segment is present. The gene segment is located when it is marked by the primer, and the first sequence is made by the DNA polymerase that assembles each of the segments. Then, it is copied to form multiple copies, which is amplified in minutes.<sup>30</sup> Prior to the intervention of RT-PCR, the broad range PCR which can process the amplification for the complete genera was used for the viral detection.<sup>31</sup> Recently, the ORF1b and the N regions of the viral genome were detected via with real-time RT-PCR. In this method, the clinical samples were diagnosed finding two positive cases proving viability of technique suitable for samples of human origin.<sup>32</sup> This RT-PCR test working on the principle of fluorescence indicated 71.2% positive cases. On the other hand, the serology test based on IgM and IgG antibodies working on the principle of chemo-luminescence indicated 93.2% positive cases among the serious patients.

### ***Antibody-based serology detection***

Antibodies can be described as the body's specific proteins that are produced by the white blood cells to line against the foreign particles or infections. Thus, antibodies leave the trace of its mechanism in the body after its action and make it possible to identify those become immune after COVID-19 infection. Therefore, being specific to COVID-19, a very precious activity of these antibodies is that they protect the COVID-19 recovered patient from re-infection, while the PCR methods are not able to do this. Currently, two strategies are used for detection of antibodies for diagnosis of COVID-19 infection. One is to design the antigen that mimic the antigen of virus to detect the human antibody and the second is to design the test antibody that trap the viral antigen. Based on the recent studies, an

overall timeframe for the generation of antibodies (IgM, IgG) and antigen were shown in the for SARS-CoV-2 infected patients.

The IgM antibodies are expressed only after 3 to 7 days of infection and robust responses can be obtained in second week of infection, while the IgG antibodies take 8 days to reach the detectable level. The antibody-based methods are not useful in the early diagnosis as it can be adopted only after infection and makes the situation difficult by not being able to find if the patient is already recovered or newly infected. During the SARS-CoV-1 and the MERS-CoV's period, several immunoassays were developed for detection of antibodies but all of those are reported to have the cross-reactivity.<sup>33-34</sup>

The first line is usually the test line which contains the capture antibodies specific to a particular region of SARS-CoV-2 antigen while the second line is the control line with gold nanoparticle-antibody conjugate to ensure a valid result.<sup>35</sup> An immunochromatographic assay was developed for the detection of SARS-CoV-2 in NP and OP swabs within 10 minutes. It uses the colloidal gold-labelled IgG targeting N antigen with sensitivity and specificity of 93.9% and 100% respectively.<sup>36</sup>

### ***Enzyme-linked immunosorbent assay (ELISA)***

ELISA can be qualitative or quantitative and generally require a lab. These tests usually use whole blood, plasma, or serum samples. A plate is coated with a viral protein, such as a SARS-CoV-2 spike protein. Samples are incubated with the protein, allowing any antibodies to bind to it. The antibody-protein complex can then be detected with another wash of antibodies that produce a color/fluorescent readout.<sup>37</sup>

### ***Computed tomography (CT) scan***

Computed tomography (CT) scan is a medical technique, which produces cross-sectional images by combining multiple X-ray measurements at different angles across a patient's chest. It helps the diagnosis of lung lesions and reveals the radiological changes in the lungs. It was observed that 76.4% of COVID-19 patients were manifested as pneumonia upon admission.<sup>38</sup> The typical pattern on CT imaging includes ground-glass opacity with consolidation, bilateral patchy shadowing and peripheral distribution with rare observed pleural effusion and lymphadenopathy.<sup>39</sup>

## **FUTURE PERSPECTIVES AND BARRIERS**

Currently, nucleic acid-based molecular tests are still considered the gold standard for the diagnosis of COVID-19 disease. The detection time has been reduced to 30 min. It is a highly sensitive specific technique in the diagnosis of infected COVID-19 patients. RT-PCR is the most used test among molecular techniques. The requirement of reliable control for confirmation, the necessity for expensive equipment and trained person, certificated



reagents, and laboratory facilities are known disadvantages of molecular methods. In future applications, alternatives such as LAMP and CRISPR-Cas methods may become more common as they are a less costly, simple procedure.<sup>40</sup> The biosensor-based virus detection systems that utilize nanotechnology and microfluidics and instrumental advances are predicted to be among the most promising technologies in pandemic situations like COVID-19.<sup>41</sup> In the future, it is thought that easier and more mature biosensor platforms will replace RT-PCR. Further studies are needed to compare existing methods in terms of robustness, reproducibility, reliability, and sensitivity.<sup>42</sup>

