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Original article:

Lock-down for COVID-19 in India: An alternative viewpoint and revised epidemiological estimates

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Abstract:

Background: The COVID-19 epidemic has been ravishing the word as well as our country since the past few months. Various epidemiological models have been forwarded in the recent past for forecasting the course of COVID epidemic in India, and most of these have been widely off the mark, overestimating the likely magnitude by many times. Similarly, there have been some harsh criticisms of the nationwide lockdown; however none of these critical writings have been able to justify their content or forward a suitable alternative to lockdown. Against the foregoing, an effort was made to develop an alternative epidemiological model to forecast the likely course of the epidemic in our country and to dispassionately analyze the effects of 10 weeks of lockdown.

Material and Methods: Data for the period 8th May to 14th June regarding cases detected on that day and cumulative number of cases till that date, cases who reached "end-point" on that day and cumulative number till that day, and deaths on that day as well as cumulative deaths till that day was obtained from Aarogya Setu, the standard Government of India application for COVID-19. The data was subjected to "time-series analysis" and parameters were calculated by linear regression, using the WHO / CDC statistical package (Epi-7).

Results: The study indicated that the "ratio of cumulative total of cases detected: cumulative cases who reached end point" and the ratio of "cases detected on that day: cases who reached end point (cured / discharged/died) on that day", would reach unity (indicating a "stabilization" of the epidemic) between 16th July and 01st August 2020. At that point of time, the cumulative total number of cases detected till that day are likely to be 11,80,000 (95% CL 10,74,368 to 12,41,768). The cumulative total number of deaths which would occurred till that day are likely to be 20,000 (95% CL 18,800 to 21,200), while the number of new cases detected on a given day by then, are likely to be 23,000 (95% CL 22,000 to 24,000).

Conclusion: The study results are at variance from the projection models forwarded by other workers who had projected very high estimates. The reasons for this variance in context of the lock-down and the various putative beneficial effects of the lockdown have been reasoned out in this study, followed by certain suggestions for control and mitigation of the epidemic.

Keywords: COVID-19, Aarogya Setu

Introduction:

The WHO declared COVID-19 as a world-wide pandemic on 11 March 2020, following which the Government of India declared a country-wide "lockdown" from 25th March 2020. It was at almost the very start of the epidemic in the country that the lockdown was implemented, with just about a thousand detected cases and small number of accumulated deaths, on that day. The world-wide pandemic and our country-wide epidemic has rapidly proliferated, and at the time of

compiling this article on 14 June, globally there have been more than 79 lakh cases with nearly 4.3 lakh deaths and a "Case Fatality rate (CFR)" of 10% (4.3 lakh deaths out of approximately 45 lakh persons who have achieved the "end-point" (either cured / discharged or died) (1). In our country too, the situation is concerning. We are an ignominious fourth in order of merit as regards number of cases in the world, with 3.21 lakh detected cases and more than 9000 deaths till now (2).

Since the implementation of lockdown till the recent past when the 5th phase of lockdown (also referred to as "Unlockdown-1) was announced on 01st June, there have been a number of published documents in scientific journals, as well as unpublished writings circulated on various social platforms, which have made efforts to critically analyse the rationale, or otherwise, of the nationwide lockdown.

Aims:

In view of the foregoing, the present study was undertaken with the aim of:

1. Critically analysing the impact of lockdown on the course of the epidemic in India.
2. Submitting an alternative epidemiological model of the possible course of the epidemic in our country.
3. To submit certain suggestions for control / mitigation of the epidemic.

Material and Methods:

Day-wise data regarding cumulative number of cases detected, deaths, and persons discharged / cured as also data regarding the day-wise occurrence of new cases detected, deaths and cured / discharged, from 08 May till 14 June was obtained from the "Aarogya Setu" (3).The data was arrayed in an Excel Sheet and was given a "code" for each date, starting from "1" for 08 May till "38" for 14 June. The data was analysed by the statistical procedures of "Time Series Analysis", using the standard healthcare statistical package of CDC and WHO, namely, Epi-7. The intercept value and beta coefficients for various dependent variables were calculated, using linear regression models, with "Time Code" as the predictor variable. The main parameter of interest was the date on which "equilibrium" is likely to be achieved, i.e., the date on which the ratio of "cumulative cases detected" to the "cumulative number of persons who have been removed, due to either cure or death", becomes unity. Another parameter of interest was the date on which the ratio of "new cases detected in a day" to "number of persons removed due to cure or death on that day" becomes unity. Once these dates were estimated, the estimates for the number of newly detected cumulative cases, number of new cases in a day and number of deaths in a day as would be likely to occur on that day of "equilibrium" were back-calculated, using the coefficients and intercept values as obtained from the regression models.

