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# Diffusion and Dynamics of COVID-19 in the Union Territory of Jammu and Kashmir, India: A Geospatial Analysis

**Mir Sumira[1], Shamim Ahmad Shah[2], Dr. M Shafi Bhat[3]**

[1]Research Scholar, Department of Geography and Regional Development, University of Kashmir, Srinagar, India

[2]Professor, Department of Geography and Regional Development, University of Kashmir, Srinagar, India

[3]Senior Associate Professor Department of Geography and Regional Development, University of Kashmir, Srinagar, India
(Corresponding Author)

**Abstract:** ***Throughout the human history it has been observed the pandemics have immensely affected various civilizations and has altered the demographic pattern of the world. In recent history Ebola, SARS, MERS and Covid 19 have profoundly impacted the epidemiological as well as socioeconomic landscape of the world. Covid 19 outbreak has adversely affected various parts of the world in general & India in particular due to high population density, lack of basic medical infrastructure, overcrowding and several other socioeconomic vulnerabilities. The Union Territory of Jammu and Kashmir is located in the North-western corner of the country and on account of cold climate, is prone to seasonal flues which makes it more vulnerable to respiratory ailments. The present Study focuses on the Diffusion and Dynamics of COVID 19 in the Union Territory of Jammu and Kashmir using Geospatial Technologies. The study reveals that the outbreak hotspots have changed over the period of time. Initially the districts like Baramulla, Bandipora, Kulgam and Shopian were the hotspots as people from these areas are usually Apple traders who frequently visit various Indian states during the winter and were the first carriers and victims of this disease. Later on, during May-June months when the lockdown was relaxed and the stranded people were allowed in, Srinagar and Budgam became the new hotspots as they act as trans-shipment stations containing both airport and railway station. In the late summer the Jammu region became the hotspot due to lack of proper response and changed people's perception regarding the COVID 19. The study reveals that the vulnerable age group to the COVID 19 fatality is above 45 years for both men and women in the valley which is in conformity with the global trends also as reported by the global COVID 19 mortality database.***

**Keywords:** Covid-19, Geographic Information System, Spatial Distribution, Gender Mortality

## 1. Introduction

Covid-19 has resulted in a worldwide disruption of the functioning of the society leading to global changes and new normal. Geographic Information System enables us to represent the spatial distribution of the physical phenomena and uses attribute information related to the geographic entity by use of different colors (Paul Bolstad). In India, Disaster Management is the state subject and it involves the interaction of new technologies and improved scientific procedures to achieve the goals of reducing the disaster risks and enhancing the resilience. The COVID-19 is spreading exponentially in all parts of the globe and thus there arises a need to generate a baseline data for its monitoring and the administrative planning. The present paper maps the entire UT of Jammu and Kashmir based on the ancillary information provided by the Press Information Bureau, Government of India and the data was also obtained from the Covid Control Room established by the Government of Jammu and Kashmir pertaining to incidences and fatality to understand the dynamic behavior of COVID 19 across the union territory of Jammu and Kashmir. There are about 105984 covid positive cases in Jammu and Kashmir, out of which 63871 are from Kashmir division and 35779 are from Jammu division as on 21st November, 2020. A total of 1624 deaths have been reported of which 1073 belong to Kashmir and 551 to Jammu region. Majority of the cases have been found symptomatic and mainly the district of Srinagar and Jammu region has shown an exponential rise in the number of positive cases since July.

## 2. Study Area

Jammu and Kashmir is a Union Territory in northern India. It lies between 33.7782$^{o}$ N and 76.5762$^{0}$ E with the highest elevation of 7135m and the lowest elevation of 247m.It has a geographical area of about 42241 sq km. It is located in the Himalayan Mountains and the States of Punjab and Himachal Pradesh and the recently formed UT of Ladakh share their borders with it. The UT is divided into two regions - Jammu and Kashmir which is divided into their respective districts which are 20 in total. Jammu and Kashmir is gifted with a number of vallies, meadows and mountains. The climate varies greatly due to its varying topography. The average summer temperature of Kashmir is 24.1$^{0}$C while in Jammu it can go up to 33$^{0}$C. Winters are very cold with a temperature dropping down up to -1$^{0}$C in Kashmir and warmer winters are experienced in most parts of Jammu region. Rivers like Jhelum, Sindh, Tawi, and Chenab provide natural drainage to the area. The annual rainfall ranges between 450-710mm. The Kashmir Region comprises of Srinagar, Budgam, Baramulla, Kupwara, Anantnag, Bandipora, Ganderbal, Pulwama, Shopain and Kulgam whereas Jammu, Reasi, Poonch, Rajouri, Samba, Udhampur, Kathua, Kishtwar, Doda and Ramban fall in Jammu region.

## 3. Methodology

In the present study, an attempt has been made to understand the dynamic behavior and spread pattern of COVID 19 in the UT of JK using geospatial technologies. The Study is based on Secondary data that was collected from the various government sources. The data was analyzed for generating different thematic maps pertaining to positive Covid cases, Deaths and Recovered cases till October. The administrative boundary of the Study was digitized and georeferenced. The attribute data was used for classifying the districts into different categories depicting the low, moderate and high incidences of COVID 19. Data was classified into various categories using Equal Count (Quantile) classification in QGIS 3.10.9 LTR version. The data was Collected month wise from April to September and was analysed in the GIS software. The attribute data for the classification of each category was based on the data issued by the Government of Jammu and Kashmir on daily bases. A database was generated from April to September to observe the changing trends and patterns of the COVID 19. Statistical analysis was carried by categorizing the male and female deaths into 6 age groups: <15 yrs., 15-29 yrs., 30-44 yrs., 45-59 yrs., 60-74 yrs. and>75yrs and age wise fatalities were analyzed in both men and women.