To summarize, current analysis methods are not sufficient to distinguish infected persons, especially in public places. There is a need to produce POC devices that can detect infections on the site without the need for professionally trained personnel. In future applications, POC diagnostic devices and tests are increasing in popularity, especially in the case of a worldwide pandemic such as COVID-19.<sup>43</sup>

## RESULTS

### *Global burden of SARS-COV-2*

COVID-19 has spread to as many as 205 countries across the world, infected 120 million people 68.1 million, recovered and over 2.66 million deaths till of 15<sup>th</sup> March 2021 and the number is rising day by day rapidly, the United States, India, Brazil and European Unions have been most severely affected. These countries have taken various measures, including nationwide lockdown, to contain the spread but have not fully successful. South Korea and other island nations were also able to almost entirely prevent an outbreak has been able to contain and drastically reduce the spread of the virus without imposing a nationwide lockdown or any draconian measures so this region many country follow South Korea model.<sup>44</sup>

### *Burden of SARS-COV-2 in India*

The Novel COVID-19 earlier known only as the Wuhan virus, initially expanded around circle in Republic of South Korea, Japan, Italy, Iran and finally spreading its routes to India. Now a day, India is second most affected county in the world after USA in COVID-19 infection. It is assumed that the virus might be linked with a wet market (with seafood and live animals) from Wuhan that was not complying with health and safety regulations. The Wuhan wet market has since been closed down indefinitely.<sup>45</sup>

The first case of COVID-19 in India was reported on January 30<sup>th</sup>, 2020; the infected patient was a student who had returned from Wuhan city of China to Kerala, India. Thereafter, only 2 more cases were reported in February 2020.<sup>5</sup> Subsequently, more cases came to the forefront in the month of March and there has been a surge in the number of cases since the second half of April 2020. As of 30<sup>th</sup> November, 2020, India is the second largest affected

county in the world after USA (Figure 3 &4).<sup>46</sup> India has suspended all tourist visas, as a majority of cases were linked to other countries.<sup>47</sup> The Govt. has also applied lockdown of 75 districts across the country where confirmed COVID-19 cases have been reported till June 2020. Most of the cases have been reported from the states of Maharashtra, Tamil Nadu, Delhi, and Gujarat, the MoHFW have reported, translating into a case-fatality rate of 1.4%. An estimate released by the Indian Council of Medical Research and Home Ministry on February, 2021 had revealed that out of 78% cases were male. People younger than 42 years and older than 62 years accounted for 49% and 21% of cases, respectively. On the contrary, 63% of all-over the deaths were occurred in age more than 60 years. Moreover, 86% of the deaths were seen in people with underlying co-morbidities, notably, diabetes mellitus, hypertension, kidney disease and/or cardiovascular disease. Although the overall mortality rates vary from one nation to another, being as low as 0.7% in Germany to as high as 10.8% in Italy.<sup>48</sup>

