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COVID-19: PANDEMIC MANAGEMENT IN DIFFERENT PARTS OF INDIA

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Purpose: Managing a pandemic in individual countries is a concern not only of governments but also of WHO and the entire international community. The pandemic knows no bounds. In this context, India is a special country - with a huge population and a very large diversity of cultural, geographic, economic, poverty levels, and pandemic management methods. In this work, we try to assess the sum of the impact of these factors on the state of the epidemic by creating a ranking of Indian states from the least to the most endangered.
Design/methodology/approach: As a method of creating such a ranking, we take into account two very, in our opinion, objective variables - the number of deaths and the number of vaccinations per million inhabitants of the region. In order not to make the usually controversial ascribing of weights to these factors, we relate them to the selected reference region - here to the capital city - Delhi. We apply a logical principle - the more vaccinations, the better and the more deaths - the worse.
Findings: The results are rather surprising. Many small regions are safe regions, such as Andaman, Tripura or Sikkim, many large or wealthy states are at the end of this ranking, such as Delhi, Maharashtra, Uttar Pradesh, Bihar, and Tamil Nadu.
What was found in the course of the work? This will refer to analysis, discussion, or results.
Originality/value: The method enables an indirect assessment of the quality of pandemic management in a given region of the country. It can be used for any country or even a group of countries or a continent. According to this criterion, the best state/region is intuitively the safest for residents. A small number of deaths and a large number of vaccinations may positively indicate the state of public health and good management of the fight against the pandemic by local and/or central authorities.

Keywords: Keywords: COVID-19, pandemics, computational intelligence, healthcare, pandemic management.

Category of the paper: research paper, case study.

Introduction

India, being one of the most populous country in the world, has experienced several epidemics over time. Several accounts of flu, cholera, dengue, smallpox, and many others can be found recorded throughout history. While the Indian health-care was able to eliminate some, many diseases continue to be a threat to Indian-society. Unusual health-emergencies in India are rare but many articles point to the causes for usual health-emergencies in developing countries such as malnutrition, poor sanitation, and the lack of a proper public health system (Murhekar, 2009; Swetha, 2019). Pandemic is an outbreak of a sudden, serious illness in different parts of world that already exists in some specific countries. It is shown in the literature that there is a link between pandemic and natural disasters and confirms that there is an increasing number of post-disaster epidemics even though events in India have not been emphasized. Pandemic symptoms are similar to common health problems that need to be organized properly in the interest of human beings (Watson, 2007).

An epidemic occurs when another new or evolved type of virus emerges, which is resistant to existing available medications and hence, the danger posed by them to human society is unthinkable. It, therefore, brings deadly diseases worldwide with high mortality and dreariness ((Nongkynrih, 2004). There are a number of infectious diseases that have caused worldwide epidemics in the past, some of them are Flu, Spanish Flu, Asian Fever and Hong Kong Flu spread in the in the year 1918, 1957 and 1968 respectively (Kumar, Sharma, 2013). Some notable examples of the emergence of highly-viral infectious diseases are flu virus swine-origin (A/H1N1) (Brookes, Khan, 2005), the Severe Acute Respiratory Syndrome (SARS) virus from the previous epidemic reported in 2003 in southern China and the Middle East Respiratory Syndrome coronavirus (MERS-CoV) reported in middle-east in 2012.

The SARS virus and the COVID-19 virus are genetically, almost, the same type but the disease and mortality rate caused by both are different (Shereen, 2020). India filed its first case on May 13, 2003. Majority of the cases declared in this way were travel-related cases and spread was among those taking trips to India from influential countries (Boulos, Geraghty, 2020). In the following we present a quick survey of some key references that present relevant studies conducted in relation to the Indian COVID-19 pandemic scenario.

