International Journal of Community Medicine and Public Health
Patra B et al. Int J Community Med Public Health. 2020 Aug;7(8):3062-3068
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: http://dx.doi.org/10.18203/2394-6040.ijcmph20203379

Original Research Article

Can we predict the duration of COVID-19 pandemic? an observational analysis

Bijoy Patra[1]*, Jharna Behura[2], Vivek Dewan[1], T. P. Yadav[1], Vikram Datta[3], Dheeraj Bahl[1]

[1]Department of Pediatrics, ABVIMS and Dr RML Hospital, Delhi, India
[2]Department of Obstetrics and Gynaecology, Kasturba Hospital, Delhi, India
[3]Department of Neonatology, Lady Hardinge Medical College and Associated Kalawati Saran Children Hospital, Delhi, India

Received: 10 May 2020
Revised: 12 June 2020
Accepted: 01 July 2020

***Correspondence:**
Dr Bijoy Patra,
E-mail: bijoy_patra@yahoo.com

ABSTRACT

Background: Since the outbreak of 2019 novel corona virus pneumonia in the Wuhan city, China, the whole world has been ravaged by the pandemic of COVID-19. In this bleak scenario, China is witnessing the near cessation of the disease. The aim of the present study was to analyze the epidemiology curve of China and five other countries, and attempts to extrapolate these findings in the epidemiology curve of individual country to answer the question how long will the pandemic last on this globe.
Methods: For the current study data from six countries namely China, Germany, Italy, South Korea Singapore, and India were considered. The resources for data collection were WHO Situation reports for corona virus disease (COVID-19), and Worldometer statistics for corona. Data were entered in to excel sheet and analyzed.
Results: Data for total cases, active cases, death, recovery, inactive cases were analyzed for each country and construed in graphs. The epidemic curve of total cumulative cases in China can be observed to have four phases and the total duration of epidemic is around 24week±2 weeks. China is in last phase of the epidemic. In South Korea, Germany, Italy the epidemic curve of active and inactive cases has crossed each other and are in 3rd phase. India and Singapore are in phase 1.
Conclusions: Despite the multitude of variables of COVID-19, the glimmer of hope for the end of pandemic can be inferred from the analysis of China, South Korea, Italy and Germany and can be extrapolated for India and Singapore.

Keywords: COVID-19, Pandemic, Reproduction number, SARS COV- n-2019

INTRODUCTION

Since the outbreak of clusters of unknown pneumonia in the Wuhan City of China, the world has been ravaged by the Pandemic of COVID -19.[1,2]

As of 28th April 2020, this disease has affected 212 countries and had killed 238628 people out of 3349786 confirmed COVID-19 positive cases.[3] The true number of affected person may be much more and the pandemic march seems to be unstoppable as the virus is novel the whole population is susceptible, there is no vaccine and there is no effective pharmacological intervention.[4,5] In the thick of this bleak scenario, China, the epicenter of epidemic is witnessing the near cessation of the disease. The present study aimed to analyze the epidemiology curve of six Countries and attempts to extrapolate these findings in the epidemiology curve of individual country to answer the question how long will the epidemic last in a country.

METHODS

This was an observational study conducted from 6th March, 2020 to 2nd May, 2020. Six Countries which have witnessed COVID-19 epidemic were selected for analysis. China and South Korea have successfully contained the epidemic and are included in the analysis. Germany and Italy were included in the analysis as the approach to contain the epidemic was different. Lastly India and Singapore were included as both the countries are following similar approach to contain COVID-19 disease.

Daily data were obtained from WHO status report for corona virus disease (COVID-19) and the Worldometer for corona. The data information included were: cumulative confirmed cases (total cases), cumulative active cases (total cases – death - recovered cases), cumulative deaths, cumulative recovered cases, cumulative inactive cases (deaths + recovered cases). Data were entered in Excel and were analyzed. Country wise graphs were constructed. Comparative analysis of the Epidemic curve of total cumulative cases for each country have been attempted using the log scale. The observed epidemic data from China and the observed and extrapolated epidemic land mark of other five countries have been tabulated. For this study, end of epidemic has been defined as no occurrence of active cases and recording of no COVID-19 positive case mortality for a period of 2 weeks. In this study, the epidemic has been divided in to four phases a. phase 1: from occurrence of index case (1st case) till the active cases reaches peak (exponential growth phase) b. phase 2: decline from peak of active cases till it crosses the line of inactive cases (recovered and death cases), c. phase 3: from crossing point till the total cases reaches plateau D. phase 4: plateau phase till the end of epidemic.

