



Exploring Correlations of COVID-19 Mortality Rates with Development Variables: The Case of Northeast India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aim: This paper explores the correlation of the Covid-19 mortality rate with some other developmental variables. This study also attempts to highlight the state-wise variability in mortality rate in the Northeastern region of India.

Study Design: The study focuses on eight Northeastern states, correlating the Covid-19 mortality rate and other development (or socio-economic) variables. This study focuses on the region of North East India because there have been few investigations on Covid-19 in the region. This study follows a cross-sectional study design.

Duration of the Study: The study was conducted and completed around three months.

Methodology: The nature of the correlation between the mortality rate of Covid-19 and the other variables is determined by using the Karl Pearson correlation approach. We began by performing a

correlation study and calculating the correlation coefficients.

Results: The results demonstrate that all independent variables adversely correlate with the Covid-19 mortality rate. Except for the number of doctors in district hospitals and health spending per capita, which have a moderate negative correlation with the predicted variable, all explanatory factors have a weak negative connection with the death rate. Surprisingly, both the NSDP per Capita and the case positivity rate have negative findings. Another major issue in the findings is that none of the factors statistically link with mortality.

Conclusion: This research shows that the more a state's socio-economic infrastructures, notably its health infrastructures, are developed, the lower the mortality rate in a pandemic will be.

Keywords: Covid-19; mortality rate; north eastern region; India; socio-economic variables; correlation.

1. INTRODUCTION

As of September 20, 2021, WHO had received reports of 228,394,572 confirmed cases of COVID-19, with 4,690,186 deaths; India is standing second with 33,478,419 confirmed cases after the USA (World Health Organization Covid-19 Statistics). India ranks third in mortality, behind the United States and Brazil (World Health Organization Covid-19 Statistics). The second wave is coming to an end in most countries, and no one knows how many more waves will follow. As a region, northeast India covers 3.26 percent of the total confirmed cases of India, with a 2.56 percent death rate (Ministry of Health and Family Welfare, Government of India). Nevertheless, an intra-regional analysis reveals a state-level variation in the number of confirmed cases and the mortality rates. This death ratio, often known as the fatality rate, has several associations with economic and developmental indicators. A government can take appropriate actions to control the severity of the sickness if it has correct information on these types of correlations, which will impact the state's socio-economic development.

Covid-19 has been studied extensively since its invention at the global, national, and regional levels and its relationship with numerous elements, particularly socio-economic factors. Some reviews of the existing literature are made in the following section.

Gangemi et al. [1] found a significant association between COVID-19 occurrence and multiple indicators in their analysis gathered from open-access data publicly available to understand how the virus is truly spreading. The GDP Per Capita, the number of flights per capita, the Nominal GDP Per Capita, and the HDI all showed a moderate positive link in COVID-19 situations. Aside from these findings, there were other minor relationships between each country's mean

population age and the total fertility rate (TFR). In particular, positive associations with age were found for COVID-19 deaths, with age being the most extensively correlated among the indicators investigated, including the HDI, GDP Nominal Per Capita, GDP Per Capita, and TFR. Knittel and Ozaltun[2] use both linear regression and negative binomial mixed models to connect county-level COVID-19 death rates in the United States with key covariates. They looked at four sets of variables: socio-economic indicators, county-level health variables, modes of transportation, climate, pollution patterns, and discovered that higher percentages of African American people in the county are linked to higher death rates. When they limited themselves to association patterns within a single state, however, the statistical significance of the death rate-to-African-American-share correlation, while still favorable, began to fade. They came up with identical conclusions regarding the percentage of the population over the age of 65. However, when they limited themselves to association patterns within a single state, the statistical significance of the death rate-to-African-American-share link, while still favorable, diminishes. They discovered comparable outcomes for the county's elderly population. They also discovered that traveling by public transportation, as opposed to telecommuting, was associated with a greater fatality rate. The relationship between driving to work and death rates was positive in both models but statistically significant only when looking across states and counties. They also discovered that a higher percentage of persons not working and thus not commuting is linked to higher death rates, whether elderly, children, or unemployed. Death rates are greater in counties with higher home values, higher summer temperatures, and lower winter temperatures. They did not detect a link between pollution and death rates, contrary to previous research. Furthermore, they discovered no link between death rates and