### UTTAR PRADESH BURDEN OF SARS-COV-2

Uttar Pradesh government confirmed that on date 10 February 2021. Among a total, 31 districts have recorded zero cases in Uttar Pradesh has reached a total of 6,05,290 confirmed cases, resulting in 8,746 deaths and 595,637 recoveries. More than 70% of COVID-19 patients who died in UP, were ages more than 50 year according to an assessment of state health department (Figure 5). As per data, 45.3% of the elderly patients died while 25% of those who died were between 50 and 60 year. The number clearly indicates that 50-plus formed the 70% COVID-19 death burden 75% of the deceased had at least one co-morbid condition like diabetes, high blood pressure, chronic cardiac or renal ailment. The state of Uttar Pradesh reported a very low rate of infection-rate in latter part of the lockdown. The daily infection-rate is showed a decreasing trend in the last few weeks in the state. It is important to note that, Uttar Pradesh may have seen fewer COVID-19 cases till now, but the war is not over yet. There are many states like Maharashtra, Delhi, Madhya Pradesh, Rajasthan, Gujarat, and West Bengal, who are still at high risk of second wave of COVID-19. On the positive side, Uttar Pradesh has shown how to effectively “flatten” or even “crush the curve” of COVID-19 cases of last few week. We hope Uttar Pradesh can be free of COVID-19 with a strong determination as already shown by the central and state Governments. UP state have most affected cities were: Lucknow, Noida, Ghaziabad, Kanpur, Meerut, Agra, Prayagraj, Gorakhpur etc (Figure 6, 7).

### *Lucknow*

Lucknow is the most populous city in Uttar Pradesh and the fourteenth most populous city in the whole over India with a population is around 2.9 million. As per Indian government population data of 2011, Lucknow is the most populous city in UP, with an estimated city proper population of 2 million living under Municipal

Corporation of Lucknow. The situation in Lucknow was very severe with respect to the number of active cases. First case of COVID-19 was found in Lucknow on 21<sup>st</sup> March 2020. As of March 15<sup>th</sup> 2021, the total number of infected cases was 82,213 confirmed cases, 80,740 recovered and 1,190 deaths. On September 11<sup>th</sup> 2020, a single day highest number of cases were seen in Lucknow ie. 917. In Lucknow, the COVID-19 cases were increased day by day till November 2020, and there were several reasons behind that situation like insufficient land for maintaining social distancing, dense population, migrant worker from different state, majority of unclean area,

humid atmosphere.<sup>49</sup> In Lucknow, 28.19% of cases were in the age group between 35-49 years and 22.40% of cases in 21-35 years age group in 10.09% of the total cases are age group between 61-70 year and the mortality rate was 7.86%, which increased up to 12.15% among people in 71-80 year group. The CFR was 15.57% and 14.69% in the age groups between 81-90 and 91-100 years respectively. However the overall CFR in Lucknow was 1.46%.<sup>50</sup> The local administrative were failing to control exponential increase in number of COVID-19 cases, but last two-three months ago the migration was stopped and the infection rate was decreased in Lucknow.

