

## Spatial Pattern of Covid-19 in Relation to Population Density: A Case Study in Assam (India)

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### Abstract

Since the time of occurrence of first wave of COVID-19, its study from multi dimensional directions becomes visible across academic disciplines globally. In this paper we analyze the correlation between spread of corona virus and population density. The study is undertaken at district level in the state of Assam, (North-eastern India), considering the confirmed COVID-19 cases (during the first wave) and population density of the districts. We use the Karl Pearson's correlation method for assessing the level of correlation, which is further tested with t-test application. A cartographic representation is also constructed using GIS platform to observe the COVID-19 spatial incidence in relation to population density pattern. We have observed that the number of infection and population density at district level have a positive relationship with R value 0.641, which can be considered statistically significant.



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COVID-19,  
Pandemic;  
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### Introduction

COVID-19 is a global catastrophic pandemic that has destabilized the entire humanity during 2020-21 in terms of their life and livelihood. World Health Organization (henceforth WHO) is continuously working on various dimensions of COVID-19 issues including data collection to general health care and specific prevention including vaccination etc. By end of January 2020, 20 countries had reported COVID-19, that gone up to 54 in February, and 202 by end of March that further rises to 212 by April 2020. It thus quickly literally becomes a global health crisis, excluding Antarctic and few islands of the Pacific. In India where the third wave

of COVID-19 is already pending, the country is battling with 25 million cases since the pandemic began. Thus, the country ranked the second highest confirmed infections cases after the United States of America.

According to a WHO global report, worldwide 243,857,028 confirmed COVID cases are detected (as on October 2021) that includes 4,953,246 deaths. India has 34,202,202 confirmed COVID cases (which are just about 14% of the global COVID cases) with 455,068 deaths, representing 9.2% of the global COVID deaths (WHO report). According to the latest updated global statistics total coronavirus

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cases is 599,283,402, that includes 6,467,402 death and 573,275,931 recovery (as on 19th August 2022). Another interesting observation is that places having high density like cities and metropolitan etc. have faster spread of the disease than places in isolation and lesser density. Among the Indian states Maharashtra reported the highest confirmed COVID-19 cases of over 6.6 million cases, followed by Kerala and Karnataka (as on October 2021), where Assam stand at 17<sup>th</sup> position in terms of confirmed cases. The paper is a spatial analysis of district level COVID-19 pattern in state of Assam, India in relation to its district population density and affect per 10000 of population, where database during the first wave of the pandemic is taken into consideration for the necessary analysis.

### Relevant Studies of Covid and Population Dynamics

At global level COVID-19 and population correlation is established by various researchers, considering various population related parameters like: density, urban population, economic status etc. In a district level study at Bangladesh a positive relationship value of  $R=0.876$  is observed between COVID-19 spread and density pattern of population, which is high degree of relationship.<sup>1</sup>

The use of geospatial tools may also play critical role in understanding the various dimensions of COVID-19. Another study has (2020) demonstrated the relevance of geospatial analysis for effective decision making and addressing the critical issues related to spread of the disease over space and time.<sup>2</sup>

Carballada and Balsa-Barreiro (2021) demonstrated how the application of geospatial analysis to fine-grained data must be urgently adopted for optimal decision making in real and near-real time.<sup>3</sup>

Another metropolitan level study has shown both direct and indirect impact of number per unit area on the COVID-19 infection and mortality rate for 913 metropolitan counties. The study found that metropolitan population is a significant predictor of infection rate. Larger metropolitan have higher infection and higher mortality.<sup>4</sup>

Since the outbreak of COVID-19 as a global pandemic, its studies have been undertaken by

academicians across disciplines. Some of the fields of studies are: genetics of the disease and its spatio-temporal mutation, medical emergencies out of the disease, various socio-economic, demographic and politico-cultural impacts assessment during and after the outbreak of the pandemic, lockdown impact in various dimensions like on health, education, economy, children psychology etc. The attempt in this paper is a demographic district level study of the initial COVID-19 outbreak in relation to population density in state of Assam, India. Some of the related studies are incorporated herewith that are undertaken at global and national level.