## 4. Results and Discussion

In this study the data collected from the Covid control room Kashmir Division was used for mapping areas with varying levels of COVID-19 incidence. It was observed that the spatial dynamics of the Covid reflected peculiar trends with the passage of time. In the month of April, we found lesser values for each category and this could be attributed to various reasons. The incidences were limited to only few numbers during the early outbreak of the virus and the situation seemed to be under control. The curve started steeping with the return of the stranded people back to the region who were out in various parts of the country and even abroad. This resulted in an exponential rise in numbers in the entire Union Territory. Though initially Jammu region remained least affected and reported lesser incidence of the COVID-19. However, owing to changed people's perception and lack of proper response on behalf of general public and administration, the scenario changed completely and a steep surge in the incidence of covid-19 was observed in the late summer. Jammu emerged as the hotspot and situation started escalating as no appropriate strategy was adopted and no sensitization was induced among the masses. The people of the valley showed different responses towards the virus.

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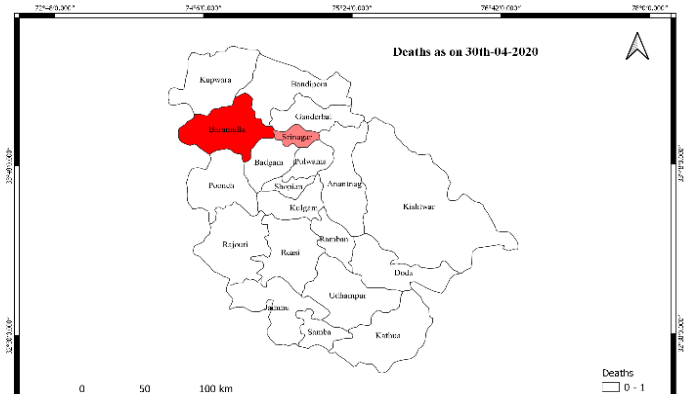


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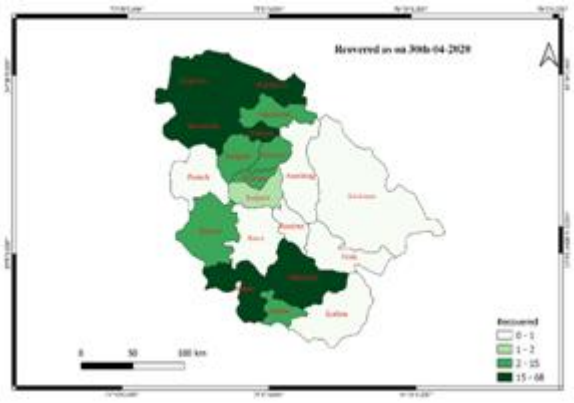
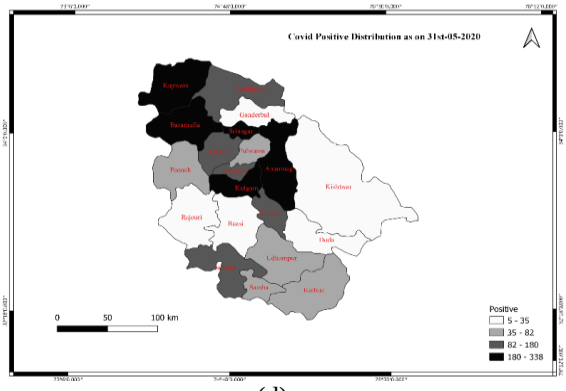


(c)

Figure a, b, c represent the thematic maps for the COVID 19 with respect to deaths, Positive cases and Recoveries for the month of April, 2020. It is seen that during the early phase of the novel viral outbreak, the area of Kashmir division reported the positive incidences and death cases. The district of Srinagar followed by Baramulla were seen highly impacted in the start. This could be attributed to the fact that Srinagar holds a significant position in the entire Union Territory as it caters the needs of a huge urban population, administrative activities and medical health facilities are all being conducted in the district at Divisional Level. The district is liable to the movement of travelers from within and the outside of the valley. So, the values started showing an increasing trend with each month passing by for the district of Srinagar. The Baramulla district being showed increasing values from the start and the reason could be the lower levels of literacy of North Kashmir and generally people are insensitive and unaware to the covid situation. The people of the district are dealing with Horticultural Practices as their source of livelihood.

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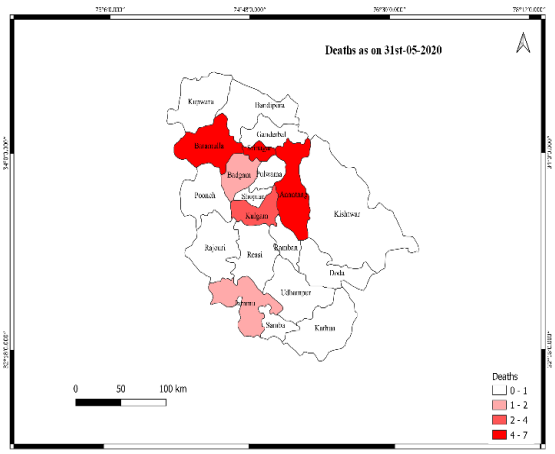


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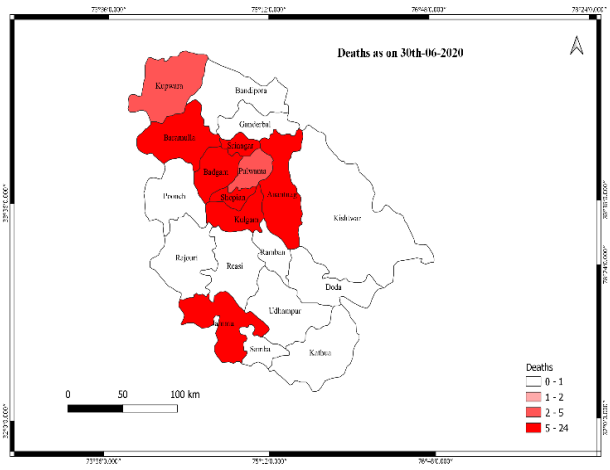