Novel Corona virus is a new and challenging virus of our time. It is so extensively and globally spread today that it is very difficult to know the direct distribution of COVID-19 in different parts of the world. Day by day the cases are still increasing, therefore, it becomes necessary to take this disease seriously (worldometers.info; who.int). The World Health Organization (WHO) reports (WHO, 2021) that the virus mainly affects a subset of people with low immunity, diabetes, high blood pressure, aging, and lung-related medical problems (Vashisht, Prakash, 2020). Because of COVID-19 millions of people are forced-confined to their own homes and the world economy has been declining. COVID-19 is a highly contagious disease and its spread is unpredictable. There are cases where a person has not been in direct contact with an infected person or has no history of travel, yet carrying the COVID-19. The prediction of the rate of growth of the novel corona virus has been discussed in (Jamwal et al., 2019; Vashisht et al., 2020) and the epidemiology and status of COVID-19 in different parts of India has been considered in (Kumar et al., 2020; Khan et al., 2020; Chowdhur, Oommen, 2020). The socio-economic implications of the coronavirus and COVID-19 pandemic in several countries from different aspects like effect on tourism etc., has been discussed in (Nicola et al., 2020; Senbeto et al., 2020). Lockdown has been the only containment tool of the public-health managing bodies to control the spread of COVID-19. Initially, twenty one days lockdown was imposed in INDIA and it's effect has been elaborated in (Sardar et al., 2020). Artificial Intelligence (AI) - based systems are preferred in urban health monitoring (Allam, Jones, 2020) and hence, AI applications were used in abundance for COVID-19 pandemic management (Vaishya et al., 2020).

In order to manage (contain the spread and prevent the death) the pandemic in India, the assessment and prediction of new active COVID-19 cases is very much required so that proper medical facilities be provided and administrative measures like lockdown, night curfew etc. can be planned effectively. Therefore, mathematical modelling of the spread of COVID-19 was required which is also studied in (Bhatnagar, 2020a; Arti, Bhatnagar, 2020; Roy, Bhattacharya, 2020; Sinha, Klahn, 2020; Banerjee, 2020; Koczkodaj et al., 2020, Mazurek, Nenickova, 2020; Mazurek et al., 2020, Wilinski, 2021; Wilinski, Szwarc, 2021; Shereen et al., 2020; Wilinski et al., 2022). Initially, there were only limited testing kits were available and number of patients were very high. Considering this some work with limited medical facility has been proposed in (Bhatnagar et al., 2020). Signal processing based analysis, specifically statistical modelling, relay based study of COVID-19 has been discussed in (Bhatnagar, 2020b; Bhatia, Mitra, 2020; Arti 2020). The aspect of uneven territorial distribution in terms of post-COVID-19 deaths is presented in (Arti, Wilinski, 2021). Most of the discussed problems used data located e.g. in sources such as (CSSE (2021); Worldometers (2021); EconomicsHelp (2021); WorldPop (2021); Gisanddata (2021): Statista (2021).

The aim of this article is to present a certain criterion regarding the severity and consequences of the COVID-19 pandemic by considering two factors - the number of deaths and the number of vaccinations.

The authors intend to use these data to show differences between administrative units of a given country in terms of the severity of a pandemic, on the one hand, and the intensity of remedial measures, on the other. This may help various states manage a pandemic nationwide by reducing regional contrasts. An example considered in the study is India, a diverse country, divided into 36 states.

The method

It is assumed that the assessment of the effectiveness of pandemic management in a given state is influenced by two factors - the number of deaths per million inhabitants and the number of complete vaccinations performed also per million inhabitants. The first effect is assumed to be negative, the second as positive. This is a simple assumption that can be discussed, for example, in terms of the strength of impact on public health in the region. In this work, the equal weight of both factors is assumed.

Let us define:

$$S(i, t) = (P(i, t), D(i, t), V(i, t)); \; i = 1,2, ..., N, \; t = 1,2, ..., T \quad (1)$$

This means the time series of health assessment (one of the many components of this assessment related to the pandemic) - for the i-state and on-the-day t since the beginning of the pandemic.

For day t = 1, the authors assume the beginning of pandemic index quotations (Confirmed Cases, Deaths, and Recovered) conducted for the whole world by WHO and the CSSE Institute of John Hopkins University in Baltimore, USA (gisanddata.maps.arcgis.com). This day tc = 1 is January 22, 2020.

Later in the article, the authors abandon the notation (1), replacing it with a simpler one, devoid of t indices, assuming that the calculated ones are carried out for an unequivocally determined pandemic day tc. In this paper, the first calculations were made for tc = 574 on (18 Aug.2021).