obesity, ICU beds per capita, or poverty rates. Finally, after controlling for the variables in their model, their model that looks within states offered estimates of how a given state's death rate compares to other states; this can be viewed as a measure of how states are doing relative to others. Even after controlling for the four sets of variables listed above, they found that death rates in the Northeast are much higher than in other states. In Michigan, Louisiana, Iowa, Indiana, and Colorado, death rates are statistically much higher. California has the lowest death rate of any state. Goswami et al. [3] evaluated the influence of the Covid-19 pandemic and its containment measures on macroeconomic performance using state-level aggregate data from India after controlling for several baseline variables, the state economies' structure, and healthcare and public health skills. According to their panel regression analysis based on state-level monthly unemployment data from April to November 2020, states with a higher spread of Covid-19, poor initial economic conditions, and a higher reliance on secondary and tertiary sector employment had suffered significantly larger economic losses. States with a better containment strategy, greater healthcare capabilities, and a higher primary-sector employment share, on the other hand, had suffered fewer economic losses. Furthermore, the nationwide lockdown in April and May had a substantial negative impact on state economies. Finally, the virus's spread interacted with all primary components to significantly impact state economic performance. Mele and Magazzino [4] found a unidirectional causality between economic growth and pollution. These results confirmed numerous very recent contributions, which discussed or presented data analyses on the relationship between air pollution levels and the COVID-19 epidemic. Bhadra et al. [5] found a moderate association between Covid-19 spread and population density. In their study, Liu et al. [6] found an unexpected positive correlation between the human development index and the risk of infections and deaths of COVID-19. In their study, Ghosh et al. [7] discussed the negative impact that was observed for the economy and human life, with the positive impact on the environment. They also analyzed how the economy managed and could potentially deal with these three factors during and after the post-COVID-19 situation. Even though various studies on the Covid-19 pandemic were conducted globally and nationally, the northeastern part of the country (India) lacks specific investigations. The country's northeastern region has distinct

characteristics, ranging from geographical to cultural, climatic to economic, and as a result, it merits special attention. This paper tried to address some dimensions of the region in this regard. The broad objective of this paper is to explore the correlation of the Covid-19 mortality rate with some other developmental variables. This study also attempts to highlight the state-wise variability in mortality rate in the Northeastern region of India.

2. MATERIALS AND METHODS

For this study, data was collected from various secondary sources. They included the National Health Profile (NHP) of India- 2020, Ministry of Health and Family Welfare [8] for the data of district hospital doctors, Government hospital beds, and per capita health expenditure. Net State Domestic Product (NSDP) per Capita is taken from Ministry of Statistics, and Programme Implementation (MoSPI), Government of India [9]; and Sustainable Development Goal Index scores are from SDG India Index and Dashboard, 2020-21 published by NITI Aayog [10]. The state-wise literacy rates are collected from the Reserve Bank of India website [11]. The positivity rate and the absolute number of confirmed positive cases of Covid-19 are taken from the Ministry of Health and Family Welfare, India (<https://mohfw.gov.in/>) [12].

The nature of the correlation between the mortality rate of Covid-19 and the other variables was determined using the Karl Pearson correlation approach. We began by performing a correlation study and calculating the correlation coefficients. The correlation coefficient, abbreviated as r , measures the strength of a linear or straight link between two variables. The correlation coefficients between HDI and each independent variable were calculated individually. Through a shaky linear rule, values between 0 and 0.3 (0 and 0.3) imply a weak positive (negative) linear relationship. Through a fuzzy-firm linear rule, values between 0.3 and 0.7 (0.3 and 0.7) imply a moderate positive (negative) linear relationship. Through a firm linear rule, values between 0.7 and 1.0 (0.7 and 1.0) imply a strong positive (negative) linear relationship.