Statistical analysis

Collected data were analyzed with excel statistical software and depicted in graphs.

RESULTS

In China (Figure 1), it took 42 days from initial cases (10th of December 2019) to reach 554 cases (22-1-20). From that point, the number of cases climbed rapidly (rapid phase) till reaching a peak (57416 cases) after a time period of 24 days (15-2-20). From the peak, the number of active cases declined (Second phase). The time lag of active cases from the peak till the crossing point of inactive cases was 12 days (27-2-20). After that the total cases gradually approached plateau (third phase) in 4 weeks. The epidemic is in its last phase.[4]

The first COVID -19 case recorded in South Korea was on 20th January, 2020. The number of cases reached 558 in 35 days (23-2-20). Then the growth became steep till the peak was achieved (7293 cases) on 12-3-2020 after time lag of 21 days. The number of active cases fell below the inactive cases after 16 days (point of crossing: 28-3-20). After that the phase of plateau of total cases was achieved gradually in 4 weeks (28-4-20). The country has entered into phase-4 (Figure 2).

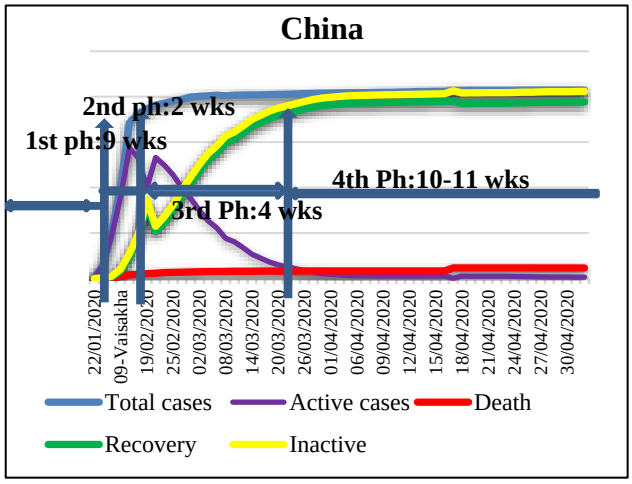

Figure 1: Analysis of epidemic curve in China.

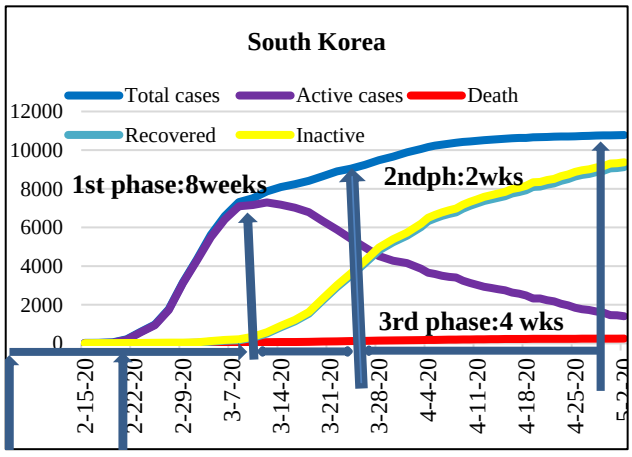

Figure 2: Analysis of epidemic curve in South Korea.

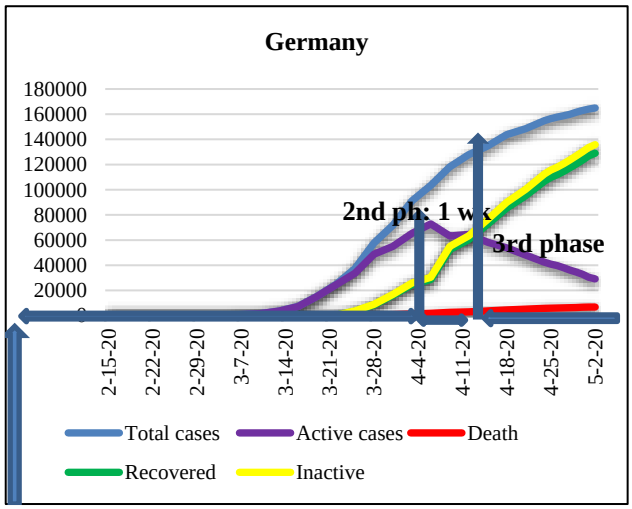

Figure 3: Analysis of epidemic curve in Germany.