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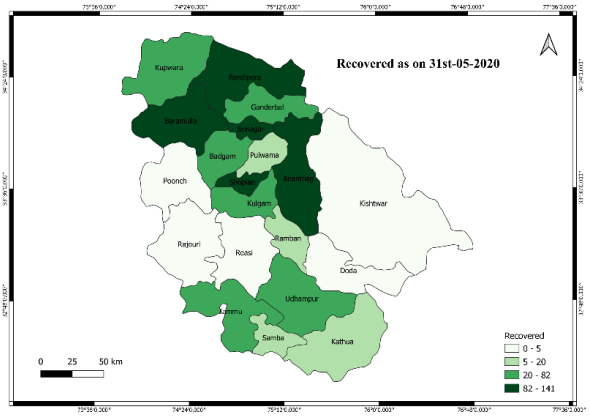


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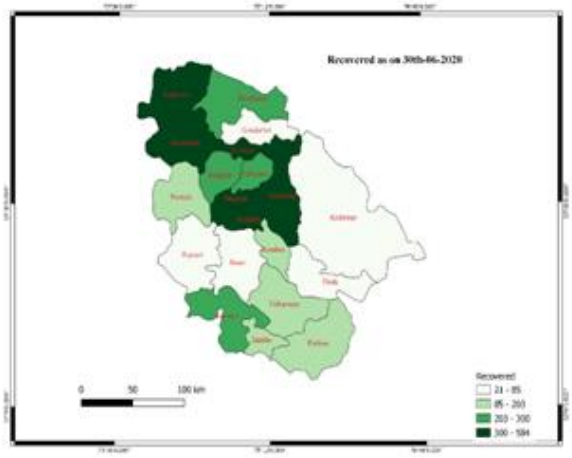
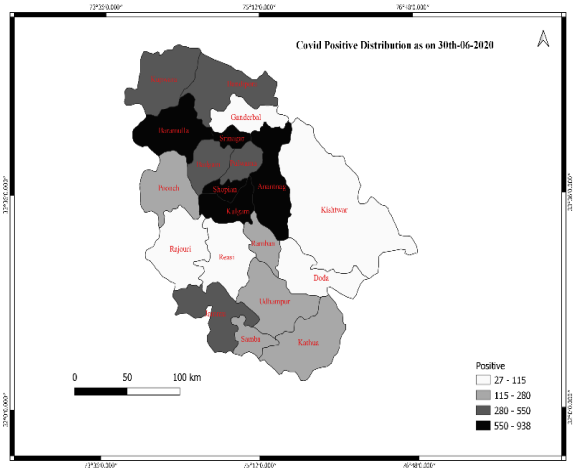


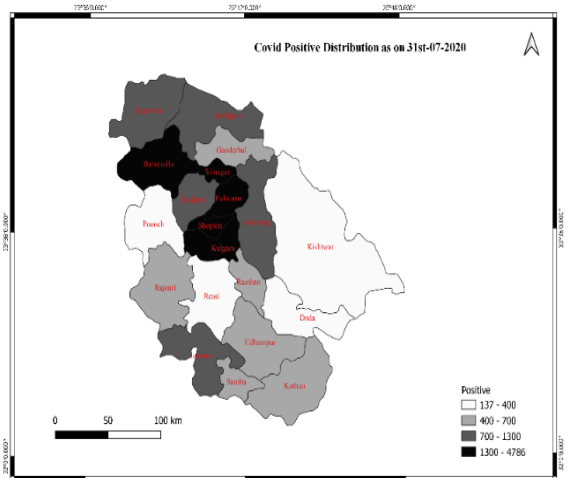

(i)

In the month of May, there was an abrupt increase in the number of deaths and positive incidences. The entire Union Territory behaved as the breeding ground for the spread and it was predicted that the situation would run out of control if the numbers continued to show an increasing trend. It was during the month of May only that the authorities in Kashmir Division started strategizing against the spread and were planning of observing intermittent lockdown.




(g)

The maps represent that the COVID 19 is dynamically changing its patterns with increasing number of deaths and positive cases. It was the month of upsurgence in Jammu region and the region experienced an exponential rise in the number of incidences within a shorter span of time amid to lenient attitude of people and authorities. Though the areas of Jammu showed lower incidences and deaths in the early phases but the situation was changed and numbers were showing an increasing trend. This could be due to the fact that Jammu observed strict lockdown in the initial phases and tried to contain the spread to an appreciable extent. District of Jammu is engaged with businesses and Corporate sectors. Most of the income is generated through the market consumption and the region could not tolerate a huge economic loss amid continuous lockdown.

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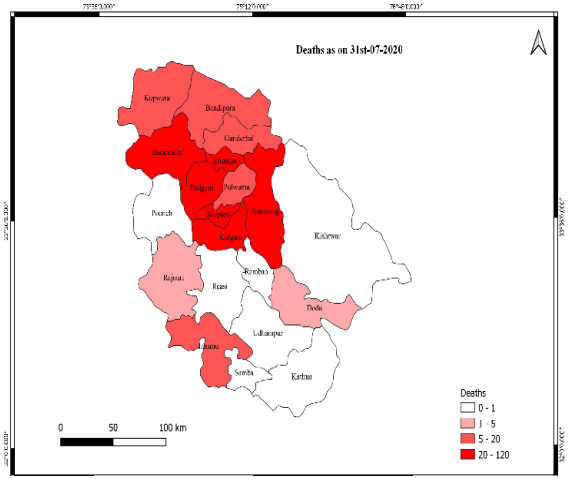