In Indian context, a study by Arif and Sengupta has explained how population density in a given unit of area affects the spread of the corona virus, its contact and subsequent diffusion. The study unfolded a positive relation between population density and the disease spread. They highlighted the study based on state level assessment in four south Indian states of Kerala, Tamil Nadu, Karnataka and Telengana.<sup>5</sup>

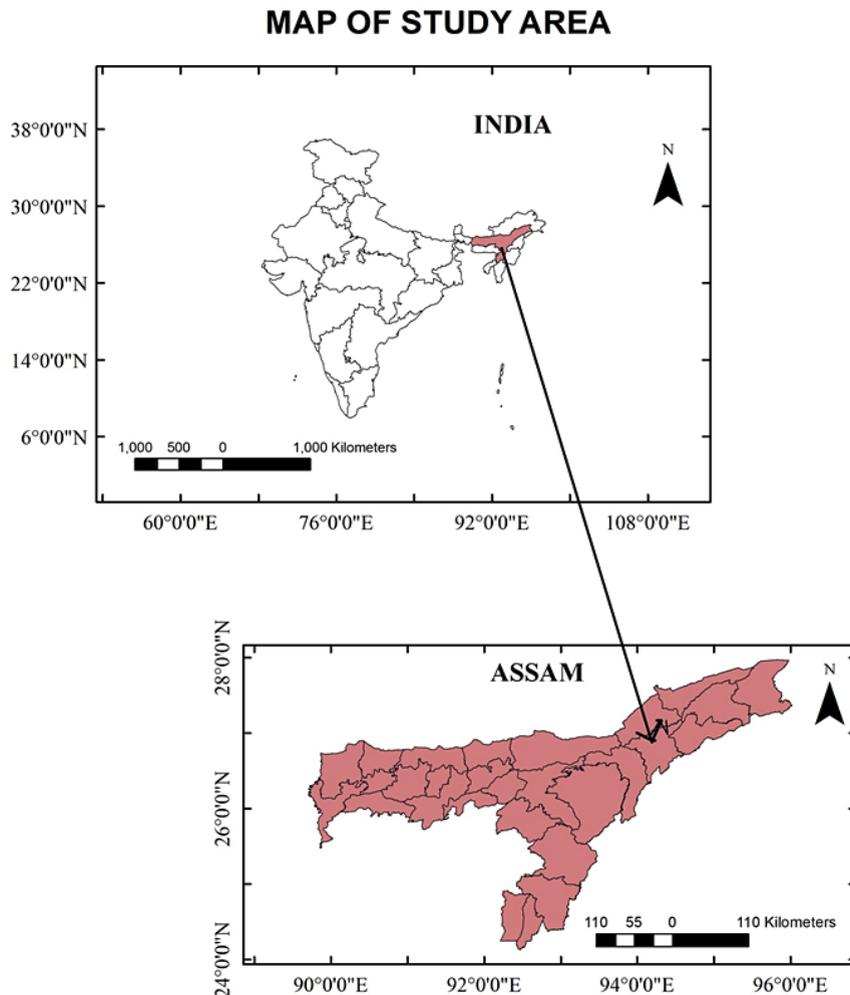
In places of high density and places where people live in close contact, there is a scope of higher spread of contagious diseases, including one like corona-virus. The study at district level have unfolded a moderately positive relation between the virus and the density of population structure of those districts.<sup>6</sup>

A select metropolitan level study in India between inhabitants against a given unit of area and its effects on transmission of corona virus have observed a strong correlation between both of them with  $R=0.842$  (2021).<sup>7</sup>

Population density is endorsed as a catalyst factor for the proliferation of COVID-19 in Algeria cities, where a strong correlation is observed between population density and spread of the virus(2020).<sup>8</sup>

### Study Area

The study area covered in this paper is the state of Assam, India. The analysis is done at district level to investigate the correlation of district level population density and COVID cases. Figure-1 have indicated the outline map of the study area.



**Fig. 1: Location Map of Study Area**

### Objectives

The main objectives of this research paper are as follows

To find out the COVID-19 affected zones in relation to population density pattern at district level, Assam.

To find out COVID confirmed cases per 10,000 of district population, Assam.