Therefore, hereinafter:

$$Si = (Pi, Di, Vi), \; i = 1,2, ..., N \quad (2)$$

where:

Pi - population vector in particular regions (states) of India.

Di - vector of the number of deaths in each i-th state on day tc.

Vi - vector of the number of vaccinations in each i-th state on day tc.

The study considers the administrative division into 36 states presented in alphabetical order in Table 1. The table contains the following columns: names of states, number of inhabitants in thousands, number of deaths since the beginning of the pandemic, and number of vaccinations (the second or last dose in thousands).

Table 1.
Basic data for the calculation of the state threat indicator as at tc = 574 (18 Aug 2021). Population in mln, Vaccination in thousand, deaths without a multiplier

No.	State	Population	Deaths	Vaccines
1	Andaman and Nicobar	0.417	129	98
2	Andhra Pradesh	53.903	13715	6653
3	Arunachal Pradesh	1.57	257	204
4	Assam	35.607	5566	2582
5	Bihar	124.8	9649	5016
6	Chandigarh	1.158	812	256
7	Chhattisgarh	14.0	13552	2895
8	Dadra and Nagar Haveli	0.615	4	96
9	Delhi	18.71	25070	3355
10	Goa	1.586	3184	342
11	Gujarat	63.872	10079	9925
12	Haryana	28.204	9666	3329
13	Himachal Pradesh	7.451	3563	1553
14	Jammu and Kashmir	13.606	4401	1611
15	Jharkhand	38.593	5132	2201
16	Karnataka	67.522	37123	8119
17	Kerala	35.699	19428	6776
18	Ladakh	0.289	207	74
19	Lakshadweep	0.073	51	18
20	Madhya Pradesh	85.123	10515	6244
21	Maharashtra	123.09	135820	13307
22	Manipur	3.366	1747	277
23	Meghalaya	3.312	1269	263
24	Mizoram	1.285	194	221
25	Nagaland	2.249	609	175
26	Odisha	46.356	7289	4612
27	Puducherry	1.413	1808	160
28	Punjab	30.141	16352	2655
29	Rajasthan	81.032	8954	9237
30	Sikkim	0.69	364	cze.00
31	Tamil Nadu	77.841	34686	5037
32	Telangana	38.51	3856	4222
33	Tripura	4.169	785	833
34	Uttar Pradesh	237.88	22792	9483
35	Uttarakhand	11.25	7377	1773
36	West Bengal	99.609	18356	9532

Source: https://worldpopulationreview.com/country-rankings/gini-coefficient-by-country, 16 Aug 2022; https://gisanddata.maps.arcgis.com/apps/dashboards/, 1 Sep 2022; https://www.statista.com/statistics/1104709/coronavirus-deaths-worldwide-per-million-inhabitants/, 10 Sep 2022.

Taking into account the huge diversity of states in terms of population, it will be logical to introduce new variables in which the above-mentioned factors will depend on the population, obtaining respectively:

- the number of deaths per million inhabitants

  di = Di / Pi i = 1, 2, …, 36 (3)

  where Pi is expressed in millions for each state,
- number of vaccinations per million inhabitants

  vi = Vi / Pi i = 1, 2, …, 36 (4)

where Pi - as for (3).

In this way, we obtain a completely different distribution of the potential pandemic threat in India, presented in Table 2. This table consists of three columns, in which, apart from the state names, we also present the above-defined variables di and vi.

Table 2.
The number of deaths due to the pandemic in individual Indian states relative to one million inhabitants and the number of vaccinations per thousand inhabitants