The first COVID -19 positive case recorded from Germany was on 27 January, 2020. From 7th March onward, it recorded steep rapid growth till 6th April (First phase: 10 weeks). The second phase lasted less than a week (6 days). It has entered into 3rd phase from 12-4-2020 (Figure 3).

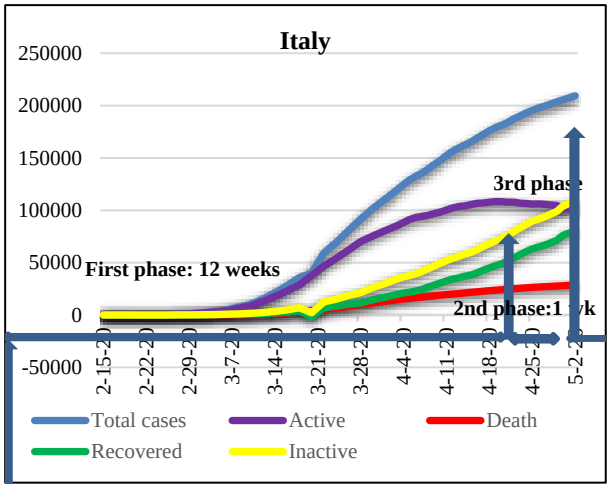

Figure 4: Analysis of epidemic curve in Italy.

First COVID-19 positive case in Italy was recorded on 31-1-2020. From 27th February, it recorded a sharp rise of it's COVID positive cases and Active cases reached a peak on22-4-20 (1st phase: 12 weeks) and has completed its 2nd phase on 29-4-20 (Figure 4).

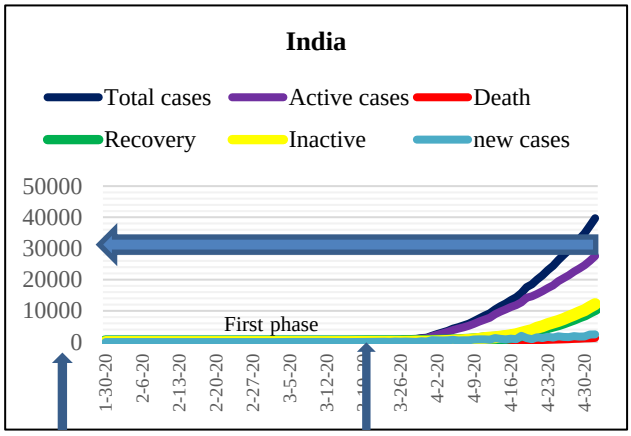

Figure 5: Analysis of epidemic curve in India.

In India, the first case of COVID-19 was reported on 30th January, 2020. It recorded 536 cases on 24-3 -20 after a time lag of 54 days (7 weeks 5days). After this point, the growth has become rapid and is in phase-1 (Figure 5).

Singapore recorded its first case on 23-1-20 and is witnessing rapid growth (phase-, exponential growth) (Figure 6).

In the comparison graphs, the value 0 stands for 10-12-2019, the onset of1st case of COVID-19 disease in China. The duration of the pandemic for each country is estimated to be around 24 weeks (Figure 7).

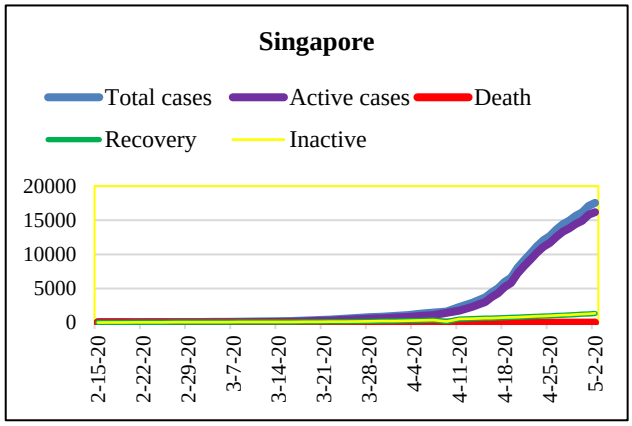

Figure 6: Analysis of epidemic curve in Singapore.