To find out the correlation between population density and COVID confirmed cases.

### Research Question

Is population density in a possible key determinant of the risk of COVID-19 transmission?

### Methodology

As a district level analysis the paper tries to investigate the correlation of the confirmed COVID-19 cases (during 1<sup>st</sup> wave) and population density of the districts of Assam. For that secondary data base of population density (census, 2011) and COVID-19 confirmed cases from COVID-19 desk board, government of Assam is taken into consideration. Karl Pearson's correlation method is used for the analysis of the relation, which is further tested with t-test application. A cartographic representation is also constructed using GIS platform to observe the COVID-19 zones in relation to population density pattern.

In addition to the 'r' analysis, there is also a projection of district-wise COVID-19 confirmed cases in Assam per 10,000 populations. It has

been arranged in descending order and presented in form of a trend line.

Defining objectives	
Literature review to enlighten the background of covid-19 in relation to population	
Data collection	
District-wise population density (Source: Census, 2011)	District-wise COVID-19 confirmed cases (Source: COVID dashboard, Govt. of Assam)
Data Analysis	
Trend Analysis of district-wise COVID confirmed cases/per 10,000 populations	
COVID-19 zoning map (on GIS platform)	
Correlation study on district level population density & COVID confirmed cases	
Findings	

**Fig. 2: The flow chart of the research methodology**

### Discussion and Analysis

Within Assam the first confirmed case of the virus was detected on 31st March 2020 from Karim ganj district. It was the 3<sup>rd</sup> confirmed case in North-East India after one case each from Manipur and Mizoram. Till 28<sup>th</sup> February, 2021 the Govt. of Assam has confirmed a total of 63,950 cases in which 18,670 are in active mode. To date, with 70.58%, 45,138 patients have recovered and 167 deaths (0.26%) have been reported in Assam.

### District Level Covid-19 Zones

As indicated in table: 1 a district level COVID zoning is done as low, moderate and high, in relation to population density. Based on data a district-wise zones of confirmed cases till 28<sup>th</sup> February, 2021, is represented through choropleth map on GIS platform (Figure:3) in which Kamrup Metro district is considered as the hotspot for COVID-19 with 20,663 confirmed cases in Assam. Along with Kamrup Metro, Nagaon, Jorhat, Dibrugarh, Tinsukia

and Cachar districts are also fall under the category of high zone with more than 3000 cases in each district. These are also the district having highest population density zone (>800 person/ sqkm.). On the other hand, Goalpara, Kokrajhar, Barpeta, Baksa, Chirang, Bongaigaon, Nalbari, Udalguri, Morigaon, Karbi-Anglong, Dima Hasao, Hailakandi, Karimganj, Sivasagar, Lakhimpur and Dhemaji districts come under the category of low COVID zone with less than 1500 cases, representing lowest population density zone (<400 person/ sqkm). The remaining districts falls under moderate category both in terms of COVID confirmed cases and population density, with cases in between 1500-3000 with density between 400-800 person/ sq km.

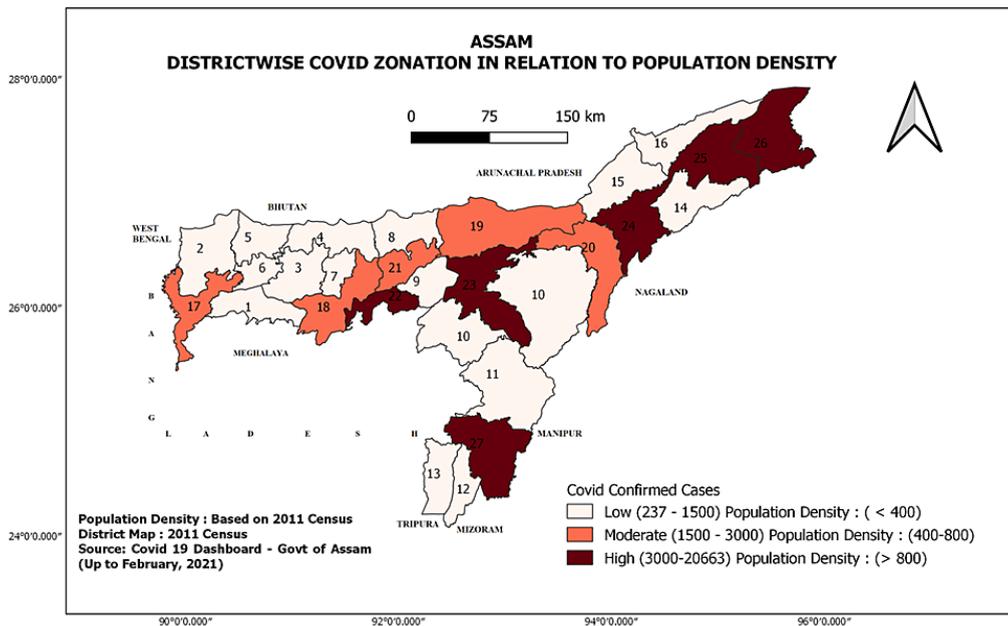
The choropleth map is based on 2011 census data for which newly formed districts including Hojai, Biswanath Chariali, Majuli, Charaideo and West Karbi Anglong are not included here.