No.	States	Population	Deaths_pm	Vaccines_pt
1	Andaman and Nicobar	0.417	309.35	235.01
2	Andhra Pradesh	53.903	254.44	123.43
3	Arunachal Pradesh	1.57	163.69	129.94
4	Assam	35.607	156.32	72.514
5	Bihar	124.8	77.316	40.193
6	Chandigarh	1.158	701.21	221.07
7	Chhattisgarh	14	968	206.79
8	Dadra and Nagar Haveli	0.615	6.50	156.1
9	Delhi	18.71	1339.9	179.32
10	Goa	1.586	2007.6	215.64
11	Gujarat	63.872	157.8	155.39
12	Haryana	28.204	342.72	118.03
13	Himachal Pradesh	7.451	478.19	208.43
14	Jammu and Kashmir	13.606	323.46	118.4
15	Jharkhand	38.593	132.98	57.031
16	Karnataka	67.522	549.79	120.24
17	Kerala	35.699	544.22	189.81
18	Ladakh	0.289	716.26	256.06
19	Lakshadweep	0.073	698.63	246.58
20	Madhya Pradesh	85.123	123.53	73.353
21	Maharashtra	123.09	1103.4	108.11
22	Manipur	3.366	519.01	82.294
23	Meghalaya	3.312	383.15	79.408
24	Mizoram	1.285	150.97	171.98
25	Nagaland	2.249	270.79	77.812
26	Odisha	46.356	157.24	99.491
27	Puducherry	1.413	1279.5	113.23
28	Punjab	30.141	542.52	88.086
29	Rajasthan	81.032	110.5	113.99
30	Sikkim	0.69	527.54	233.33
31	Tamil Nadu	77.841	445.6	64.709
32	Telangana	38.51	100.13	109.63
33	Tripura	4.169	188.29	199.81
34	Uttar Pradesh	237.88	95.812	39.864
35	Uttarakhand	11.25	655.73	157.6
36	West Bengal	99.609	184.28	95.694

With indicators such as di and vi related to one million inhabitants, it is still not clear how to fairly determine the ranking of states regarding a pandemic threat. While comparing two states, it is obvious that if in the first one there is a higher death rate per million di and at the same time a lower vaccination rate per million vi, then the former is more at risk. However, this is only a general observation that will not allow for the preparation of a ranking for the entire administrative division.

So it was decided to find a measure of the relative deterioration or improvement of both indicators di and vi relative to one selected state. The following were selected as the basis for the comparison:

$Rdi = di / di_D$ (5)

$Rvi = vi / vi_D$ (6)

where di_D, vi_D - indicators for Delhi.

Each state can therefore be assessed against Delhi. If Rdi > 1, the number of deaths per million inhabitants in the i-th state will be greater than for Delhi, if Rvi > 1, it will mean a greater number of vaccinations per million inhabitants in i-th state than per million inhabitants of Delhi. The Rdi and Rvi indicators are already some kind of normalization that allows comparing the threats in states.

Index_D introduced allowing reference to Delhi. It could be any other state (but only one):

Index_D = Rvi - Rdi (7)

Since the Rvi and Rdi values for Delhi will be 1 according to the definitions (5) and (6), Index_d will be 0. All states in better positions from the pandemic from the capital will have the Index_D a little bigger, those in worse - lesser.

In tab. 3 shows the results of these calculations.

Table 3.

Comparison of pandemic threat states in Indian states compared to the capital state - Index_D = Rvi – Rdi

No.	States	Population	Deaths_D	Vaccines_d	Index_D
1	Andaman and Nicobar	0.417	1.3106	0.1795	1.1311
2	Andhra Pradesh	53.903	0.6883	0.1805	0.5078
3	Arunachal Pradesh	1.57	0.7246	0.0953	0.6293
4	Assam	35.607	0.4044	0.1156	0.2888
5	Bihar	124.8	0.2241	0.06	0.1642
6	Chandigarh	1.158	1.2329	0.517	0.7158
7	Chhattisgarh	14	1.1532	0.7484	0.4048
8	Dadra and Nagar Haveli	0.615	0.8705	0.0122	0.8583
9	Delhi	18.71	1	1	0
10	Goa	1.586	1.2026	1.4156	-0.2131
11	Gujarat	63.872	0.8666	0.1172	0.7494
12	Haryana	28.204	0.6582	0.2654	0.3929
13	Himachal Pradesh	7.451	1.1624	0.3516	0.8108
14	Jammu and Kashmir	13.606	0.6603	0.2475	0.4128
15	Jharkhand	38.593	0.318	0.097	0.2211
16	Karnataka	67.522	0.6706	0.4101	0.2605
17	Kerala	35.699	1.0585	0.3774	0.6812
18	Ladakh	0.289	1.428	0.5179	0.91
19	Lakshadweep	0.073	1.3157	0.5126	0.8625
20	Madhya Pradesh	85.123	0.4091	0.0879	0.3211
21	Maharashtra	123.09	0.6029	0.8208	-0.2179
22	Manipur	3.366	0.4589	0.378	0.081
23	Meghalaya	3.312	0.4428	0.2712	0.1717
24	Mizoram	1.285	0.9591	0.0582	0.9009
25	Nagaland	2.249	0.4339	0.1997	0.2343

