IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Correlations among early data of total, cured and deceased cases from COVID-19, and socioeconomic indicators across states of India.

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Abstract- Background- COVID-19 has spread worldwide and follows a growth depending upon policy and socioeconomic indicators. In India COVID-19 has been localized & measured viral disease, as per the early data till 18th April. It is interesting and informative to look at various associations. Up till April 18th new cases per day in India were less than 1000. **Objective-** What are the socioeconomic correlates with early COVID-19 data? **Materials and methods**- Data were extracted from national repositories and correlations were checked using SPSS16.0 for windows. **Results-** Places with generally better medical facilities, have a cluster of cases distributed unevenly and are traceable. Indian states with larger areas have less of the patients (r = -.458*). More populous states have less cases (r = -.551*). This may be due to extensive, early & nationwide lockdown declared by government of India. Better agriculture gains are correlated positively with cured/discharged cases (rho = +.369*). Better infrastructure in the form of highway length of states may cause clustering (r= +.379*) of fatalities due to more healthcare facilities of COVID-19. **Conclusion-** These trends of localized spread are reported till during intermission of phase II of local transmission and phase III of community transmission, dated up till April 18th. These trends may change later during the end phase of COVID-19 pandemic in India. Opening of lockdown in a graded & controlled manner shall be observed considering for these correlations.

Keywords- Socioeconomic indicators, COVID-19, Indian states.

Introduction-

India is a country of diverse socioeconomic status among its states. Within the states also there is urban and rural divide. COVID-19 has spread globally; all Indian states are known to have cases except Sikkim as on April 18th, 2020. [1] There are three specific indices which are being checked and reported widely - i.e. a)- Total number of positive COVID-19 cases (TPC); b)- Total number of cured/discharged cases of COVID-19, (C/DCs); c)- Total number of COVID-19 deaths (CD). [2] India has substantial socioeconomic diversity as seen from its socioeconomic indicators across its states. [3] In the present study we looked at correlations of socioeconomic indicators and SARS-COV-II brought COVID-19 epidemiology across Indian states. Up till April 18th new cases per day in India were less than 1000. It is informative and useful for future planning that we investigate any correlations among these COVID-19 data and socioeconomic factors, for identification of vulnerabilities in our socioeconomic structure.

Objectives-

The socioeconomic indicators may be correlated with the early COVID-19 data. The objective of this investigation was to check the correlations of early COVID-19 data with socioeconomic indicators across Indian states.

Methodology –

Study Design – Correlational study with data review.

Data review- The COVID -19 data was downloaded from government COVID database, - (up till 18.04.2020). https://www.mygov.in/corona-data/covid19-statewise-status. [2]

Socioeconomic indicators were taken from government of India database – Open government database India (OGD) https://data.gov.in/resources/major-socio-economic-indicators-2011-01082014-state-wise-ranking. [3]

Statistical analysis- SPSS 16.0 for Windows was used for data analysis. Correlation coefficients – Pearson's correlation 2 tails, Kendall's Tau –B, and Spearman's rank order correlation coefficients were analysed and checked for a p- value of <0.05. Pearson's is better for ratio/ interval level data whereas ordinal data is better checked by Kendall's Tau and Spearman's rank order correlation coefficient.

Results & Discussion-

A total of 13,555 cases of COVID-19, including 1771 cases cured/discharged and 462 deaths are considered, 1 migrated case is not considered. Maximum and minimum range for total cases is – 0- 3323; cured/discharged cases was- 0 - 331, and range of deaths was – 0 - 201; among Indian states. Maharastra is the worst affected state. The correlation coefficients and p values are tabulated below in table-1.

Significant correlations are seen for area, population, sex ratio and maternal mortality with total cases (TPC); same trend is followed for total number of cured/discharged cases of COVID-19, (C/DCs) and total number of COVID-19 deaths (CD). Additionally, significant correlations are seen for highway length with total deaths and agriculture related Growth State Domestic Product with cured/discharged cases.