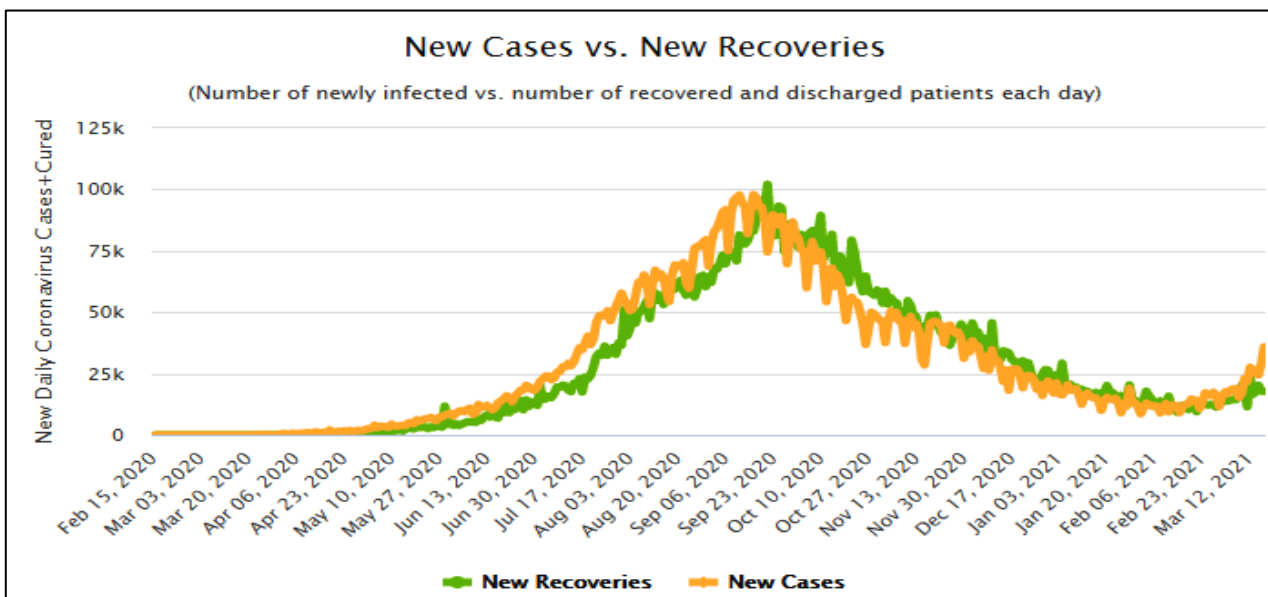


Figure 3: Newly infected versus newly recovered COVID-19 cases in India from mid February 2020 to mid March 2021.

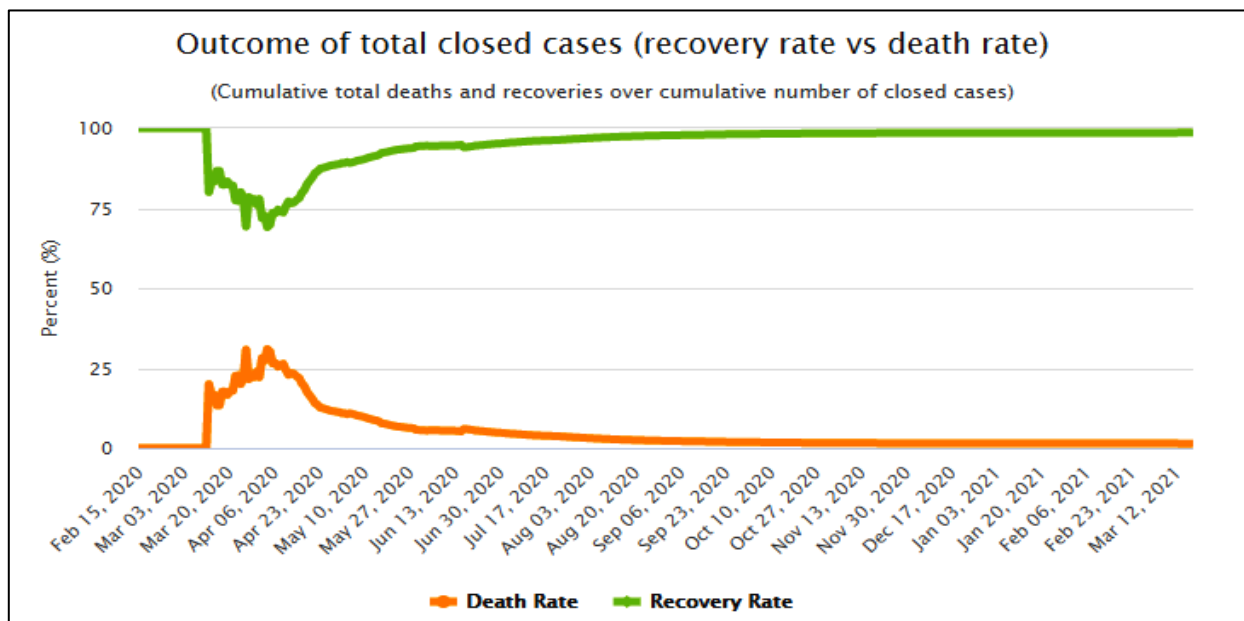
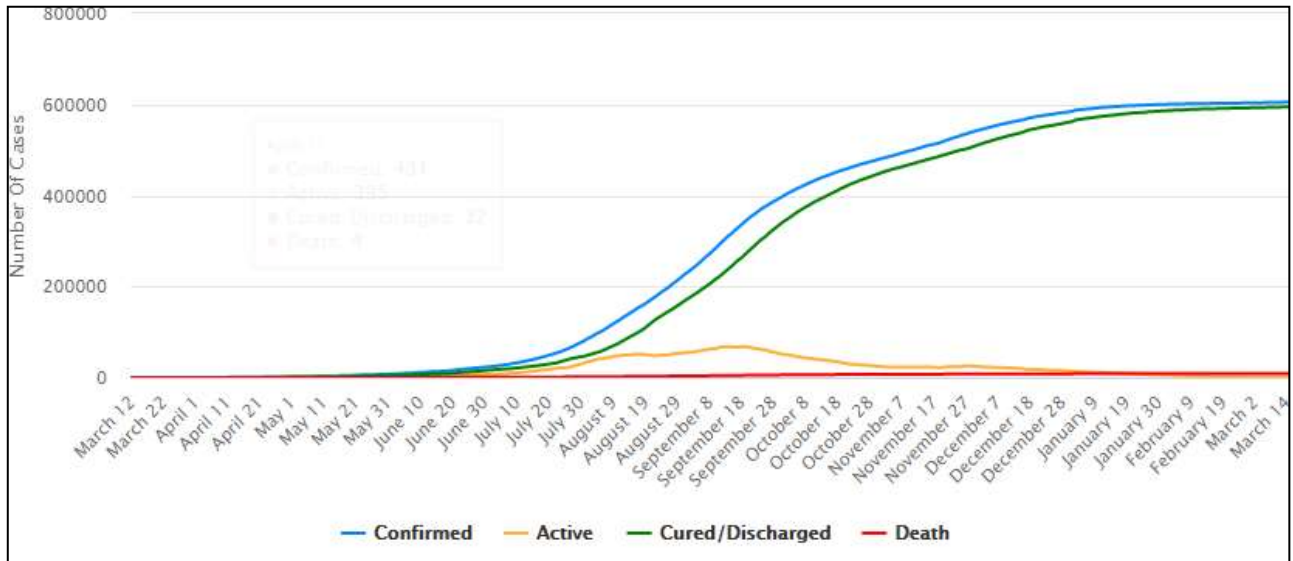