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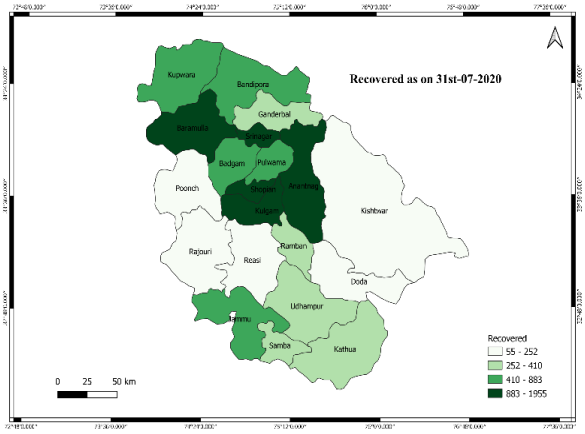
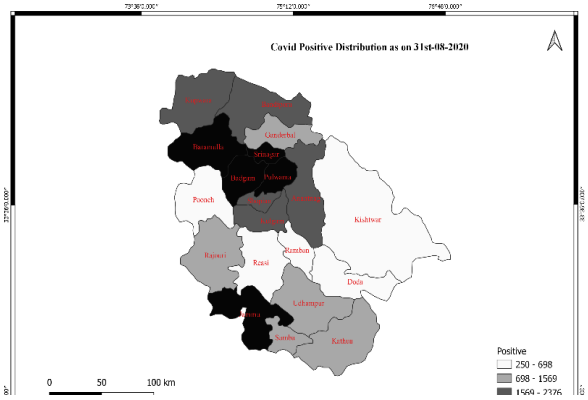



(l)

The division of Kashmir witnessed complete lockdown and prelude of social distancing was somewhat maintained on the administrative front in the beginning of this viral journey. Marriage ceremonies were either cancelled or the celebration was limited to few attendants following the SOPs and the funerals were observed avoiding massive gatherings. Religious places were shut and shrines were closed. As we moved from April to July, the results depict very scary inferences as the virus deep rooted itself in the valley amid changing perception of people across the region. People now seemed to shift the response from being proactive to reactive and considered to deal with the disease as the new normal of the life. Covid struck the valley in the peak season of Agricultural and allied practices and the farmers could not bear the impact on their livelihoods and were compelled to move out amid the lockdown situation and work in fields without adhering the SOPs. Moreover, the people of the Valley work in other states and in foreign countries and when the situation worsened in those parts, people of the valley returned back to their native places which resulted in the transmission of the Covid virus to the different parts of the valley.

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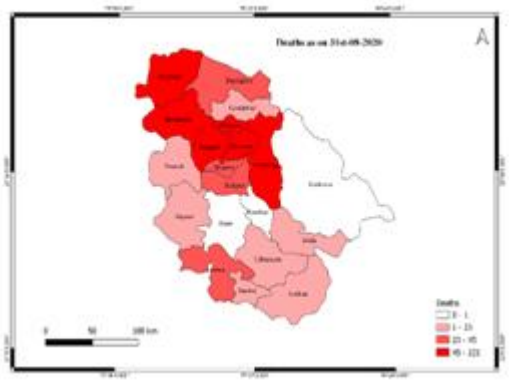

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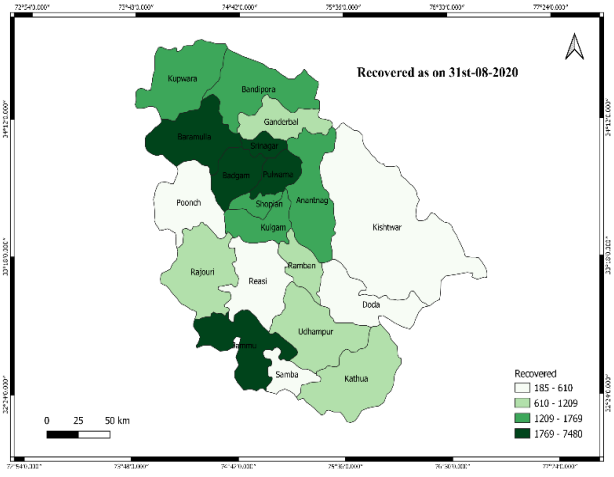
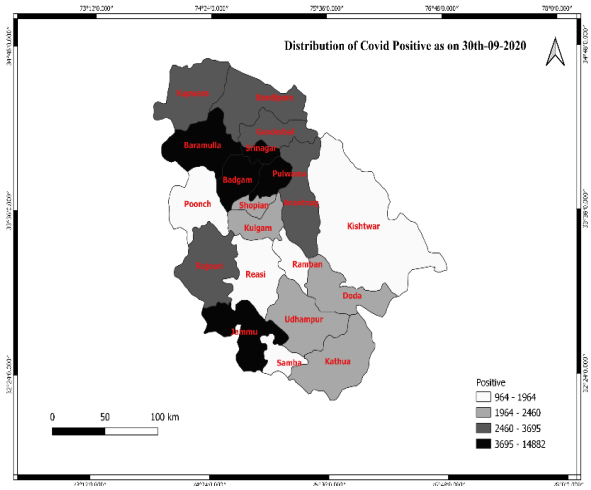



(o)

Though the number of recoveries is showing positive results but the situation still remains conducive even in the month of August. More and more numbers have been reported from the rural areas of Kashmir division and urbanized areas of Jammu. People of the Union Territory had to resume their normal routine and get back to earn their bread and butter. This exposed them to viral infection and lead to greater

increase in the number of deaths and positive incidences across the Union Territory.