Results:

(i) Basic data. An "abridged" part of the basic data used in this study, as obtained from Aarogya Setu Application is depicted in Table -1. (Complete data can be downloaded by interested readers from Aarogya Setu or obtained on request from the author)

Table-1: Abridged part of the data used for the study

Date	Cumulative Total of cases detected till that day	New cases detected on that day	Cumulative Total of Cured / discharged till that day	Cured / discharged on that day	Cumulative Total of Deaths till that day	Deaths on that day	Cumulative Total of persons who reached end point on that day (Cured / discharged / died)
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h) = {(d) + (f)}
8 / 5	56342	3390	16540	1273	1886	103	18426
9 / 5	59662	3320	17847	1307	1981	95	19828
10 / 5	62939	3277	19358	1511	2109	128	21467
↓							
12 / 6	297535	10956	147195	6166	8498	396	155693
13 / 6	308993	11458	154330	7135	8884	386	163214
14 / 6	320922	11929	162379	8049	9195	311	171574

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(ii) *Relationship between "Ratio of cumulative total of cases detected: cumulative cases who reached end point", against "Time-Code" as predictor var*. The results are given in Table-2.

Table – 2: Regression between "Ratio of cumulative total of cases detected: cumulative cases who reached end point {(b) ÷ (h)} ", against "Time-Code" as predictor var

Variable	Beta	SE	F Test Value	P value	R^2
Time Code	(-) 0.031	0.002	310	<0.001	0.90
Constant	2.878	0.039	5363	< 0.001	

The above model fits the data very well, with a very strong correlation (R^2 = 0.90) and statistically highly significant (p < 0.001) results. Using the equation A = Y + {(B + 2 * SE) * (Xi)} and since value of time code is set at 1, therefore, Upper limit ~~is~~ was calculated as 1.00 = 2.878 – {(0.031) + (2 * 0.002)} * Xi}]; hence, {1 – 2.878 = (-) 0.031 + (0.002 * 2) *Xi} ; Xi = - 1.878 / - 0.027 = 69.55 or 70 days. Taking 07th May as "Zero Day" (since data started from 08 May), the point of 70 days will be realized on 16th July. Thus a balance between total cumulative number of detected cases and the total patients who reached end point (i.e., either cured / discharged or died), having ratio of 1 : 1 is likely to be reached on 16th July. At this point of time, the number of total cases detected till that date are likely to be equal to the number of cases who have reached finality till that date.

(iii) *Relationship between "Ratio of cases detected on that day : cases who reached end point (cured / discharged/died) on that day", against "Time-Code" as predictor var*. The results are presented in table – 3.

Table – 3: Regression between "Ratio of cases detected on that day : cases who reached end point (cured / discharged/died) on that day {(c) ÷ {(e + g)} ", against "Time-Code" as predictor var

Variable	Beta	SE	F Test Value	P value	R^2
Time Code	(-) 0.013	0.005	67	<0.05	0.15
Constant	2.121	0.011	373	< 0.001	

Using the model: A = Y + B*Xi; since value of time code is set at 1; therefore, 1 = 2.121 + {(-) 0.013 * Xi) = 86 days and taking 7th March as the "Zero Day", the point period of 86 days will be 01st August 2020. Thus a balance between "new cases detected on a day" and the "total patients who reached end point on that day (i.e., either cured / discharged or died on that day), with a ratio of 1 : 1 is likely to be reached on 01st August. On that date, the number of new cases detected on a given day are likely to be equal to the number of cases who have reached finality (cured / discharged or died) on that particular day.

