SPATIAL BIG DATA ANALYSIS OF COVID-19 FOR DETERMINING SEVERITY OF THE OUTBREAK INTHE SOUTHEAST ASIAN REGION

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KEYWORDS: Covid-19 spectrum, Population mortality, Daily New Cases of Covid-19, Variability of Population Mortality, Impact of latitude

ABSTRACT: The outbreak of the 2019 novel coronavirus disease (Covid-19) originated from Wuhan City, quickly spread across China and beyond following human mobility patterns covering more than 210 countries of the globe, and World Health Organization (WHO) declared the outbreak a pandemic on 11 March 2020. The outbreak of Covid-19 spread geo-spatial and spatiotemporal way in countries situated at latitude between 64°N and 35°S, causing more than 25.416 million people infected and 0.851 million deaths (as of 30 August 2020), which leads to geo-spatial big data. The exponential spreading of Covid-19 spectrum to the new geographical locations has seriously threatened the human health and life of the people as well as posed the challenges for countries to control the severity of the outbreak due to varied population mortality between different countries. The spatial spreading of coronavirus spectrum due to large-scale migrations were reported in the southeast Asian region, with the first case in Thailand on 13 January 2020, which is followed by South Korea on 20 January 2020, and Vietnam and Taiwan on 22 January 2020 prior to reach Hong Kong and Singapore on 23 January 2020. Malaysia reported the first coronavirus case on 25 January 2020, which further geo-spatially spread to Philippines on 30 January 2020 prior to reach Indian Sub-continent on 31 January 2020. With the surge of cases, measures such as avoiding mass gatherings, wearing face masks, and voluntary physical distancing were implemented, prior to impose National lockdowns as measures to control the severity of the outbreak as well as placing healthcare response system. The Hong Kong, Vietnamese and South Korean governments imposed national lockdowns from 8, 13 and 20 February 2020 respectively along with strategy of Testing, Tracing and Treatment as measures to control the spreading of the spectrum of the severity. The governments of Singapore, Malaysia, Philippines, Thailand, Taiwan and India imposed these measures from 6, 13, 15, 20, 24 and 25 March 2020 respectively, whereas, the Indonesian government imposed a national lockdown from 15 March 2020. There are marked variations in the spectrum of daily new Covid-19 cases and population mortality between different countries in the Southeast Asian region such as India, South Korea, Taiwan, Vietnam, Singapore, Thailand, Malaysia, Indonesia, Philippines, Hong-Kong, and Myanmar. In this paper, spatial big data predictive analysis have been carried out based 5-days moving averages of new covid-19 cases from 19 February to 30 August 2020 and Population Mortality data from 15 April to 30 August 2020.This paper further describes the impact of latitude on variability factor of population mortality as determining factor for the severity of the outbreak, whereas relatively lower population mortality

observed for the countries situated at latitude below 38°N.This paper further describes correlation between population mortality and daily new cases of Covid-19,which is responsible for controlling the severity of the spectrum in Taiwan, South Korea, Hong-Kong, Thailand, Malaysia, Vietnam, Singapore and Myanmar, whereas Philippines, Indonesia and India attained critical/ beyond the critical stage of the outbreak.