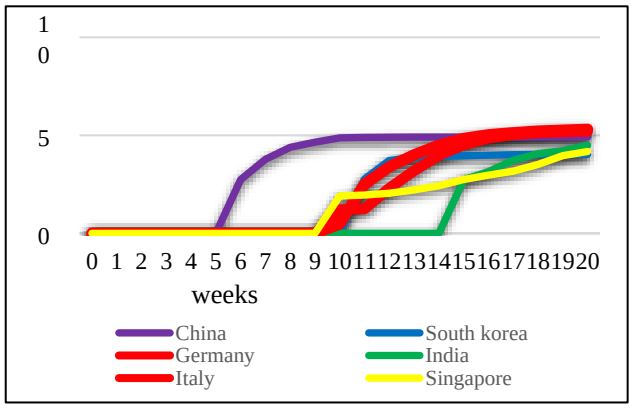

Figure 7: Comparison analysis of epidemic curve between countries.

DISCUSSION

In the last week of November and early part of December, clusters of Wuhan City, the capital of Hubei province of China witnessed pneumonia of uncertain etiology. WHO was notified of its occurrence on 31th December, 2019.On the same day, the CDC (Center for disease control and prevention) team of China was dispatched to investigate the epidemic. The team found a causal link to the Seafood market.[6,7] On analyzing the clinical samples, the etiology was noted to be a new corona virus, belonging to the Beta corona subgroup sharing homology with SARS Co virus and was named as SARS-C0 V-2.[8] WHO named the virus as novel corona virus on 7th January 2020. Based on the relentless progression and rapid spread of the disease, WHO declared it as Public health emergency of international concern on 30th January, 2020. On 11th February, 2020, WHO named the disease as COVID-19. Inspite of global concern and public health containment measures the epidemic spreaded rapidly to involve many countries and COVID-19 was accorded a status of Pandemic by the WHO on 11th March 2020.[9,10]

Table 1: Details of the epidemic trend.

Epidemic milestone	China	South Korea	Germany	Italy	India	Singapore
1st case	10/12/2019	20/01/2020	27/01/2020	31/01/2020	30/01/2020	23/01/2020
Onset of rapid growth	22/01/2020	23/02/2020	07/03/2020	23/03/2020	24/03/2020	24/03/2020
Peak of rapid growth	15/02/2020	12/03/2020	06/04/2020	20/04/2020	7/05/2020	07/05/2020
Date of crossing	27/02/2020	28/03/2020	12/04/2020	27/04/2020	21/05/2020	21/05/2020
End of epidemic	28/06/2020	28/05/2020	12/06/2020	28/06/2020	21/07/2020	21/07/2020

Table 2: Variables affecting the duration of an epidemic.

Known variables	Confounding variables
Agent: 2019nCo-V[20,21]	Demographic profile of the country
Vector: Reservoir: Bat[22] **Intermediate: Pangolin[23]**	Geographical location
Host: Susceptible population[24,25]	Season of the outbreak
Mode of transmission: Droplet and Fomite[26,27]	Temperature
Virulence of virus[28]	Humidity
Transmissibility of virus: Incubation period, duration of infectivity[29,30,31]	Climate
Dynamics of the epidemics: Serial interval, Reproduction number(R0)[32,33,34]	Population density
Availability of confirmatory tests, testing capacity and testing policy	Culture
Public health resource and efficiency	Religious belief
Health infrastructure, resource and expenditure	Social behavior
Strong proactive committed political leadership	Super spreaders
Administrative capacity for implementation of policy and rules	Super spreading events

During this ongoing pandemic of COVID-19 sweeping across the globe, China is witnessing the cessation of new cases and the disease seems to have run its course. There are many variables, known and confounding, which can influence the duration of an epidemic in a country (Table-2). Despite these uncertainties of the epidemic, one can surmise that China has successfully contained the epidemic by deploying both the strategies of mitigation and suppression.[11] South Korea, Singapore and India have adopted Suppression strategy supplemented with mitigation. Germany and Italy have predominantly put emphasis on mitigation strategy.[12] All these six countries have been included in this study to find out any pattern to predict the duration of the epidemic.