(iv) *Relationship between "new cases detected on that day" against Time-Code as predictor var*. Results are presented in Table-4.

Table-4: Regression between "new cases detected on that day" against Time-Code as predictor var

Variable	Beta	SE	F Test Value	P value	R^2
Time Code	236	6.7	1246	< 0.001	0.97
Constant	2474	149	274	< 0.001	

Using the model: A = Y + B*Xi and since the total period on 01st August will be 86 days from the start of data point, therefore, Average 'A' = 2474 +{ (236 *86)} = 22770 = Approximately 23,000 new detected cases daily.

Upper 95% Confidence Limit = 2474 +{ (236 + (2 * 6.7)} *86) = 23974 = Approximately 24,000 new detected cases daily.

Lower Limit = 2474 +{ (236 - (2 * 6.7)} *86) = 21,566 = Approximately 22,000 new detected cases daily. Thus the number of new cases detected in a day on 01st Aug are likely

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to be 23,000 (95% CL range: 22,000 to 24,000)

(v) *Expected number of "cumulative total of detected cases" on 01 August*. Results are presented in table-5.

Table-5: Calculation of expected numbers of "cumulative total of detected cases" on 01 August

New cases detected on a day on 14 June = 12,000 (approximately)
New cases expected to be detected per day on 01 Aug 2020 = 23000 (approx)
Therefore, Average daily case detection of new cases between 15^{h} June and 01st August = 17,500.
Newly detected cases between 15th June to 1st August = 17,500 X 49 = 8,57,500
Plus already total detected cases as on 7th June: 3,20,922
Total cumulative cases detected as on 1st August = 11,78,422, say, 11,80,000 (approx).

(vi) *Relationship between "Case Fatality Rate (CFR)" {(f) ÷ (h) of basic data presented in table-1} against Time-Code as predictor var*.In the present study, CFR was calculated as {(Cumulative number of persons who died) ÷ (Cumulative total of persons who reached the "end point", i.e., cumulative total of those who were cured / discharged plus those who died till that day)}. This is as per the standard, laid down method of calculating the CFR and NOT how it is being presented in daily reports in the media. The results are presented in Table – 6.

Table-6: Regression between "CFR" {(f) ÷ (h)} against Time _Code as predictor var

Variable	Beta	SE	F Test Value	P value	R^2
Time Code	(-) 0.167	0.008	452.7	< 0.01	0.97
Constant	9.86	0.144	4702.8	< 0.01	

A = Y + B*Xi; A = 9.86 +{ (- 0.167 * 52) = 1.18%

Thus the expected CFR on 01 Aug will be as low as 1.18%, or 12 deaths out of 1,000 persons who reach the "end-point" i.e., either are cured / discharged or die.

(vii) *Summary of important estimates and their 95% CL from the present model*. Results are shown in table-7.

Table-7: Showing the various predictions as seen from the time-series model

Parameter	Present level (14 June 2020)	Estimated level between 16th July to 01st August 2020 (Expected date of reaching "stability")		
		Average	Upper 95% CL	Lower 95% CL
Cumulative Total number of cases expected to have been detected till that day	320922	**11,80,000**	12,41,768	10,74,368
Cumulative total number of deaths likely to have occurred till that day	9,195	**20,000**	21,200	18,800
New cases likely to be detected on a given day by that date	11,929	**23,000**	24,000	22,000

Discussion:

The main objective of this paper was to analyse whether the 10 weeks of country wide lockdown was successful in controlling or at least mitigating the epidemic. A number of eminent persons have forwarded their views during the past couple of months on this aspect, including certain professional bodies, either in formal print form or on informal social media platforms. Most, if not all, have been quite unsupportively critical of the lockdown; surprisingly, the mainstay of their criticism has been with respect to the "financial slowdown" rather than pointing out any deficiency purely from medical / health point of view. Unfortunately, while severely criticizing the decision to impose a lockdown, these writings have not been able to suggest any substantial answer to "if so, so what" question, i.e., if lockdown was incorrect then

what was the other best alternative (s) which could have been implemented instead of lockdown.