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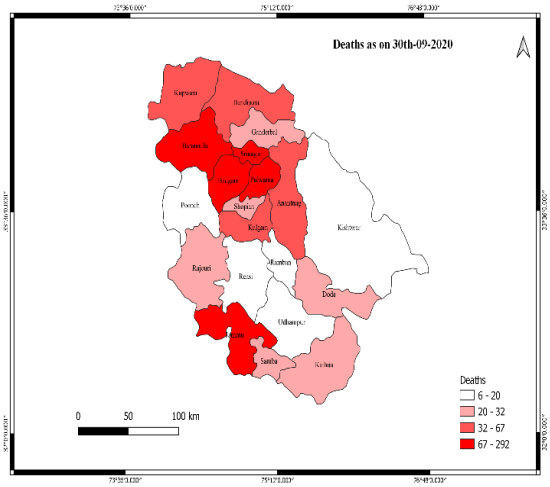


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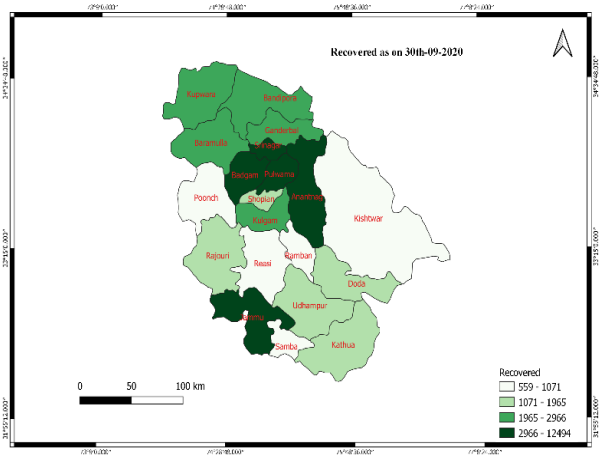
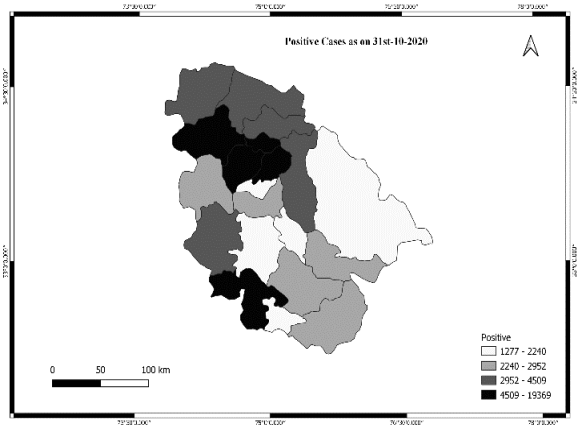



(r)

Though the rate of incidences and deaths started showing a decrease for the month of September, yet the number of deaths were quite high for the Union Territory. The perception of people changed towards the disease and people started assuming that the deaths are caused among elderly people and associated the deaths with comorbidities.

It was assumed that people with ailments and secondary diseases are an easy victim for COVID 19 and there is no risk of death for healthier and young people. This was mere an assumption that was not having any scientific basis and most of the studies revealed that age and health status would not be a criteria for the COVID 19 fatalities and that there have been reported deaths among younger men and women across all age groups globally.

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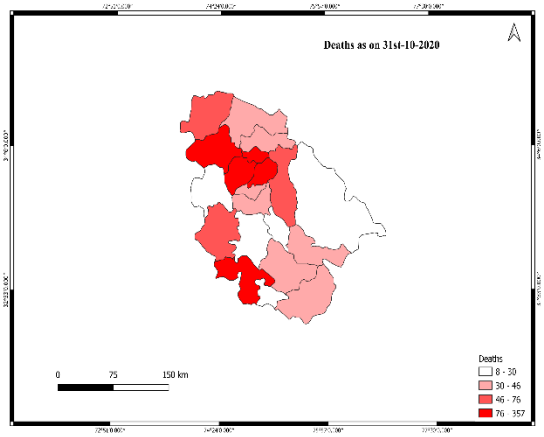


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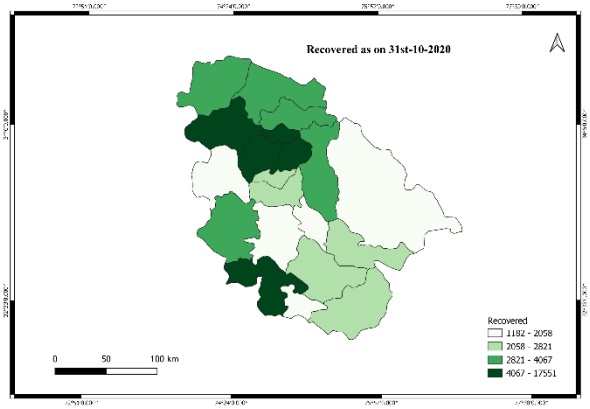


(v)

The disease again started playing with numbers as it was witnessed that a second phase of COVID 19 is ready to befall. On 31st of October, 94785 cases were reported in the region with 1478 deaths across the Union Territory. Baramulla, Srinagar and Jammu again emerged as the hotspots and majority of incidences were reported from the

same areas. This is the result of various socioeconomic and psychological drivers that reside within the vulnerable community of Jammu and Kashmir that influenced their approach towards the pandemic and caused a vast number of populations to get affected.