Figure 4: Outcome of COVID-19 cases (recovery or death) in India from mid February 2020 to mid March 2021.



**Figure 5: Number of confirmed COVID-19 cases (active, cured, and death) in UP from mid March 2020 to mid March 2021.**

### **Kanpur Nagar**

Kanpur also known as Cawnpore, is a metropolis and the largest city of the state of Uttar Pradesh in India. Kanpur is the second most populous city in Uttar Pradesh after Lucknow and is around 2.1 million as per Indian government population data of 2011.<sup>51</sup> The first person who tested positive for corona virus in the city has been 5<sup>th</sup> April 2020. Maximum number of positive case seen in Kanpur district was 15 September 2020. The situation in Kanpur is as March 15, 2021, the total number of infected cases is 33,111 confirmed cases, 32,196 recovered, and 839 deaths. The CFR was high as compared to other cities in the state, 2.53%. In Kanpur, the COVID-19 cases were increased on starting April 2020, to mid November and confirm cases were reached in the end of November and December 2020, after that the cases were decreased rapidly and there were several reasons behind that situation like proper lockdown government management .

### **Prayagraj**

Allahabad district, officially known as Prayagraj district, is one of the largest and the most populous district of Uttar Pradesh state of India.<sup>52</sup> The district headquarters is Allahabad city which was renamed Prayagraj at the same time as the district was renamed. The District is divided into blocks within tehsils. As of 2011, there are 20 blocks in eight tehsils. The Allahabad division includes the districts of Fatehpur, Kaushambi and Allahabad, with the western Prayagraj District becoming part of the new Kaushambi district .<sup>53</sup> The situation of COVID-19 in Prayagraj is 29,436 confirm cases 28,919 recovered and 409 was died and as on 15<sup>th</sup> March 2021, total active case in Prayagraj was only 108.