**Table 1: ZONES OF COVID CONFIRMED CASES AND POPULATION DENSITY**

ZONE (Based on COVID Confirmed Cases)	DISTRICTS	DENSITY	DISTRICTS
Low	Goalpara, Kokrajhar, Barpeta, Baksa, Chirang, Bongaigaon, Nalbari, Udalguri, Morigaon, Karbi-Anglong, Dima Hasao, Hailakandi, Karimganj, Sivasagar, Lakhimpur and Dhemaji.	Low (Below 400)	Dima Hasao, Karbi Anglong, Kokrajhar, Sonitpur, Dhemaji, Tinsukia, Dibrugarh, Jorhat, Golaghat, Chirang and Baksa.
Moderate	Dhubri, Kamrup Rural, Sonitpur, Golaghat and Darrang.	Moderate (400-800)	Goalpara, Barpeta, Morigaon, Nagaon, Lakhimpur, Sivasagar, Cachar, Karimganj, Hailakandi, Bongaigaon, Kamrup Rural, Nalbari, Darrang and Udalguri.
High	Kamrup Metro, Nagaon, Jorhat, Dibrugarh, Tinsukia and Cachar.	High (Above 800)	Kamrup Metro and Dhubri.

Source: COVID zones are based on COVID 19 Dashboard – Govt. of Assam (<https://covid19.assam.gov.in/>).<sup>9</sup>

Population Density zones are based on Census Report, 2011.



**Fig. 3: District-wise COVID-19 zones in relation to population density**

Among the various controlling factors that give direct or indirect inputs towards daily rise of COVID cases, urban population and population density followed by availability of testing laboratories, doctors, other health workers, bed in public health centers, govt. hospitals, population below national poverty line, percentage of marginal workers and percentage of the elderly population etc. are the most prominent one. Areas with higher number of people are expected to have more cases as population density is one of the most important promoting factors of COVID-19. For this purpose, here an attempt is made to study about the inter relationship between population density and COVID cases in Assam.

Trend Analysis of COVID cases/per 10,000 Population, Analysis of district-wise COVID-confirmed cases per 10,000 people of Assam is estimated as shown in table: 2. It has been arranged in descending order and projected through a trend line as indicated by figure: 4. The graph has clearly shown much higher cases/ per 10,000 people in Kamrup metro district (164.78/ per 10,000 people), which is also the highest district in terms of total confirmed cases. Rests of the district are falling way behind at below 40/per 10,000 people.