Total positive cases of COVID19 (TPC), have shown no correlation with Net State Domestic Product (NSDP) per capita and Growth rate in Gross State Domestic Product (GSDP) –Agriculture of states. Despite an obvious big player- NSDP is seen not linked to TPC, directly. NSDP has a multifactorial causational effect on any nation, however there are many disparities in India like urban and rural divide, every state has urbanization as a social issue affecting economics and health; in its constituents disturbing the relationship. [4] TPC correlates significantly and negatively with area of states in Sq Kms. All three correlation coefficients (Pearson's correlation 2 tails, Kendall's Tau –B, and Spearman's rank order correlation coefficients), show significant and negative correlation of area for TPC. It simply means lack of community transmission with in the landscape of India and clustering of cases till April last week. [5] Pearson's correlation coefficient is seen as moderately negative (r= -.458; p=.012), as seen in figure-1, bigger areas shall have more cases usually, if there is normal distribution of all variables, the negative correlation signals a divergent distribution of the COVID-19 in India with smaller states like Delhi having larger number of positive cases. Bigger states have lesser comparative numbers, thus so far the spread is not uniform as per the area of the states. Thus, the widespread community spread is not seen. [5] Early lockdown which is extensive and nationwide may be a factor responsible for it. There is negative and significant correlation (r= -.551; p=.002) of population numbers with TPC, as seen in figure-1. Population densities of Indian states has given a negative correlation (r= -.371; p=.012) with TPC. It is signifying localized disease with certain hotspots and not spread to the whole of the population. It may be a finding due to widespread lockdown. [6-8] In the event of *relaxation of lockdown*, strict strategies (guidelines for public) to prevent spread to populations in larger states with poor infrastructure may be one of the intervention of choice. Sex ratio (0 – 6 yrs.) Indian female population per 1000 males gives a positive and significant correlation of the COVID-19. Skewed sex ratio among populations has been a cause of concern for many factors. [9] TPC have shown negative correlation with maternal mortality data. Maternal mortality signifies lower hospital access which is seen with peripheral rural areas more, in urban areas there is better medical facilities; however, such areas have seen more TPC. [10] There is no correlation of TPC with birth rates, death rates, length of highways and literacy rates of the states. Thus, lockdown has a domino effect in COVID epidemiology in India.

Cured/discharged cases (C/DC) have seen a similar pattern with socioeconomic data, as TPC. It may be because there are more total cases the number of cases cured /discharged are also more and the pattern is same. However, there is a significant positive correlation of *Spearman's– rho,* of cured cases with Growth rate in Gross State Domestic Product (GSDP) –Agriculture (rho=.369; p= 0.49), as seen in figure-1. Thus, monetary gains from agriculture may be affecting cure rates (C/DC) via some intermediary variable like better nutrition and expenditure on health. [11] General nutrition and better agricultural gains may remain factors for emphasis during the fight from COVID-19. There is no uniform health insurance coverage in India so income remains determining factors for health care costs. [12]

Total number of COVID-19 deaths (CD) have followed similar pattern with socioeconomic data, as seen for TPC, except there is a positive and significant correlation with Highway Length per sq. km (r=.379; p=.043), as seen in figure-1. Highway Lengths per sq. km are suggestive of better

Table 1 – The COVID-19 data of Indian population with respect to socioeconomic indicators. The correlation coefficients (Pearson's–r, Kendall's Tau –B & Spearman's–rho) with the actual p- values are given. The coefficients with p value <0.05 are * marked.

COVID-19 data (Dependent)	Socioeconomic Indicator	Correlation	Correlation Coefficient's value	Actual p-Value
Total No. of positive COVID-19 Cases (TPC)	Net State Domestic Product (NSDP) per capita	*Pearson's–r*	-.289	.128
		Kendall's Tau –B	-.087	.511
		Spearman's–rho	-.118	.541
	Growth rate in Gross State Domestic Product (GSDP) -Agriculture	*Pearson's–r*	.187	.331
		Kendall's Tau –B	.161	.222
		Spearman's–rho	.212	.268
	Area (Sq. Km.)	*Pearson's–r*	-.458*	.012
		Kendall's Tau –B	-.493*	.000
		Spearman's–rho	-.633*	.000
	Population (number)	*Pearson's–r*	-.551*	.002
		Kendall's Tau –B	-.627*	.000
		Spearman's–rho	-.799*	.000
	Population Density (Per Sq. Km.)	*Pearson's–r*	-.292	.124
		Kendall's Tau –B	-.394*	.003
		Spearman's–rho	-.531*	.003
	Sex Ratio (0-6 years) (Female children/ 1000 male children)	*Pearson's–r*	.416*	.025
		Kendall's Tau –B	.404*	.002
		Spearman's–rho	.568*	.001
	Death Rate (%)	*Pearson's–r*	.004	.984
		Kendall's Tau –B	.232	.081
		Spearman's–rho	.323	.088
	Maternal Mortality Rate (MMR) (per 100000 live births)	*Pearson's–r*	-.376	.125
		Kendall's Tau –B	-.378*	0.30
		Spearman's–rho	-.419	.084
	Total Literacy Rate (%)	*Pearson's–r*	-.1	.606
		Kendall's Tau –B	.097	.464
		Spearman's–rho	.127	.570
	Birth Rate (%)	*Pearson's–r*	.074	.703
		Kendall's Tau –B	.132	.319
		Spearman's–rho	.239	.212
	Highway Length per sq. km	*Pearson's–r*	.328	.082
		Kendall's Tau –B	.235	.074
		Spearman's–rho	.331	.079
Total No. of Cured/discharged COVID-19 Cases (C/DC)	Net State Domestic Product (NSDP) per capita	*Pearson's– r*	-.288	.130
		Kendall's Tau –B	-.111	.407
		Spearman's– rho	-.163	.397
	Growth rate in Gross State Domestic Product (GSDP) -Agriculture	*Pearson's– r*	.357	.057
		Kendall's Tau –B	.256	.054
		Spearman's– rho	.369*	.049
	Area (Sq. Km.)	*Pearson's– r*	-.418*	.024
		Kendall's Tau –B	-.407*	.002
		Spearman's– rho	-.583*	.001
	Population (number)	*Pearson's– r*	-.569*	.001
		Kendall's Tau –B	-.583*	.000
		Spearman's– rho	-.767*	.000
	Population Density (Per Sq. Km.)	*Pearson's–r*	-.371*	.047
		Kendall's Tau –B	-.397*	.003
		Spearman's–rho	-.548*	.002
	Sex Ratio (0-6 years) (Female children/ 1000 male children)	*Pearson's–r*	.184	.338
		Kendall's Tau –B	.359*	.007
		Spearman's–rho	.486*	.007
	Death Rate (%)	*Pearson's–r*	.136	.480
		Kendall's Tau –B	.177	.187
		Spearman's–rho	.271	.155
	Maternal Mortality Rate (MMR) (per 100000 live births)	*Pearson's–r*	-.583*	.011
		Kendall's Tau –B	-.404*	.02
		Spearman's–rho	-.533*	.023
	Total Literacy Rate (%)	*Pearson's–r*	-.191	.322
		Kendall's Tau –B	.030	.821
		Spearman's–rho	.011	.953