1. INTRODUCTION

The outbreak of the 2019 novel Coronavirus disease (COVID-19) emerged from Wuhan and spread throughout the Hubei province of China, and further spatially transmitted in an exponential spread to more than 210 countries (Pranab*et al*., 2020). World Health Organization (WHO) declared the outbreak a pandemic on 11 March 2020. The outbreak of Covid-19 spread geo-spatial and spatiotemporal way in countries situated at latitude between 64°N and 35°S, which spread globally creating a public health emergency of international concern causing more than 25.416 mil people of the global population to be infected and 0.851 mil deaths (as of 30 August 2020) and leads to geo-spatial big-data.The exponential spreading of Covid-19 spectrum to the new geographical locations has seriously threatened the human health and life of the people as well as posed the challenges for countries to control the severity of the outbreak due to varied population mortality between different countries. The outbreak of coronavirus is still increasing exponentially and spreading in a spatiotemporal way to new geographical locations, which seriously threatens the life of the people as well as affecting economic and social development(Chenghu*et al*., 2020; Coronavirus, 2020; Rajesh &Priya, 2020). With the surge of cases, measures such as avoiding mass gatherings, wearing face masks, and voluntary physical distancing were implemented, prior to impose National lockdowns as measures to control the severity of the outbreak as well as placing healthcare response system.The spatial spreading of coronavirus due to large scale migration from the Hubei province resulted in a outbreak in the southeast Asian region, covering the latitude of 38°N to 6°S, with the first reported coronavirus case at Thailand on 13 January 2020,followed by South Korea on 20 January 2020 as well as Vietnam and Taiwan on 22 January 2020. The first coronavirus case was then reported in HongKong and Singapore on 23 January 2020, which was followed by Malaysia on 25 January 2020 and Philippines on 30 January 2020, prior to reaching India on 31 January 2020. The spread of coronavirus in the southeast Asian region posed challenges to control the severity of the spectrum of the outbreak (BBC, 2020; WHO, 2020).The HongKong, Vietnamese and South Korean governments imposed national lockdowns / recommendations to control the outbreak of the coronavirus spectrum to control the exponential rise of the spectrum of coronavirus from 8, 13 and 20 February 2020 respectively, after 16, 22 and 31 days of the first reported coronavirus case. The governments of Singapore, Malaysia, Philippines, Thailand, Taiwan and India imposed these measures from 6, 13, 15, 20, 24 and 25 March 2020 respectively, whereas, the Indonesian government imposed a national lockdown from 15 March 2020, after 13 days of the first reported coronavirus case (BBC, 2020). The Myanmarese government executed a national lockdown on 13 March 2020, prior to the arrival of first coronavirus case on 27 March 2020, which was found to be most effective to control its outbreak and keep the country in the most safe zone (BBC, 2020).

The design of different spatial measures of the national lockdown/ recommendations/ health emergency measures, such as surveillance, identification, testing, tracking, segregating the different zones and medical treatment to control the outbreak of coronavirus spectrum, differs from populations, geographical area, communication and medical infrastructure of the country depending on their socio-economic conditions (Rajesh &Priya, 2020; Verma et al., 2020).Coronavirus spatial

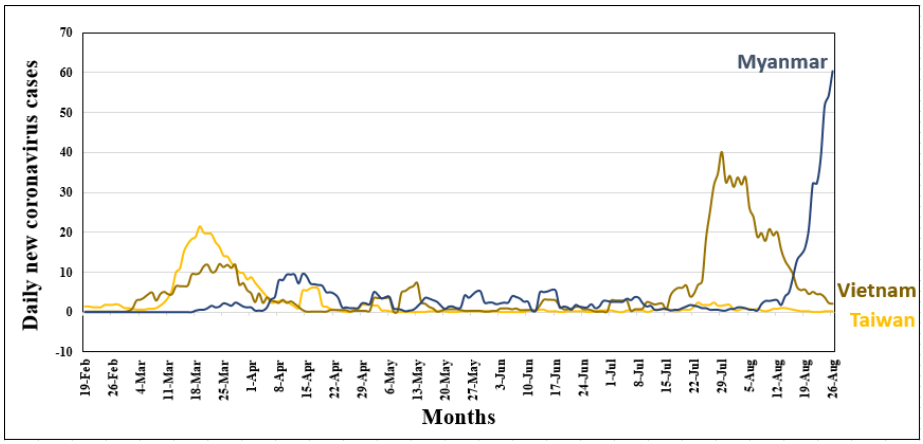
big data predictive analysis plays an important role for predicting the trend of the spectrum and suggesting different measures including supply chain infrastructure to control the outbreak by using geographical information systems (GIS) technologiesfor geospatial big data analysis (Chenghu*et al*., 2020).In Jonathan *et al*. (2020), when mortality per million population was plotted against latitude for 120 countries located in the Northern and Southern Hemispheres based on the mortality data for15 April 2020, it showed marked variation in mortality among different countries due to the potential impact of immune-modulating therapies, highlighting the importance of nutrition and vitamin D. Countries situated beyond the latitude of 35 °N and 35 °S, people do not receive sufficient sunlight to retain adequate vitamin D levels during the winter. It showed relatively low population mortality for countries situated at latitude below 35 °Nand35°S with correlation coefficient of 0.53 between mortality and latitude. In Verma et al. (2020), the variation of population mortality (death per 1 mil population) from coronavirus from 15 April to 06 June 2020 for countries of the southeast Asian region situated at the latitude between 35 °N to 6 °S showed confirms lower mortality as compared to the countries situated at latitude above 35°N. Further, significant variation of variability factor of population mortality from 15 April to 06 June 2020 for 28 countries that lie at the latitude between 60°N to 35°S showed as a determining factor for the severity of the outbreak.