3. RESULTS AND DISCUSSION

The first part of this section discusses the statewide variation in the death ratio of the study area, the status of the development variables of

the study in the study area, and some descriptive statistics. The second part provides a correlation analysis of the development variables with Covid-19 mortality rate.

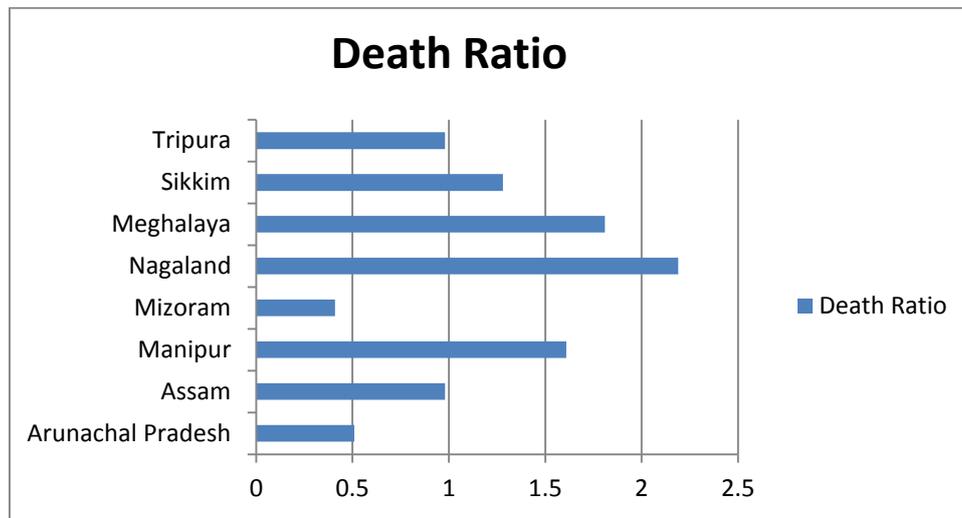


Fig. 1. Statewise variation in Covid-19 mortality rate

Table 1. Status of development variables in the study area

State	Death Ratio/mortality rate	Net State Domestic Product per capita	Literacy Rate	District Hospital Doctors	Government Hospital Beds	Per capita Health Expenditure	Sustainable Development Goal Score	Positive Case Rate	Total Positive Cases
Arunachal Pradesh	0.51	97080	65.4	699	2402	10869	60	3.43486	53943
Assam	0.98	60695	72.2	774	28039	2086	57	1.67553	596606
Manipur	1.61	51180	76.9	230	1768	2680	64	3.80706	117697
Mizoram	0.41	129609	91.3	201	2022	5145	68	6.09	75470
Nagaland	2.19	72969	79.6	176	2461	3200	61	1.36601	30731
Meghalaya	1.81	62458	74.4	309	4467	3938	60	2.33846	78729
Sikkim	1.28	242002	81.4	469	2260	5971	71	4.45316	30738
Tripura	0.98	82632	87.2	435	4343	2568	65	2.00864	83756

Source: Reference- [9,10,11,12]

Table 2. Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Death Ratio	8	1.78	.41	2.19	1.2213	.62337	.389
NSDP PC	8	190822	51180	242002	99828.13	62586.569	3917078647.268
Literacy	8	25.9000	65.4000	91.3000	78.550000	8.2790614	68.543
District hospital doctors	8	598	176	774	411.63	227.137	51591.411
Govt. Hospital beds	8	26271	1768	28039	5970.25	8976.145	80571173.071
per capita health exp.	8	8783	2086	10869	4557.13	2878.397	8285169.268
SDG score	8	14	57	71	63.25	4.652	21.643
Total positive cases	8	565875	30731	596606	133458.75	189363.411	35858501366.214
Valid N (listwise)	8						

Table 3. Correlation Summary

		NSDP per Capita	Literacy rate	District Hospital doctors	Government hospital beds	Health expenditure per capita	SDG score	Positive Case Rate
Mortality rate	Pearson correlation coefficient	-0.246	-0.095	-0.487	-0.136	-0.495	-0.187	-0.169
	Sig.(Two tail test)	.557	.822	.221	.748	.212	.657	.163
	No. of observation	8	8	8	8	8	8	8