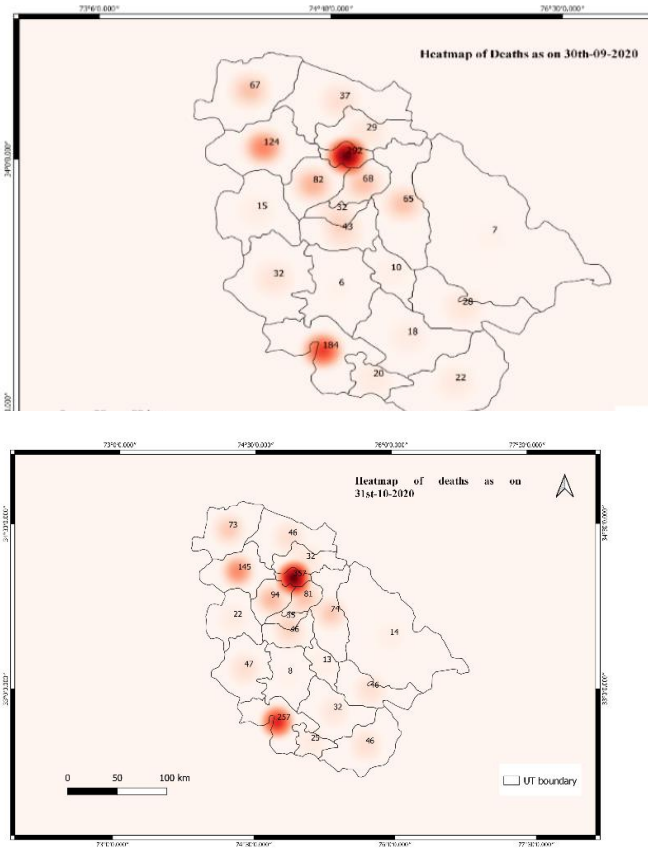


**Figure:** Heatmap of COVID 19 deaths within the UT

The spatial representation of heatmaps identify that the central parts of the region have encountered majority of deaths amid high Covid 19 incidences. The districts of Srinagar, Baramulla, Budgam and Jammu significantly represent the higher number of deaths reported till date while the eastern part is still showing lower numbers. It is due to the fact that majority of the population lives within the central part of Jammu and Kashmir and towards the south. The eastern areas are profoundly occupied by nomads and economically weaker sections. The people tend to move around the UT or their livelihoods and thus there have been less numbers for Covid dynamics from the early stages.

**Age Segregated Analysis of COVID 19 within the Union Territory**

The statistical analysis of the deaths based on gender segregated incidences and age wise distribution of Covid 19 data of the Kashmir region revealed that the Viral disease hardly showed any marked difference in causing deaths in one particular gender. The chart represented more or less the same statistics for both the affected genders where 2 males and 1 female in the age group of < 15 years, 6 males and 14 females in the age group 15-29 years, 34 males and 11 females in the age group of 30-44 years, 122 males and 68 females in the age group of 45-59 years, 290 males and 164 females in the age group of 60-74 years and 134 males and 59 females in the age group of > 75 years age group have been reported as dead till 12 October 2020. From the analysis of the data it is revealed that the age above 45 years is vulnerable to the covid deaths. Though there needs an extensive physiological research to be carried out on the gendered nature of the epidemiology of the disease yet it seems that the virus does not have any specific gender requirements or a specific type of physical host body. It needs a carrier to get transmitted and produce its progeny without preferring one particular gender. However, the age group severity is alarming as most of the death cases have been reported in the age groups above 45 years till date. This could be attributed to the fact that the productive class of age group and elderly fall victims to the exposure of the infection and Kashmir Valley being a place of lower economic status and marginally adequate health care facilities available to the people, the people were highly exposed to the risk and this resulted in high incidence levels followed by increased number of deaths. Out of 899 deaths reported, 588 were among men and 311 were female deaths till 12 October 2020. This could be related to the level of exposure to covid infection and vulnerability of men is more compared to those of women amid various socioeconomic, cultural as well as behavioral parameters. Most important of all the parameters is the perception among men and women regarding the novel virus and the gendered perspective plays an utmost important role in the perseverance of any physical phenomena and thereby deciding the gendered nature and impact of the epidemiology of disasters.