It also needs to be noted that criticizing the decision of lockdown purely on financial grounds is no great science, since that would be known to even college going students. Apparently, if a whole country of 1350 million population doesn't work, economy nose-dives, and if the exchequer is drained, the public health also dries up. Against this background, let us see the possible positive aspects of lockdown:

(i) Estimates from a number of epidemiological models developed in the initial stages of the Indian epidemic, with the data analysis undertaken somewhere during the end of March, had estimated that the peak of the epidemic in India would occur in mid May to mid June, and the estimated number of cases would be in many millions (4, 5). However, in the middle of June, we stand at less than even 3.5 lakh cases and less than 10,000 deaths, and this is itself a proof of the effectiveness of the lockdown which was implemented towards the end of March.

(ii) We know it very well that this disease is primarily transmitted when populations or humans get "huddled up" (the ideal word in Hindi language which describes it is "jamghat" or "jamawara"). The basic unit in our country where such "huddling"" becomes inevitable is a "family" or"home". By enforcing a very large majority of our national population to remains huddled up within their homes, it is quite likely that transmission, maybe of a low level, leading to very mild or even asymptomatic cases, within the homes / families, has been completed in the nearly 10 weeks of lockdown, leading to substantive proportion of the population having developed a low level, albeit protective, immunity.

(iii) In the 10 weeks of lockdown, it is expected that, with a median incubation of approximately 7 days, almost 10 transmission cycles would have occurred within the families / homes / other "huddled" populations as urban slums, etc. It is a biologically plausible fact that any virus reduces in virulence after repeated cycles of transmission have taken place, either in vivo or in vitro. Thus, after 10 weeks of lockdown, the virus that the community faces now, once "un-lockdown" has started, is likely to be of much lower virulence, and maybe, of much lesser infectivity. A readily available proof of this deduction can be seen when we browse the Case Fatality Rate (CFR) from the data; it would be appreciated that the CFR has been very remarkably and consistently declining from 10.24% on 8th May to 5.36 on 14 June 2020. During this period, we have neither developed any other good reason to bring about such a remarkable decline in CFR (as any specific drug to treat this infection, nor any immuno-modulating substance to artificially increase the immunity). Hence, such steady, outstanding and statistically significant decline in CFR can only be due to declining virulence of the circulating SARS-Cov-2, over this period of time, after repeated cycles of human transmission in the "locked-down" populations.

(iv) These 10 weeks of lockdown, coupled with various frightening messages on the media, has raised the level of "perceived consequences" and created adequate apprehension, besides knowledge, among the population about the disease, thereby driving large sections of the population to adopt preventive "Non Pharmacological Interventions (NPI)". It is obvious that simple health educational process would not have been able to create this much of inner drive amongst the large and diverse population of our country, to use face mask and social distancing, compared to what we are observing now, after 10 weeks of lockdown.

(v) It has given the nation a vital "lead time" to develop massive response regarding preventive, diagnostic and curative measures. We have greatly increased production / availability of health care resources and procedures. We have the enhanced availability of ventilators, hospital beds, PPE, PCR enabled Laboratories, antigen based rapid testing, HCQ and other drugs, surveillance teams, isolation and quarantine systems, and so on, just to cite a few examples, are evidence in support of this statement.

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As a comparison with the present study, in a similar type of epidemiological model, Kumar and Roy, working on data from our country, have recently estimated that when the number of infected cases is equal to the number of removed patients, the coefficient will reach 100% threshold and the epidemic will be extinguished. The workers reported that the trend would reach to 100 in the month of mid of September, 2020. (6).

Conclusions:

Based on the findings of the present study, the following conclusions and recommendations are submitted:

(i) We should ~~C~~capitalize on the benefits accrued due to lock-down. We need to appreciate that the 10-week long, country wide lock-down has reaped substantial benefits, for the national population at large (as described above) and we need to capitalize on these benefits with a view to control / mitigate the COVID – 19 epidemics in our country.