### **Ghaziabad**

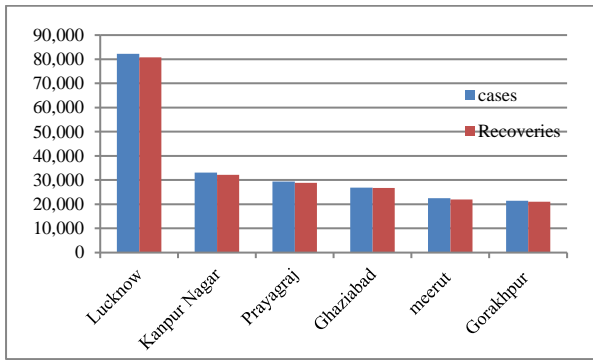
Ghaziabad city is in the Indian state of Uttar Pradesh and a part of the National Capital Region of Delhi.<sup>54</sup> It is the administrative headquarters of Ghaziabad district and is the largest city in western Uttar Pradesh, with a population of 1,729,000 As per Indian government population data of 2011 as on March 15<sup>th</sup> 2021, total number of confirm case in Ghaziabad was 26,902 out of this 26,694 was recovered and 102 were death and 106 active cases in this time and CFR of the Ghaziabad division was very low that is only 0.37 %.

### **Meerut**

Meerut is a city in the western part of the Indian state of Uttar Pradesh. It is an ancient city, with settlements dating back to the Indus Valley civilisation having been found in and around the area. The city lies 70 km northeast of the national capital New Delhi, within the National Capital Region and 485 km west of the state capital Lucknow. On June 16<sup>th</sup> 2020, highest number of COVID-19 cases were recorded in single day in Meerut ie. 673.<sup>55</sup> As of March 15<sup>th</sup> 2021, total number of confirm cases in Meerut was 22477, out of this 21929 was recovered, 442 death and 106 active cases and case fertility rate in Meerut was around 1.9 %.

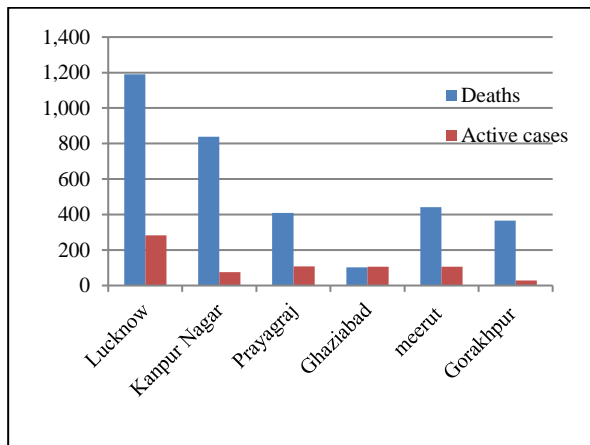
### **Gorakhpur**

Gorakhpur is a city along the banks of the Rapti river in the Purvanchal region of the Indian state of Uttar Pradesh. It is situated 273 kilometres north-east of the state capital Lucknow. On dated, 27<sup>th</sup> April 2020, first case of confirm corona virus infection was reported in Gorakhpur district, who has travelled from Mumbai to Gorakhpur.<sup>56</sup>



**Figure 6: Status of number of COVID-19 cases and recovery in different metro cities of UP.**

At the start of the novel corona virus outbreak the Basti district has reported the first case of COVID-19 following this time the number of corona virus patient increase to 11 after they come in the contact with the infected person in two day whereas, Gorakhpur saw its first case in very last. Currently, the situation does not seems very promising with 42 new cases being identified in the past 24 hours, and distribution of number of cases on 15<sup>th</sup> March 2021. The total number of confirm cases in Gorakhpur were 21510, out of this, 21115 was recovered, and 366 death, and 29 active cases and case fertility rate was 1.7 %. The highest numbers of COVID-19 cases were recorded in a signal day in Gorakhpur was on 10<sup>th</sup> September 2020, ie. 462.