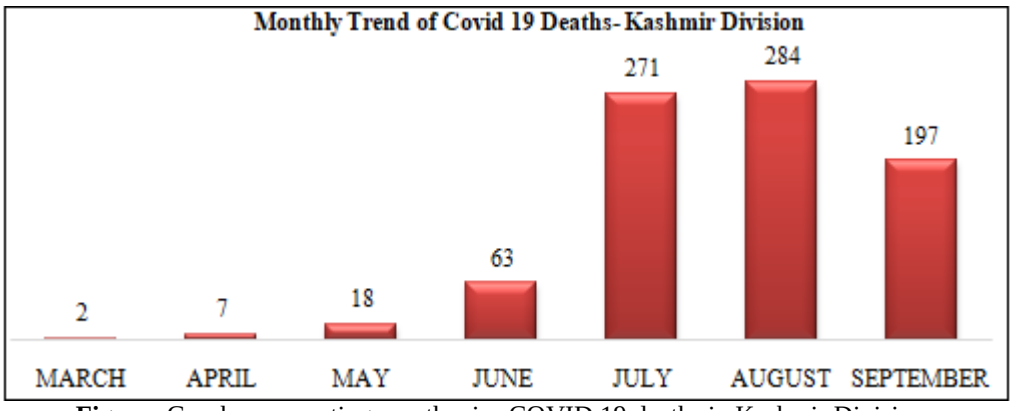


**Figure:** Graph representing month wise COVID 19 deaths in Kashmir Division.

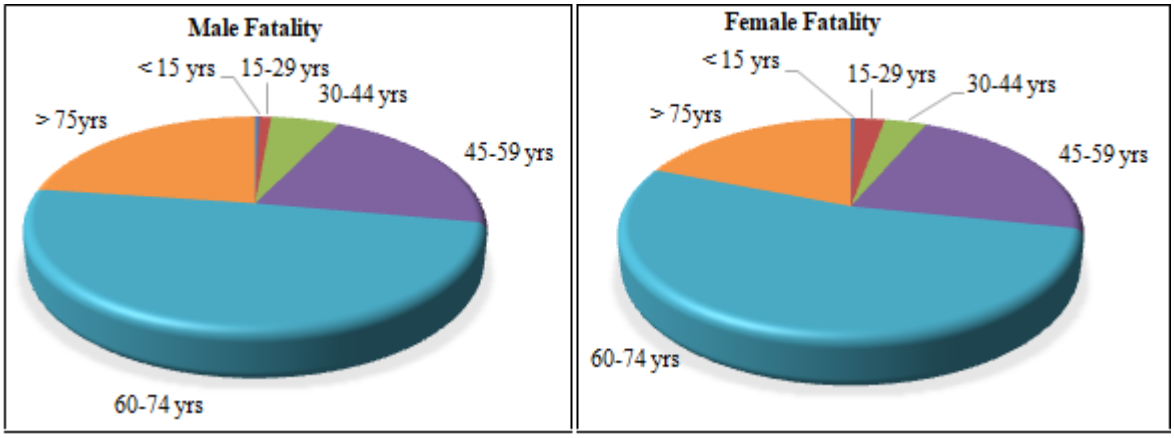


**Figure:** Pie Charts representing gender wise Covid 19 fatalities among different age groups in Kashmir region

**Part B: Covid 19 Analysis for Jammu Region:**

Jammu region though responded profoundly during the initial transmission phase of the infection but then gradually it started to emerge as the hotspot with a rapid speed particularly from the middle of the summer season with respect to incidnces and fatalities. The data was analysed for Jammu Region and it came out not as a surprise that majority of the deaths were reported in Government Medical College, during the month of September (53%) followed by October ( 27%). The region followed a causual and routine approach towards the viral disease taking it forgranted that the virus transmission and its survival is related to the cold temperature only. The people took it as the seasonal flu and did nothing on precautionary level to break the transmission chain of the viral infection. As a result, the region faced the upsurgence with respect to positive Covid cases followed by deaths. Total COVID 19 deaths reported as on date are 487, of which 336 are the deaths reported among male category and 151 among female category. Furthermore, age wise distribution represents 5 deaths among males and 1 among females in the age group of < 15 years, 12 male deaths and 6 female deaths were reported in the age group of 15-29 years, 27 male deaths and 8 female deaths belong to age group of 30-44 years, 82 male deaths and 36 female deaths were reported among the 45-59 years of age category, 137 male deatgs and 73 female deaths belong to the age group of 60-74 years and 69 male deaths and 27 female deaths have been reported in the age group of > 75 years.