(ii) We need to ~~R~~redefine the current strategy of "contact tracing – quarantine – test – isolate"(test-track-treat strategy). We need to come out of the conventional "surveillance – containment" approach and adopt an "out-of-the-box" thinking. There is no denying the fact that "surveillance and containment" has traditionally played a very important role in eradication of some of the most difficult diseases. However, the epidemiological fact remains that surveillance and containment is ideal as a public health strategy, either in the very initial stages of an epidemic (when it can be effectively used to "stamp out the fire") and, more fruitfully, when the epidemic is towards its nadir, when it is used to "mop away" each and every case of residual infection, till the last case. The eminently suitable examples are smallpox and polio. However, surveillance and containment may not be the strategy of choice when the epidemic is on the rise, rather on its full bloom, as seems to be happening today in our country. In these circumstances, surveillance (by way of contact tracing and their testing) and containment (by way of quarantine of contacts) may not pay ~~any~~ much dividend; it may, in fact, only drain out the costly and scarce healthcare resources. Just to give a hypothetical example, let us assume each of the detected case gives a history of having come in contact with just 5 persons (a pretty small figure though), and with twelve thousand cases detected every day, we would need to trace and quarantine sixty thousand people in one day; and, it has to be done on that very day, since the next day, another sixty thousand contacts will appear, requiring tracing / quarantine. The health resources for contact tracing as well as the administrative resources for ensuring quarantine will be strained out within a matter of weeks. It is therefore suggested that we adopt a different strategy and utilize all our healthcare as well as administrative resources towards home isolation and treatment of mild / moderate cases and institutional treatment of serious / critical cases only. Surveillance and containment may be limited to districts with low level of transmission, where this strategy can still be used for stamping out the fire. However, we are also aware that two-thirds of all cases have occurred only from four states and within these state, there are clearly defined containment areas / red zones where transmission is very high. In these high transmission zones, we need to do away with the strategy of "contact tracing – contact testing – quarantine" (technically, the "surveillance and containment" strategy) and, instead, focus on case management strategies ~~as~~ with a focus on 100% clinical assessment of complete population in these defined high transmission zones for any evidence of ILI followed by their home management (if mild / moderate) or institutional management (if serious / critical).

(iii) We need to have a ~~R~~re-look at our diagnostic strategies. The current diagnostic strategy is based exclusively on "RT-PCR" and its variants as TrueNat / CBNAAT. Though the diagnostic capabilities have been expanded, as of now there are less than a thousand laboratories for more than 700 districts in India, for undertaking this test. The practical difficulties are even more, since the diagnostic accuracy is just 65 to 70% and false negatives are likely to be an issue. Moreover, it needs not only the equipment but also specialized persons to handle this investigation. The turn-around time for this test for most of the population will not be less than 48 hours and number of tests that can be handled in a day are limited. Against this background unnecessary testing of contacts should be done away with and scarce testing facilities

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utilized only for diagnosis of persons who present with any symptom / sign of ILI. It would also be in order to look at developing and making available "rapid diagnostic tests" which are cheap, can be done at the user end point or at a less sophisticated laboratory and give rapid result. In this context, the recent possibility of introduction of an antigen based test by the ICMR is a very optimistic move.

(iv) We need to do away with our "obsession" for certain terms. This COVID pandemic has brought with it certain terms, which were hither-to-fore not much used; terms like "community transmission" are an example. The interesting part is that these terms have been used more by the media and in political debates rather than by healthcare or administrative professionals actually involved in addressing this epidemic. It is suggested that we replace these terms with more situationally relevant terms as "nil or low transmission zones", "moderate transmission zones", "high transmission but NOT explosive / containment zones" and "high transmission, explosive / containment zones".

(v) We need to accord an over-riding importance to Non Pharmacological Interventions (NPIs). Reasonably good amount of understanding has accrued by now regarding the agent factors and transmission dynamics of this disease. It is primarily a disease transmitted by droplets which remain viable only over a short distance, among "huddled" populations in closed / congested places and to a lesser extent, indirectly through hands contaminated from inanimate surfaces. Given these transmission dynamics, the triad of "use of masks, hand hygiene and social distancing" can be near 100% effective in prevention (except for healthcare settings where PPE should be the minimum norm). Efforts to educate, motivate or even adopt humanely coercive methods for adopting these steps by the community should continue to get an over-riding priority from all community leaders, administrators and healthcare providers.

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