In this paper, spatial big data predictive analysis have been carried out based 5-days moving averages of new covid-19 cases from 19 February to 30 August 2020 and Population Mortality data from 15 April to 30 August 2020.This paper further describes the impact of latitude on variability factor of population mortality as determining factor for the severity of the outbreak, whereas relatively lower population mortality observed for the countries situated at latitude below 38°N. This paper further describes correlation between population mortality and daily new cases of Covid-19,which is responsible for controlling the severity of the spectrum in Taiwan, South Korea, Hong-Kong, Thailand, Malaysia, Vietnam, Singapore and Myanmar, whereas Philippines, Indonesia and India attained critical/ beyond the critical stage of the outbreak.

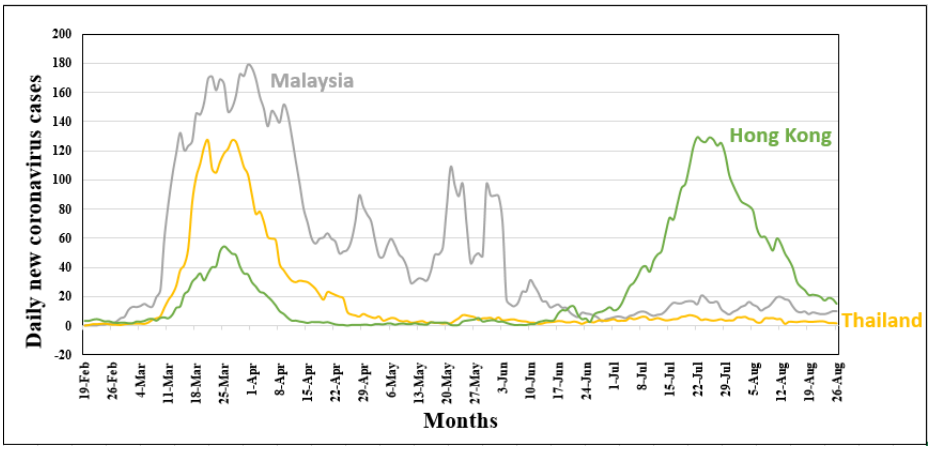
2. COVID-19 SPECTRUM IN SOUTHEAST ASIAN REGION

Figure 1 depicts the variation of the spectrum of 5 days moving average of daily new coronavirus cases from 19 Februaray to 30 August 2020 for the southeast Asian region. The spectrum of coronavirus outbreak increased expoentially to reach the first peak of the spectrum prior to decesase exponentially to attain the stablity for South Korea during February 2020, whereas the spectrum for Vietnam, Hong Kong, Malaysia, Thailand and Taiwan attained first peak during March 2020. The spectrum of coronavirus outbreak increased non-linearly to reach first peak during April 2020 for Singapore and decreaseas non-linearly with multiple lower peaks, whereas non-linear exponential increase of the spectrum of Phillipines, Indonesia and India stabilises to attain the first peak of the outbreak. The spectrum of daily new cases showed non-linear exponential increase for Mayanmar from 12 August 2020. The coronavirus spectrum attained first and second peak of the outbreak for Vietnam, Hong Kong, Malaysia, South Korea, and Singapore, whereas Taiwan and Thailand attained the complete recovery of the outbreak after attaining first peak of the spectrum during March 2020. Figure 1(a) and Figure 1(b) depicts the second peak of coronavirus spectrum of Vietnam and Hong Kong reaches four times and three times respectively higher than the first peak of the outbreak after achieving the first recovery and controlling the outbreak for four months, whereas Figure 1(b) and Figure 1(c) depicts the second peak of the coronavirus spectrum reaches less than half of first peak of the spectrum for Malaysia, South Korea and Singapore showing the