**Table 2: District wise COVID-19 Confirmed Cases per 10000 People, Assam (as on oct. 2021)**

Name of the districts	Total confirmed case	Total district population	COVID Cases /10000 People
Kamrup Metro	20663	1253938	164.78
Jorhat	3358	1092256	30.74
Dibrugarh	3927	1326335	29.61
Tinsukia	3366	1327929	25.35
Golaghat	2387	1066888	22.37
Hailakandi	1387	659296	21.04
Darrang	1907	928500	20.54
Kamrup (Rural)	2902	1517542	19.12
Cachar	3302	1736617	19.01
Bangaigaon	1113	738804	15.06
Nagaon	3895	2823768	13.79
Nalbari	948	771639	12.29
Sonitpur	2351	1924110	12.22
Lakhimpur	1266	1042137	12.15
Dima Hasao	237	214102	11.07
Udalguri	758	831668	9.11
Dhubri	1723	1949258	8.84
Karimganj	1025	1228686	8.34
Dhemaji	502	686133	7.32
Morigaon	638	957423	6.66
Barpeta	1121	1693622	6.62
Karbi Anglong	632	956313	6.61
Goalpara	658	1008183	6.53
Chirang	280	482162	5.81
Baksa	487	950075	5.13
Kokrajhar	408	887142	4.59
Sibsagar	529	1151050	4.59

Data Source: Confirmed COVID-19 Cases are based on COVID-19 Dashboard – Govt. of Assam

Total Population data is based on Census Report, 2011.<sup>10</sup>

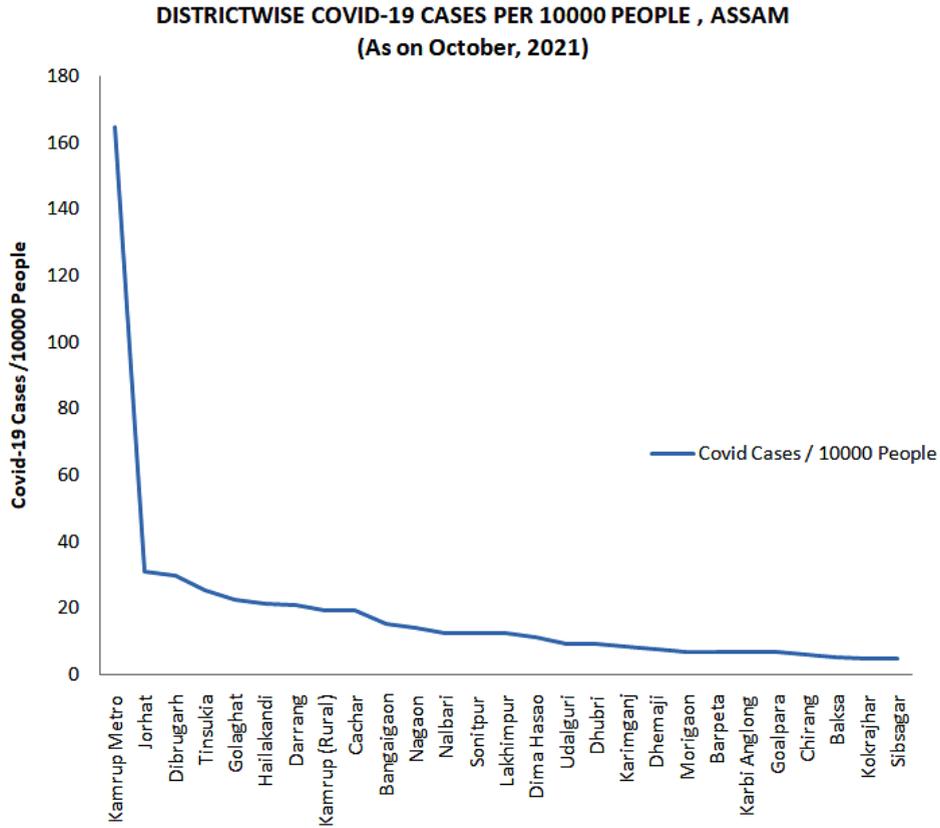


Fig. 4: District-wise confirmed COVID cases/ 10,000 population

**Calculation of Correlation**

Based on district-wise population density and COVID confirmed cases, 'r' is calculated using Karl Pearson

correlation, which is further, tested using t-test. The result is enlisted in table: 3 & table: 4 respectively.

**Table 3: CORRELATIONS**

	Population Density	COVID Confirmed Cases
Population Density		
Pearson Correlation	1	.641**
Sig. (2-tailed)		.000
N	27	27
COVID Confirmed Cases		
Pearson Correlation	.641**	1
Sig. (2-tailed)	.000	
N	27	27

\*\* . Correlation is significant at the 0.01 level (2-tailed).