26	Odisha	46.356	0.5548	0.113	0.4418
27	Puducherry	1.413	0.6315	0.9534	-0.3219
28	Punjab	30.141	0.4912	0.3973	0.094
29	Rajasthan	81.032	0.6357	0.0831	0.5526
30	Sikkim	0.69	1.3012	0.3254	0.9759
31	Tamil Nadu	77.841	0.3609	0.3269	0.034
32	Telangana	38.51	0.6114	0.0777	0.5337
33	Tripura	4.169	1.1143	0.1257	0.9886
34	Uttar Pradesh	237.88	0.2223	0.0724	0.15
35	Uttarakhand	11.25	0.8789	0.4657	0.4132
36	West Bengal	99.609	0.5337	0.1352	0.3984

Source: https://worldpopulationreview.com/country-rankings/gini-coefficient-by-country, 16 Aug 2022; https://gisanddata.maps.arcgis.com/apps/dashboards/, 1 Sep 2021; https://www.statista.com/statistics/1104709/coronavirus-deaths-worldwide-per-million-inhabitants, 10 Sep 2022.

The results

The most important result from the above table 3 is presented in the form of histogram in Fig. 1. It shows three bars with negative values, so these states are worse than Delhi according to the established criterion. The capital city, on the other hand, as a reference state, has a value of zero. All states with a positive index are better than the capital city, while a negative index means that the state is worse than Delhi.

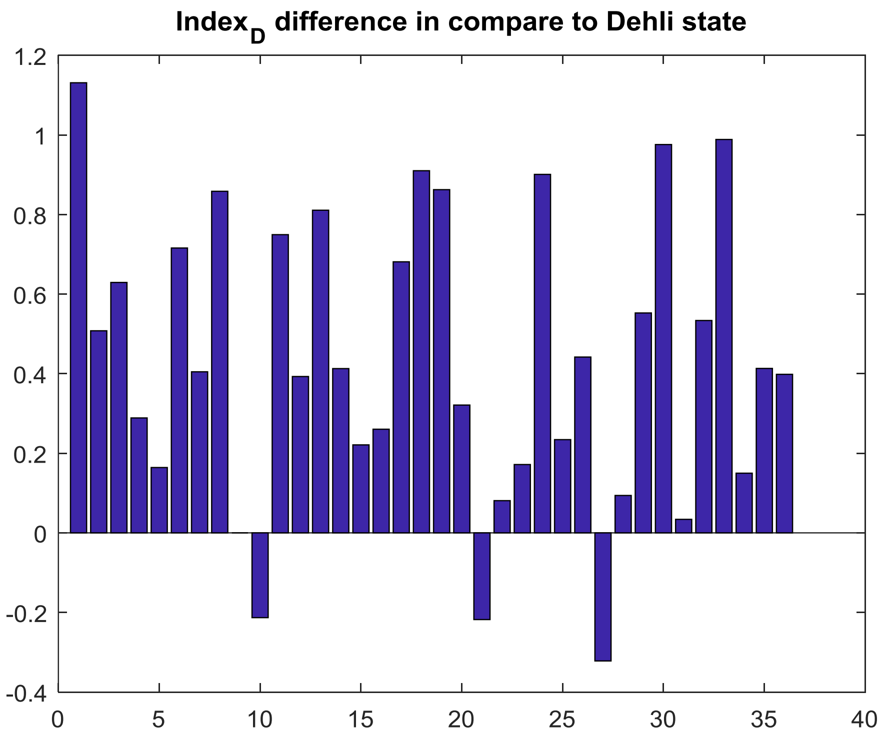

Figure1. Histogram of the main Index_D index for the states of India; For Delhi (number 9) Index_D equal to 0.