Total No. of COVID-19 Deaths (CD)	Birth Rate (%)	*Pearson's–r*	-.102	.600
		Kendall's Tau –B	.071	.597
		Spearman's–rho	.114	.554
	Highway Length per sq. km	*Pearson's–r*	.215	.262
		Kendall's Tau –B	.201	.131
		Spearman's–rho	.295	.121
	Net State Domestic Product (NSDP) per capita	*Pearson's–r*	-.256	.180
		Kendall's Tau –B	-.089	.516
		Spearman's–rho	-.103	.593
	Growth rate in Gross State Domestic Product (GSDP) -Agriculture	*Pearson's– r*	.104	.593
		Kendall's Tau –B	.099	.468
		Spearman's– rho	.141	.466
	Area (Sq. Km.)	*Pearson's– r*	-.391*	.036
		Kendall's Tau –B	-.487*	.000
		Spearman's– rho	-.599*	.001
	Population (number)	*Pearson's– r*	-.435*	.018
		Kendall's Tau –B	-.596*	.000
		Spearman's– rho	-.778*	.000
	Population Density (Per Sq. Km.)	*Pearson's–r*	-.155	.423
		Kendall's Tau –B	-.382*	.005
		Spearman's–rho	-.525*	.003
	Sex Ratio (0-6 years) (Female children/ 1000 male children)	*Pearson's–r*	.3	.114
		Kendall's Tau –B	.374*	.007
		Spearman's–rho	.525*	.003
	Death Rate (%)	*Pearson's–r*	-.025	.899
		Kendall's Tau –B	.231	.092
		Spearman's–rho	.311	.101
	Maternal Mortality Rate (MMR) (per 100000 live births)	*Pearson's–r*	-.364	.137
		Kendall's Tau –B	-.388*	.030
		Spearman's–rho	-.469*	.049
	Total Literacy Rate (%)	*Pearson's–r*	-.135	.483
		Kendall's Tau –B	.094	,468
		Spearman's–rho	.173	.372
	Birth Rate (%)	*Pearson's–r*	.024	.902
		Kendall's Tau –B	.173	.207
		Spearman's–rho	.253	.186
	Highway Length per sq. km	*Pearson's–r*	.379*	.043
		Kendall's Tau –B	.272*	.047
		Spearman's–rho	.371*	.048

infrastructure, thus better the infrastructure more are the deaths - means there are clusters of cases in better medical centres in the country. [13] It may lead to overburden of these centres in long-term. [14] Therefore, widespread accessibility of better medical facilities across the country in given times, during enduring fight with COVID-19 are warranted. Poor labourers are already reported as on the receiving end. [15]

Conclusions & Implications – It is to be seen how COVID-19 unfolds, but on the basis of above as an educated guess we may do the following after lockdown 3.0 –

1)- To prevent progression to phase III, Indian states may continue graded or phasic lockdown as much as possible to prevent overwhelming of Indian healthcare system and flattening of the curve of COVID-19.
2)- Public guidelines after lockdown shall be technically preventive and strict in adherence to decrease TPC and CDs for prevention of disease.
3)- Increase the peripheralization of health services to primary health centres for better disease epidemiology - C/DCs cases. Better services for the people on the lower levels of socioeconomic status.
4)- Security check on highways for preventing transportation of cases to deeper communities for spread of COVID-19 (a travelling pandemic).
5)- Better upgraded healthcare in rural settings like providing ICUs for vulnerable groups of elderly, hypertensive, diabetics and immunocompromised individuals to increase C/DCs.