China

Even though the outbreak of 2019-nCoV pneumonia was witnessed in last week of November, 2019, the first official case was recorded to be 8-12-2020.[13] After the isolation and genomic characterization of COVID-19 virus, genomic data were shared with the world community on 10th January, 2020. After that, RT-PCR (reverse transcriptase -polymerase chain reaction) tests were available for laboratory confirmation of COVID-19.[14] After a gap of 6 weeks, the number of COVID cases reached 556 on 22-1-20. On the same day china declared total lockdown in many cities and provinces including Wuhan in addition to other containment measures that were in place. Despite the initial alarming hospital mortality, and rapid spread of COVID-19 disease, China could bring down the reproduction number below one in the last weeks of January by swift implementation of stringent containment measures. These include travel restriction, contact tracing, isolation and quarantine of cases, admission and treatment of serious and critical cases and non-pharmaceutical measures like social distancing, face masking, banning mass congregation, closure of school and academic institutions, working from home and selective lockdown of cities.

Within 3 weeks of its implementation many locations noticed nonviable reproductive number as shown in the study by Zhang et al.[15] The number of active cases reached peak after 3 weeks on 15-2-20 as shown in the graph. It took another two weeks (12 days) for the active cases to drop below the inactive cases (recovered and deaths). From that land mark day of crossing, the total cumulative cases reached a plateau in 4 weeks (phase-3). During the continuation phase-4, stray cases continues to occur and the epidemic may meet its end with a total run of 20-24 weeks (150-180 days).

South Korea

The first case of COVID-19 imported from china was recorded on 20th January, 2020 in South Korea.[16] The country instituted an early and a liberal policy of COVID testing. As a consequence, it reached 556 cases after 35 days (5 weeks) and a peak of active cases after 3 weeks, a week earlier than China. The country was aggressive in its implementation of contact tracing, isolation and quarantine of asymptomatic as well as symptomatic patients. Symptomatic serious and critical patients were

treated in hospitals. On the cutoff date, the total number of cases are 10694 out of which 8450 has recovered and 238 has died. The duration of 1st phase was 8 weeks. After 2 weeks of reaching peak, the active cases crossed the inactive case graph on 28-3-2020, signaling end of 2nd phase and beginning of 3rd phase. Since then the country is in 3rd phase and is likely to reach a plateau in 4 weeks. The epidemic may likely to continue till last week of May, 2020. The total duration of epidemic may be slightly lesser than china.

Germany

Germany recorded its first case in last week of January, 2020.With an initial emphasis of mitigation and later on of suppression, the country has been able to contain the epidemic below the viable effective reproductive number of one as can be seen in the crossing of active and non-active cases on12-4-20 after 11 weeks and is in phase 3 even though the Country had recorded a very high number of total cases andmortality.[17] Extrapolating the duration of phase 3 and Phase 4 as 8-12 weeks, the country may witness the end of epidemic in last week of June.

Italy

In the first half of February, only 3 positive COVID-19 cases were identified in Italy. In the second half of the month, it witnessed a surge of hospitalization of COVID positive cases after the first recorded severe pneumonia of COVID-19 disease.[18] The country after a heavy affliction of the disease and mortality has entered into phase-3 after 13 weeks. Like Germany, China and South Korea, it may take another 8- 12 weeks for the end of the epidemic.

Singapore

Recorded its first COVID case on 23rd January, 2020. Even if the country has an appreciable less mortality (14 deaths), still it seems to be in phase 1 of epidemic and is yet to enter phase 2. The country has adopted a stringent set of preventive measures called circuit breaker from 7th April to 4th May with an extension upto 1st June. Therefore, the duration of the epidemic may be slightly longer.[19]

India

The first case of COVID-19 was recorded on 30 the January, 2020, the day WHO declared COVID-19 as Health emergency of international concern. Even before that, the country had implemented fever screening for international passengers from affected China. Indian nationals stranded in affected countries (China, Japan and Iran) were evacuated and kept in isolation centers and quarantined for 14 days. Public health measures like contact tracing and isolation were strictly implemented. Symptomatic cases were tested for COVID-19. The total number of cases reached the mark of 556 after 54 days (7 weeks) on 24-3-20. On the same day, total lockdown for 3 weeks was declared in the whole country following a successful implementation of Janata curfew 2 days before. However, the country is in still phase 1 and is witnessing a longer phase1 like Singapore.