We then sort the Index_D column in Table 3 to rank the Indian states by pandemic risk. In the Matlab environment, in which the research was carried out, this can be performed using the sort function that allows us to determine the input data vector in ascending or descending order, along with the possibility of determining the vector of indices. We sort from the best to the worst values of Index_D, and we get:

[W Ind_states] = sort (Index_D, 'descend') (8)

where:

W - is the vector of Index_D values from the largest to the smallest,

Ind_states - it is a vector of indices/state numbers according to this order.

Table 4 was obtained after sorting.

Table 4.
The states after sorting by (8)

Order	State_Number	State	Index_D
1	1	"Andaman and Nicobar"	1.1311
2	33	"Tripura"	0.9886
3	30	"Sikkim"	0.9759
4	18	"Ladakh"	0.91
5	24	"Mizoram"	0.9009
6	19	"Lakshadweep"	0.8625
7	8	"Dadra and NagarHaveli"	0.8583
8	13	"Himachal Pradesh"	0.8108
9	11	"Gujarat"	0.7494
10	6	"Chandigarh"	0.7158
11	17	"Kerala"	0.6812
12	3	"Arunachal Pradesh"	0.6293
13	29	"Rajasthan"	0.5526
14	32	"Telangana"	0.5337
15	2	"Andhra Pradesh"	0.5078
16	26	"Odisha"	0.4418
17	35	"Uttarakhand"	0.4132
18	14	"Jammu and Kashmir"	0.4128
19	7	"Chhattisgarh"	0.4048
20	36	"West Bengal"	0.3984
21	12	"Haryana"	0.3929
22	20	"Madhya Pradesh"	0.3211
23	4	"Assam"	0.2888
24	16	"Karnataka"	0.2605
25	25	"Nagaland"	0.2343
26	15	"Jharkhand"	0.2211
27	23	"Meghalaya"	0.1717
28	5	"Bihar"	0.1642
29	34	"Uttar Pradesh"	0.15
30	28	"Punjab"	0.094
31	22	"Manipur"	0.081
32	31	"Tamil Nadu"	0.034
33	9	"Delhi"	0
34	10	"Goa"	-0.2131
35	21	"Maharashtra"	-0.2179
36	27	"Puducherry"	-0.3219

In column 2 of the table, the numbers of states are indicated in order from best to worst, i.e. 1, 33, 30, 18, 20 ... that is Andaman, Tripura, Sikkim, Ladakh, Madhya, ...

The worst is 9,10,21,27, i.e. Delhi, Goa, Maharashtra, Puducherry.

Discussion

A discussion on the ranking of Tab. 4, thus prepared, appears necessary and logical to put forth this work in right perspective. A recent study (Lahariya and Bhardwaj, (2019) does point out the fact that the traditional vaccination paraphernalia in India, which actually targets the traditional vaccination age-group (children) more, has improved in recent past but the immunization for the age-group beyond this traditional group does require improvement in strategies for the benefit of the adult population. Another study (Gurnani et al., 2018) presents the outcome of an Intensified Mission Indradhanush (IMI), a project conceptualized, coordinated and implemented by ministry of Health, central government of India, which was also closely monitored by Prime Minister of India office, targeted to improve the traditional (children) vaccination mechanisms in selected 190 centers all over country. In these two studies (Lahariya, Bhardwaj, 2019; Gurnani et al., 2018) presented, it does appear that the ground reality in the improvement of existing traditional immunization mechanism has visibly shown upward trend but these work also highlight the urge for further improvement.