To show the relation between population density and COVID confirmed cases Karl Pearson's Correlation Coefficient is calculated as it's a statistical tool to examine the association between two variables as well as whether two variables are positively or negatively related and what is the intensity of their

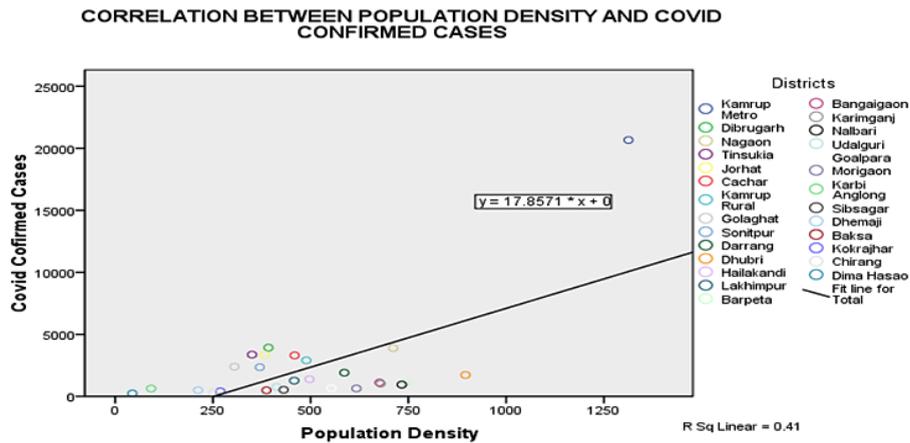
relationship. From the table 3 it is cleared that there exist a positive correlation in between population density and COVID confirmed cases as the value of R is 0.641 which is in between 0.5 to 1. However, without applying the test isn't feasible to generalize this positive relationship for all the districts.

**Table 4: Paired Samples t-Test**

	Paired Differences			95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1 COVID confirmed cases - Population Density	1.795E3	3695.848	711.266	332.860	3256.918	2.524	26	.018

Here, t value is highly positive and the p value is < .05 so, it is cleared that there is a relation between population density and COVID confirmed cases

which is statistically significant also. Thus, it may be concluded that this positive correlation is applicable for all the districts.



**Fig. 5:** shows that district of Kamrup Metro followed by Dibrugarh, Tinsukia, Jorhat, Cachar, Kamrup Rural, Golaghat, Sonitpur, Kokrajhar, Dhemaji, Chirang, Karbi Anglong and Dima Hasao fall above the fit line and rest are below the same.

**Findings**

Based on the study it has been observed that Kamrup Metropolitan has the highest COVID cases, which is also the highest population density belt. It has also indicated the highest COVID affect/10000

population. Overall the state as a whole have a positive correlation between confirmed COVID cases and population density, which is moderately correlated with a 'r' value of .641. Some of the finding of the study is summarized in the following ways.

Till 28th February, 2021 the Govt. of Assam has confirmed 167 people succumbed to COVID, while with 70.58%, 45,138 patients have recovered out of 63,950 confirmed cases in which 18,670 are in still active mode.

Among the various controlling factors large population size (especially urban population) with high density plays a dominant role in raising daily mark of COVID cases in Assam.

The trend of COVID affect per 10000 people has indicated highest cases in Kamrup Metroplitan (164.78/ per 10,000 people), which is also the highest district in terms of total confirmed cases. Rests of the district are falling way behind at below 40/per 10,000 people.

As per the Karl Pearson's Correlation Coefficient there exist a positive relationship in between population density and COVID confirmed cases as the value of 'r' is 0.641 which is in between 0.5 to 1. In this regard, with high population density Kamrup

Metro district has become the hotspot for COVID-19 with 20,663 confirmed cases in Assam, with highest affect per 10,000 people.

Kamrup Metropolitan district followed by Dibrugarh, Tinsukia, Jorhat, Cachar, Kamrup Rural, Golaghat, Sonitpur, Kokrajhar, Dhemaji, Chirang, Karbi Anglong and Dima Hasao fall above the line of best fit and rest are below the same.

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#### Conflict of Interest

The authors declare no conflict of interest in the completion of the work.

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