On analysis of the epidemic curve of China one can observe the 4 phases and crossing point of active and inactive cases. Similar pattern and crossing can be noticed in the epidemic curve analysis of Germany, Italy and South Korea. All these countries have entered into Phase-3. The crossing point can be an important land mark in the epidemic life cycle and is a reflection of reproductive number (R0) falling below 1, signaling the non-sustainability of an epidemic. South Korea could achieve this by stringent containment and mitigation measures. But Germany and Italy have entered in to phase 3 albeit at a cost of higher magnitude and mortality. The epidemic curves of Singapore and India are similar and have taken a milder course despite the seeming difference in mortality. This may be due to the difference of the health infrastructure of both countries and other known and unknown variables.

This study introduces a concept of crossing of inactive cases (recovery and death) over active cases as an indication of dying down of an epidemic for a country or geographic territory. This is the likely situation where the reproductive number (Ro) is less than one and crossing point can be an easy visualized date and land mark in the epidemic cycle of a disease. The nonviable reproductive number of less than one can be achieved by adopting either alone or in combination, strategies of mitigation and suppression. Countries who have relied on mitigation may not see a recurrence due to a concurrent buildup of herd immunity unlike the countries who have flattened the epidemic curve by stringent suppression measures.

Limitation

The study is not a mathematical model. Rather it is an observational analysis which has been used to predict the duration of the COVID-19 epidemic.

CONCLUSION

Among the multitude of many uncertainties of a pandemic, the duration and magnitude of COVID-19 disease seems to be unfathomable and shrouded in mystery. Going by the trend of virus behavior and epidemic dynamics in all six analyzed countries, it may be reasonable to predict a duration of 20-24 weeks for the annihilation of the pandemic in each Country. However, prolongation or reemergence of the epidemic looms large in Country like China. Hence, despite the seeming lesser magnitude of the epidemic in South Korea, Singapore and India by stringent suppressive measures, the duration of the epidemic may depend upon acquisition of herd immunity by periodic relaxation and continuation of need

based containment and mitigation measures till the epidemic is perished.