The suggested mechanisms for improvements therein (Gurnani et al., 2018) have included involvement of cross-sectoral participation, strengthening of systems and practice change, sustained high-level political support with flexibility to earmark resources afresh, staff capacity enhancements, better communication and coordination, and to tackle the vaccine hesitancy by involving non-health stakeholders (such as religious leaders) in planning and messaging (as mentioned in (Gurnani et al., 2018). Also, (Gurnani et al., 2018) highlights that the IMI project did not cover Punjab, J&K, Himachal Pradesh, Uttarakhand, Chhatisgarh, Goa, Telangana, Tamilnadu, Kerala (only one district), Andhra Pradesh (only two district), Jharkhand (only two). Puducherry, Haryana, West Bengal (only one). Out of 190 priority centers most of them were from Northeast, UP, Bihar, MP Rajasthan, Maharashtra. In light if IMI coverage, the higher rankings, as reflected by Tab. 4 above, of states or union territories, which are smaller in area and low population-density is understandable such as those at rank 1-8. This is also, precisely, due to these state's ease of managing the pandemic-mitigating paraphernalia, that is, their medical support systems looking after the outbreak containment and the inoculation mechanisms in their regions.

So, in light of the availability of the above stated existing improved immunization paraphernalia (Lahariy, Bhardwaj, 2019; Gurnani et al., 2018) all over country in general and in the states and union territories covered under IMI project (Gurnani et al., 2018) in particular, the state rankings as reflected in Tab.4 look fairly convincing and consistent. However, there are also element of surprises in rankings such as that of Maharastra, Goa and Pudduchery which has been indicated relatively worse than Delhi. The other relatively higher rankings of states in comparison among themselves, also, do indicate surprising status but that is precisely identical to other commonly observable chaotic pandemic-responses of countries to the COVID-19 globally. India being hugely diverse in its federal setup, in many ways, does undergo variety of push-and-pulls of socio-political nature at the centre and at various state levels. These broader social and political determinants also affect coordination and decision, thereby making it arbitrary and chaotic at various levels of central and state governments. The observance of some kind of chaotic rankings as shown in Tab. 4 may also have got affected by some kind of influences of political diversities at work in centre and in states. The potentialy influential public utterances by political leadderships do affect the affirmative-vaccination and vaccination hesitancy and such news in relation to utterances by few key world leadership has been in the public domain in the recent past of the ongoing COVID-19 pandemic which is found true in the case of India too. Hence, the diverse political establishments all over country in India have not been unaffected from this and its effect may also be linked to rankings. With above in mind, in general, the rankings appear pretty consistent with the national perception of the intellectuals about the pandemic response by state and regional administrative bodies as observed during COVID-19 till the time the data for this article were collected.

In the aftermath of Ebola outbreak 2014, there has been efforts in the direction for preparing an indexing mechanism showing the pandemic preparedness index globally. This conceptualization and commissioning of Global Health Security Index (GHS Index, 2021) endeavor happened at John Hopkins University's Bloomberg School of Public Health in collaboration with the Nuclear Threat Initiative a think-tank based at Washington DC. It is worthwhile to note that the 2019 GHS Index indicated US and UK as the two best countries prepared to address any future pandemic catastrophe, however, the data from the ongoing COVID-19 pandemic narrate story otherwise. The GHS indexing mechanisms, thus, are also being questioned (Mahajan, 2021) as they appear to have overlooked some important broader social and political determinants of public health which also affect the contagion preparedness of respective countries. Thus, any indexing effort including the indexing work of this article, is never a complete work. We have only tried to suggest a way forward in this direction which would attract subsequent refinement.

India is a country with many faces and enormous diversity. For example, Figure 2 shows the Gini coefficients for two variables considered in this study as significant for the pandemic risk - the number of deaths per million and the number of vaccinations per million. The number of deaths indicates a variation between states that is unprecedented in other countries (Wilinski and Szwarc, 2021), a much smaller variation is shown by the Gini index for vaccinations, but also very large.