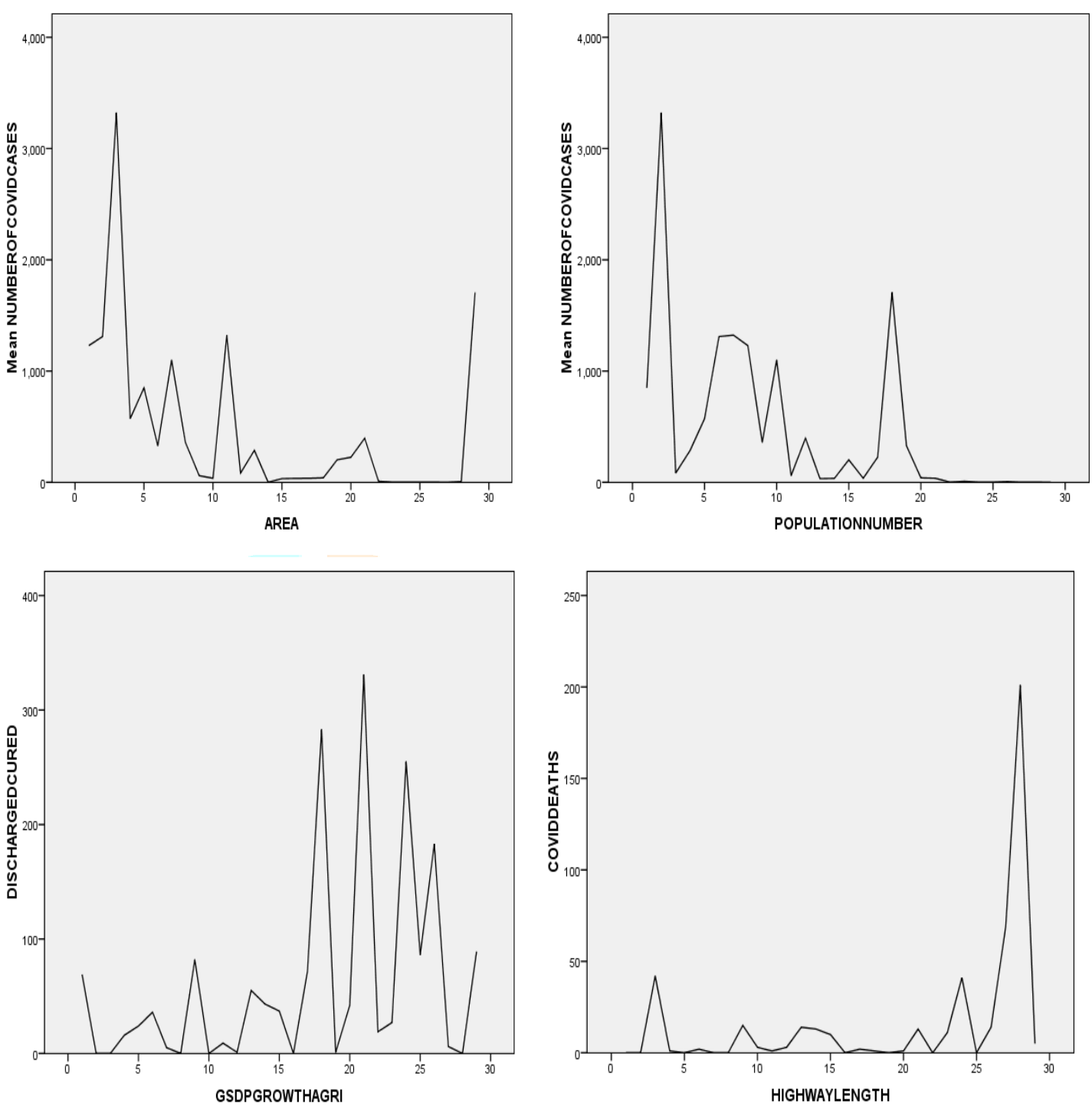

Figure 1 – Line diagram showing total cases against the Area in Sq. Kms & Population numbers (negative correlations); Discharged/Cured cases against GSDP growth rate – Agriculture, (positive correlation); COVID-19 deaths against the highway length (positive correlation) across states of India up till 18th April 2020. These trends are reflective of initial success of containment of disease in the early phase across the Indian states.

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