3.1 Statewise Variation in Death Ratio in North Eastern Region

As a region, northeast India covers 3.26 percent of the total confirmed cases of India, with a 2.56 percent mortality rate. However, an intra-regional analysis reveals a state-level variation in the number of confirmed cases and the mortality rates. Fig. 1 shows the intra-regional variation of Covid-19 mortality with a state-wise analysis. It is seen that Nagaland is occupying the top place with a 2.19 percent mortality rate, while Mizoram stands at the bottom with 0.41 percent. Manipur, Nagaland, Meghalaya, and Sikkim are four states with a mortality rate of higher than 1%. Compared to the national average of 1.32 percent (as of September 20, 2021), three northeastern states, namely Manipur, Nagaland, and Meghalaya, are all above it. Nagaland has the lowest overall number of positive cases and the highest positivity rate in the region, but surprisingly it has the highest mortality rate. This status of Nagaland can be explained by the fact

that the state has the region-lowest district hospital doctors and low comparative performance in the other indicators included in this study. Interestingly, on the other hand, Mizoram has the lowest mortality rate in the region while also having the highest positive case rate.

Table 1 shows the status of the developmental variables of the study area that are included in the study.

With the data given in table 1, we used descriptive statistics to describe the basic features and provide simple summaries about the samples. Table 2 shows the descriptive statistics of the variables (both dependent and independent) used in this study. Descriptive statistics are a series of short descriptive coefficients that summarize a data set, representing the entire population or a sample of the population. In this study, among various parameters of descriptive statistics, the range,

the minimum, the maximum, the mean and standard deviation, and the variance are considered for the variables.

3.2 Correlation Analysis

A total of 8 Indian states (specifically the North Eastern Region) are taken in the study, considering their availability of data on different indicators used here. Table 3 summarizes the correlation of mortality rate with other socio-economic indicators taken for the study with Karl Pearson coefficients.

The results show that all the independent variables negatively correlate with the mortality rate of Covid-19 that is reflected by the Pearson correlation coefficients. All the explanatory variables show a weak adverse correlation with the mortality rate except the numbers of doctors in districts hospitals and the health expenditure per capita that have a moderate negative correlation with the predicted variable. A moderate positive correlation exists between GDP per capita and HDI with Covid-19 situations [1]. Liu et al. [6] also found an unexpected positive correlation between the human development index and the risk of infections and deaths of COVID-19 [6]. This study contrasts with the previous findings in those regards with NSDP per capita and the literacy rate. Unexpectedly, two variables, i.e., NSDP per capita and case positivity rate, show negative results. Though Asfahan et al. [13] found negative correlations of cash fatality rate of Covid-19 with GDP per capita, medical doctors per 10000 populations and life expectancy. It is generally expected that the more a state have positive patients, the more is the death rate there. In this paper, the unusual negative association between case positivity rate and the death rate can be explained by the unique setup of the northeastern region, which has various dissimilarities with the rest of the country and the global level. The other variables are giving similar results of association with the mortality rate.

Another prime issue regarding the results is that all the variables show a statistically insignificant relationship with the mortality rate. The reason for the issue is purely technical that is associated with lower numbers of observations. It is well known that more numbers observations generally tend to statistically significant correlation results between variables.

4. CONCLUSION

This study concludes that the more a state develops its socio-economic infrastructures, specifically the health infrastructures, the lower the mortality rate in the pandemic will occur. Some states like Mizoram is showing better results with lower mortality rate instead of having highest positive case rate can be well justified through its developed status in the explanatory variables considered for the study. The northeastern region has unique characteristics in different dimensions, and for that reason, the area deserves thorough and more comprehensive research. Among the vast elements of other socio-economic indices, which significantly affect mortality, is a new matter of study. Despite the fact that several studies on the Covid-19 pandemic have been undertaken globally and nationally, there have been no special investigations in the northeastern area of the country. This study will thus provide new dimensions and direction for future research in northeast India, mainly based on the ongoing pandemic.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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