ACKNOWLEDGEMENTS

Author would like to thank Dr. Vijay Rai, MD, for his support during the study.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Lu H, Stratton CW, Tang YW. Outbreak of pneumonia of unknown aetiology in Wuhan China: the mystery and the miracle. J Med Viral. 2020;16:54-9.
2. Pneumonia of unknown cause - China: disease outbreak news. Geneva: World Health Organization. Available at: https:// www. who. int/ csr/don/05-january-2020-pneumonia-of-unkown-cause-china/en/. Accessed on 7 April 2020.
3. World Health Organization. Situation reports. Available at: https:// www.who.int/emergencies/ diseases/novel-coronavirus-2019/ situation-reports/. Accessed on 3 May 2020.
4. Coronavirus outbreak. Available at https:// www. worldometers. info/coronavirus/. Accessed daily.
5. Wang C, Horby PW, Hayden FG, Gao GF. A novel coronavirus outbreak of global health concern. Lancet. 2020;6736(20):30185-9.
6. Novel coronavirus pneumonia emergency response epidemiology team. Vital surveillances: the epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19)-China, 2020. China CDC Weekly. 2020;2(8):113-22.
7. China's CDC detects a large number of new coronaviruses in the South China seafood market in Wuhan. Available at: https:// www. xinhuanet. com/2020-01/27/c_1125504355.htm. Accessed on 20 February 2020.
8. Zhu N, Zhang D, Wang W. A novel coronavirus from patients with pneumonia in China, 2019. N Engl J Med. 2020;54:44-9.
9. Callaway E. Time to use the p-word? Coronavirus enter dangerous new phase. Nature. 2020;579:12.
10. WHO Director-General's opening remarks at the media briefing on COVID-19. Available at: https://www. who. int/ dg/ speeches/ detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---25-may-2020. Accessed on 11 March 2020.
11. Andrew AS, Luquero FJ. From China: hope and lessons for COVID-19 Control. Lancet Infect Disease. 2020;3099(20):30264-4.
12. Ferguson NM, Laydon D, Gilani NG. Impact of non-pharmaceutical interventions (NPIs) to reduce COVID-19 mortality and healthcare demand. Available at: https:// www. imperial. ac.uk/media/imperial-college/medicine/sph/ide/gida-fellowships/Imperial-College-COVID19-NPI-modelling-16-03-2020.pdf. Accessed on 7 April 2020.
13. Chen N,Zhou M,Dong X,et al.Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet 2020;395:507-13.
14. Report of the WHO-ChinaJointMissionon Coronavirus Disease 2019 (COVID-19). Available at: https://www.who.int/docs/default-source/ coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf. Accessed on 16 February 2020.
15. Zhang J, Litvinova M, Wang W. Evolving epidemiology and transmission dynamics of coronavirus disease 2019 outside Hubei province, China: a descriptive and modelling study. Lancet Infect Dis. 2020;3099(20):30230-9.
16. Song JY, Yun JG, Noh JY. Covid-19 in South korea Challenges of Subclinical manifestations. NEJM. 2020;8:87-95.
17. Modellierung von Beispielszenarien der SARS-CoV-2-Epidemie 2020 in Deutschland. Available at: https://edoc.rki.de/handle/176904/6547.2. Accessed on 7 April 2020.
18. Remuzzi A, Remuzzi G. Covid-19 and Italy: what next? The Lancet. 2020;6736(20):30627-9.
19. Ansah JP, Matchar DB, Wei SLS. The effectiveness of public health intervention intervention against COVID-19: lessons from the Singapore. Experience Medrxiv. 2020;20:71-9.
20. Wu A, Peng Y, Huang B. Genome composition and di- vergence of the novel coronavirus (2019-nCoV) originating in China. Cell Host Microb. 2020;27:325-8.
21. Chen Y, Qianyun L, Guo D. Emerging corona viruses: Genome structure, replication, and pathogenesis. J Med Virol. 2020;92:418-3.
22. Roujian L, Xiang Z, Juan L. Genomic Characterisation and epidemiology of 2019 corona virus: implications for virus origins and receptor binding. Lancet. 2020;6736(20):30251-8.
23. Zhou P, Yang X, Wang X. A pneumonia outbreak associated with a new coronavirus of probable bat origin. Nature. 2020;1038:41586-20.
24. Zimmerman P, Curtis N. Coronavirus infections in children including COVID-19 an overview of the epidemiology clinical features diagnosis, treatment and prevention options in children. Pediatr Infect Dis J. 2020;39(5):355-68.
25. Wilde AH, Snijder EJ, Kikkert M, Hemert MJ. Host factors in coronavirus replication. Curr Topic Microbiol Immunol. 2018;419:1-42.
26. Li G, Fan Y, Lai Y, Han T, Li Z, Zhou P. Coronavirus infections and immune responses. J Med Virol. 2020;92:424-32.
27. Kampf G, Todt D, Pfaender S, Steinmann E. Persistence of coronaviruses on inanimate surfaces

and its inactivation with biocidal agents. J Hosp Infect. 2020;6701(20):30046–3.
28. Doremalen NV, Bushmaker T, Morris DH. Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. N Engl J Med. 2020;382:1564-7.
29. Fauci AS, Paules CI, Marston HD. Coronavirus infection more than just the common cold. JAMA. 2020;323(8):707-8.
30. Chen J. Pathogenicity and transmissibility of 2019-nCoV a quick overview and comparison with other emerging viruses. Microbes Infect. 2020;4.
31. Chan JFW, Yuan S, Hang KK. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person -to- person transmission: a study of a family cluster. Lancet. 2020;395:514-23.
32. Lauer SA, Grantz KH, Bi Q. The incubation period of coronavirus disease 2019 (COVID-19) from publicly reported confirmed cases: estimation and application. Ann Intern Med. 2020;7326:2-5.
33. Zou L, Ruan F, Huang M. SARS-CoV-2 viral load in upper respiratory specimens of infected patients. N Engl J Med. 2020;56:200-17.
34. Li Q, Guan X, Wu P. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. N Engl J Med. 2020;56:200-13.

Cite this article as: Patra B, Behura J, Dewan V, Yadav TP, Datta V, Bahl D. Can we predict the duration of Covid-19 pandemic? an observational analysis. Int J Community Med Public Health 2020;7:3062-8.