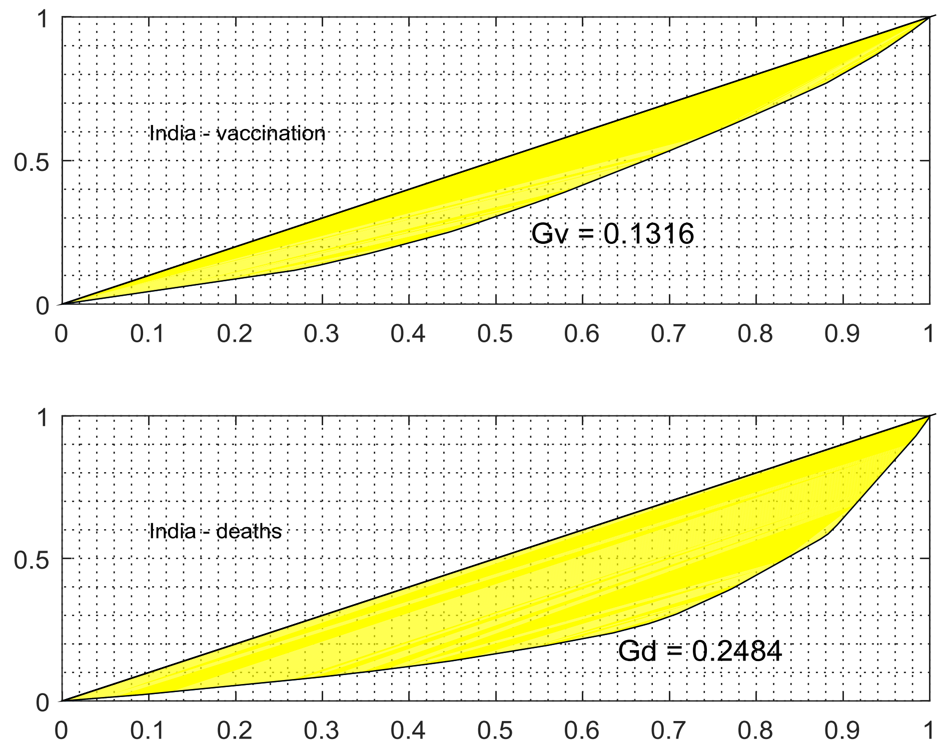

Figure 2. The Gini Index for the Distribution of Deaths and Vaccinations in India.

Interpreting these two graphs in Fig. 2 as a summary of a relatively up-to-date picture of the results of the fight against the pandemic of this enormous country, it is possible to state the superiority of the power of human influence over the forces of nature.

Conclusions

Summing up the work, there are some obvious conclusions and some unexpected ones. First, the authors would like to convince the reader of the fairly obvious criterion expressed by Index_D - it is good to have few deaths and a lot of vaccinations in a given state. The comparison of the meaning of these two variables could be obtained through various mathematical procedures, e.g. using weights. Here it was decided to compare it with the criterion for the capital of the country and introduce relative variables. This simple procedure allowed for a fairly obvious comparison and could cause different ratings among readers, as not all ratings (positions in the ranking) will be considered as expected. However, the authors justify each position in the ranking with reliable data obtained from government websites.

However, one can consider the reasons for these large discrepancies in the values of the comparative criterion (7).

As in many countries, the overall picture of India's fight against the pandemic as a country with large regional differences consists of various factors, for example, such as:

- the state of vaccination of the society,
- strength of influence and degree of organization of vaccines opponents,
- condition of the health service and funds of potential support for this service (state of readiness and speed of operation, availability of infrastructure and qualified medical personnel,
- the advancement of the IMI project,
- the power of influence of central and local authorities of various nature - political, social, religious and scientific,
- demographic factors - density of residence, migration intensity, tourist traffic, culture, and religion,
- climatic conditions.

In fact, each of these factors can be the subject of separate independent scientific research, be it for India or any other country. Attempts to apply quantitative methods can be observed, for example, through the GHS Index (Worldometers, 2021).

These factors, as well as many others of greater or lesser importance, cause such a large variation in the distribution of the two factors in question in this study - the number of deaths per million inhabitants and the number of vaccinations per million inhabitants. Figure 2 could therefore be considered a good summary of the Indian authorities' prudence in fighting the pandemic - the forces of nature represented by the Gini chart of deaths reveal a much greater variation in the number of deaths per million inhabitants by the state than the Gini chart for vaccination. Here, the discrepancy measured by the Gini index is much smaller, although still very high compared to other countries. It should be remembered that in both Gini characteristics the states are arranged in a different order - resulting from sorting, so it is impossible to read information about the role and place of individual states in these charts from Fig. 2.

Compliance with Ethical Standards:

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

The co-authors give their informed consent to the publication.

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