**Figure 7: Status of number of COVID-19 active cases and death in different metro cities of UP**

## SECOND STRAIN (NEW STRAIN) IN UNITED KINGDOM/BRAZIL/SOUTH AFRICA

The new variant of COVID-19 was detected in early December 2020 in Greater London, even as countries around the world intensified efforts to prevent transmission of an earlier mutated strain of the virus from the island nation. This mutant strain was 70 percent more infectious than original SARS-CoV-2 strain.<sup>57</sup> The new variant of COVID-19 spreads in September 2020 and then

circulated at very low levels in the population. The increase in cases linked to the new variant first came to mid November 2020, in great London in United Kingdom (UK) was investigating that infection rates in Kent were not falling despite national restrictions. United Kingdom then investigated a cluster linked to this variant spreading rapidly into London and Essex in first week of December 2020. The new UK variant of virus, which scientists have named “VUI-202012/01”, includes a genetic mutation in the “spike” protein, which could result in coronavirus spreading more easily between people. It was first UK health secretary on 14<sup>th</sup> December 2020. The government of India has banned travel from UK and track passenger arrived from last few weeks from the Britain. On 23<sup>rd</sup> December 2020, 22 peoples including 6 from Delhi tested positive with UK travel history, and their samples were sent for genome sequencing.<sup>58</sup>

Brazil strain of corona virus was first identifying on February 10. Brazil variant is more transmissible than earlier forms of the coronavirus. It may also be partially resistant to immunity generated by prior infections or vaccination. The same research also suggests that among people who have natural immunity after being infected with an earlier coronavirus strain, Brazil variant may be able to re-infect them between 25% and 61% of the time. It is important to know that the Brazilian variant is highly unlikely to be completely impervious to the immunity raised by a vaccine. Evidence suggests that Brazil variant has a higher chance of infecting people, who have the Oxford/AstraZeneca vaccine than older versions of the virus.<sup>59</sup> The Brazilian strains can more easily infect a person's lungs than the UK mutation, scientists have said. The South African variant, known as “B.1.351” or “501.V2”, has worried scientists because of its unusually large number of mutations, especially in the spike protein, which the virus uses to attach to and infect human cells. The spike protein is also the part of the virus targeted by COVID-19 vaccines and antibody treatments. The South African variant is around 50% more faster rate of COVID-19 transmission its nature of changes to the structure of the virus, which appear to make it easier for it to attach to and infect human cells. The researchers speculated that the new variant doesn't appear to lead to more severe cases of COVID-19.<sup>60</sup> The reverse transcription polymerase chain reaction (RT-PCR) the RT-PCR kit that use in detected in COVID-19 gene detection where the mutation has happened for detecting virus may give out false negatives

## STATUS OF SECOND WAVE OF COVID-19 IN UP

Uttar Pradesh is witnessing a second wave of infections from February, with daily new cases rising again. Considering the number of days from the current level of daily new cases to the peak level during the first wave, Uttar Pradesh might reach the peak in the second wave in the mid of April 2021. The daily spike in corona virus cases during the peak in the second wave could be much higher than last year. The report said that, the global COVID-19 second wave will be much higher in intensity



than the first wave. However, the presence of vaccine will make some difference this time, and India will be able to manage the situation better. It called for increasing the pace of vaccination in the country. UP witnessed a single-day spike of more than 500 corona virus cases 542 on, March 22, taking the state's tally to 608,076. One death in Kanpur pushed UP's death toll to 8,760.<sup>61</sup>

## CONCLUSION

As per latest reports, there was a highly increase in daily cases in past few days in India as well as Uttar Pradesh. After more than 3 months, less than thirty thousand cases were reported. On 15<sup>th</sup> March 2021, 120 M patients, recovered 68.1M and 2.66M deaths have been reported from 32 states/union territories of India. And Uttar Pradesh state has 6,05,290 confirmed cases, resulting in 8,746 deaths and 595,637 recoveries. Case fatality rate in Uttar Pradesh was stands at 1.4% on 15<sup>th</sup> March 2021. The Union Minister of Health, Govt of India, assured that India is on the forefront of developing COVID-19 vaccines. Approximately, 800 million peoples are line-listed for COVID-19 vaccination in India, including healthcare, frontline workers and prioritized population groups. The MoHFW assured that, eight vaccine candidates including three indigenous vaccines are under process to be manufactured in India. The Union Minister of Education, Govt of India has interacted with teachers, parents, students and urged students to continue their studies after following proper guidelines on COVID-19. The MoHFW has also chaired event that marking Universal Health Coverage Day and also emphasized the role COVID-19 has played in highlighting the need to build landmark healthcare systems in India ensuring equitable access to all.

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