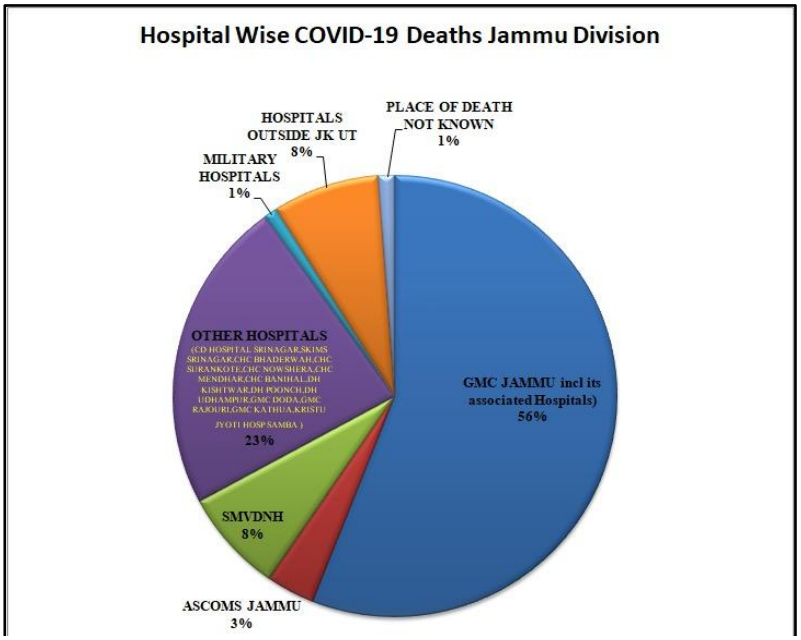


**Figure:** Pie chart representing Covid 19 deaths reported hospital wise in Jammu Region

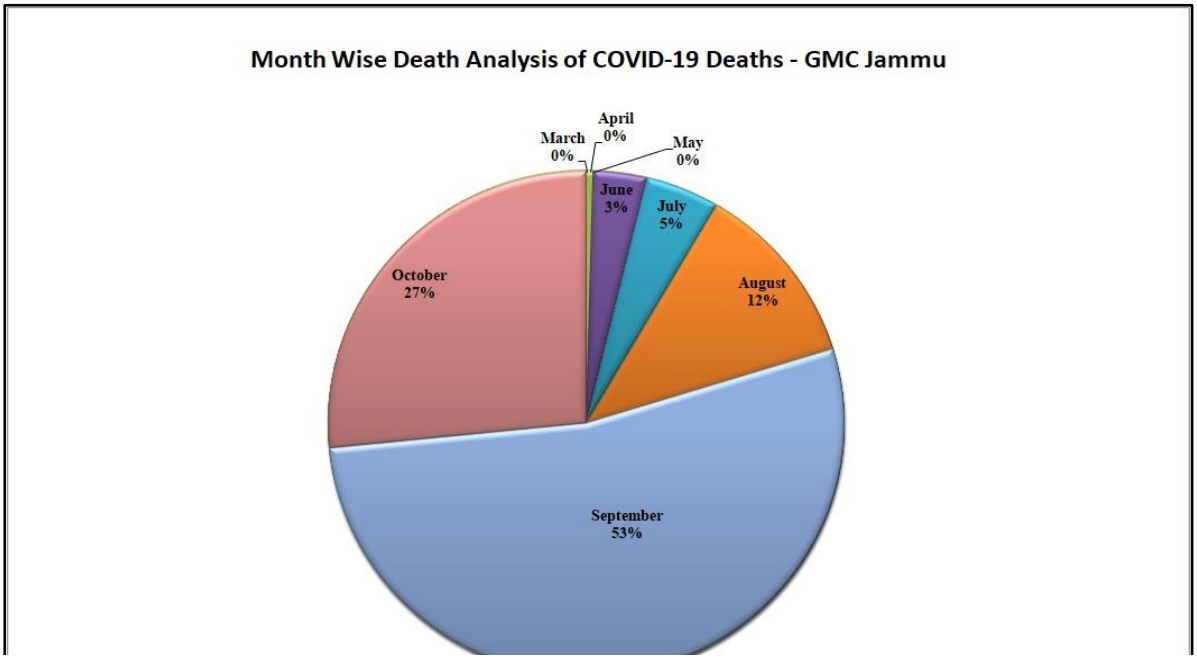


**Figure:** Pie chart representing percentages of Covid Deaths in Jammu Region (source: GMC. Jammu)

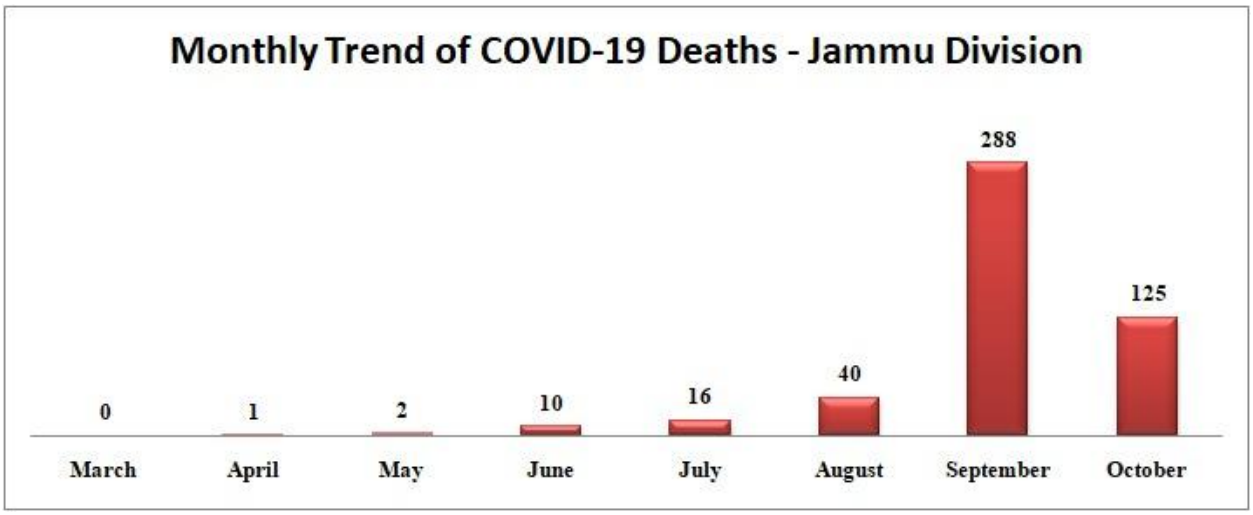


**Figure:** Graph representing the month wise Covid 19 deaths for Jammu Division

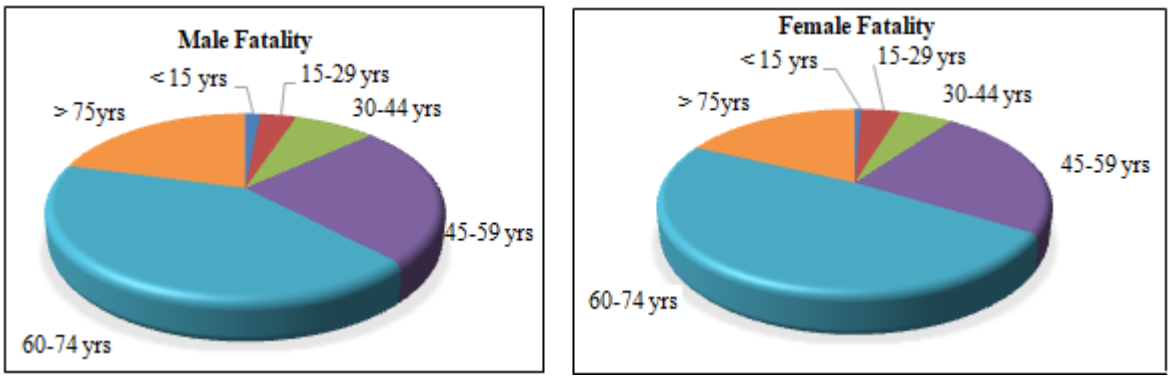


**Figure:** Pie Charts representing gender wise Covid 19 fatalities among different age groups in Jammu region

## 5. Conclusions

It is concluded from the study that though the deadly disease took a toll of millions of people across the globe yet the situation in Jammu and Kashmir did not seem to deteriorate to a worst-case scenario which is reflected from the analysis of the data. Surprisingly the people of the region adhered the precautionary measures despite being trodden in the economic front and lack of proper treatment facilities unlike the most developed nations of the globalized and modernized era as was seen in America, Italy, Spain, Europe and so on who had to suffer the drastic and deadliest ramifications on account of their attitude towards the transmission and containment of the deadly virus. The

inferences drawn from the study are up to date and can be utilized by administration for the effective and efficient management of resources such as the availability of ventilators, COVID-19 testing kits, distribution of masks, sanitizers and other relevant assistance. The use of GIS has made the task of management and planning for the disasters or adverse events very easier. Districts of Srinagar and Jammu in particular need special attention from the administration to curb the increasing trend of covid spread and deaths associated. There arises a need for better coordination among different stakeholders at the institutional as well as local levels. The fatalities ratio among male and female through the statistical analysis of the data determined that the most vulnerable age for the death due to COVID 19 is above 45 years. Gender perspective needs to be evaluated furthermore to understand the mode of transmission, effect of life style patterns and physiological relationship of the virus among the two genders. An intensive research has to be carried out to analyze the gender-based practices, perceptions and psychologies that determine the driving forces for the virus present in the society that have led to the massive disruption of the normal functioning of the world and now the goal of the DRR should be more biological disaster inclusive rather than developing strategies for natural disasters and armed conflicts.

## 6. Author's Contribution

The conceptualization, methodology, analysis and writing of the paper is the mutual work of all the authors.

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