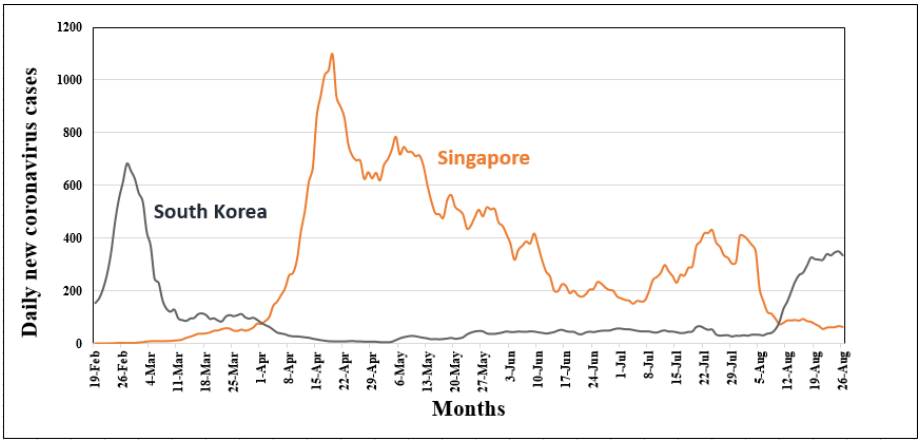
complete recovery of the outbreak from May, August and July 2020 respectively. Figure 1(e) shows 5 % increase of the spectrum of daily new coronavirus cases for India , after attaining 2,000 daily new cases to reach beyond the critical stage of the outbreak and attain stabilises to control the outbreak,whereas Malaysia, South Korea, Singapore, Thailand and Taiwan attained the spectrum to completely recover from the outbreak of coronavirus. Figure 1(f) depicts the variation of 5-days moving average of coronavirus spectrum from 19 February to 31 March 2020 for 9 countries of the southeast asian region, wherein, the spectrum reached first peak of the outbreak prior to non-linear decrease of the spectrum for South Korea, Hong Kong, Malaysia, Thailand and Taiwan (Verma et al., 2020).



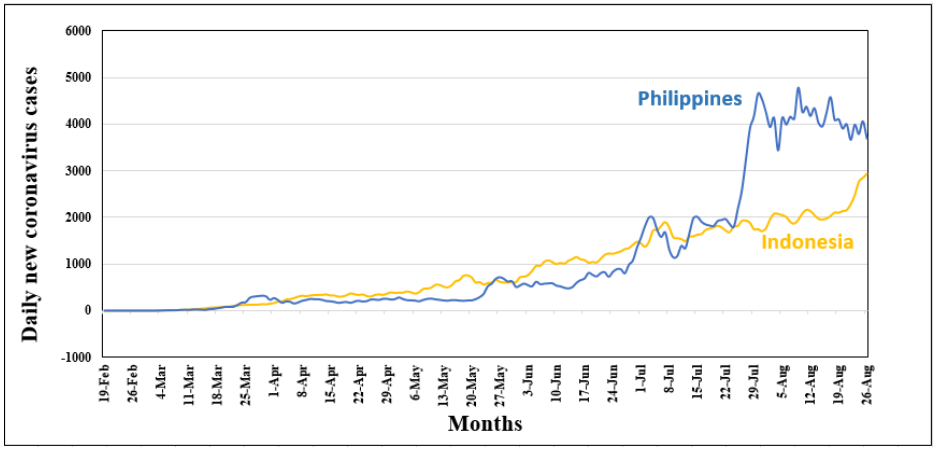
(a)



(b)


Daily new coronavirus cases
1200
1000
800
600
400
200
0
Singapore
South Korea
19-Feb
26-Feb
4-Mar
11-Mar
18-Mar
25-Mar
1-Apr
8-Apr
15-Apr
22-Apr
29-Apr
6-May
13-May
20-May
27-May
3-Jun
10-Jun
17-Jun
24-Jun
1-Jul
8-Jul
15-Jul
22-Jul
29-Jul
5-Aug
12-Aug
19-Aug
26-Aug
Months

(c)


Daily new coronavirus cases
6000
5000
4000
3000
2000
1000
0
-1000
Philippines
Indonesia
19-Feb
26-Feb
4-Mar
11-Mar
18-Mar
25-Mar
1-Apr
8-Apr
15-Apr
22-Apr
29-Apr
6-May
13-May
20-May
27-May
3-Jun
10-Jun
17-Jun
24-Jun
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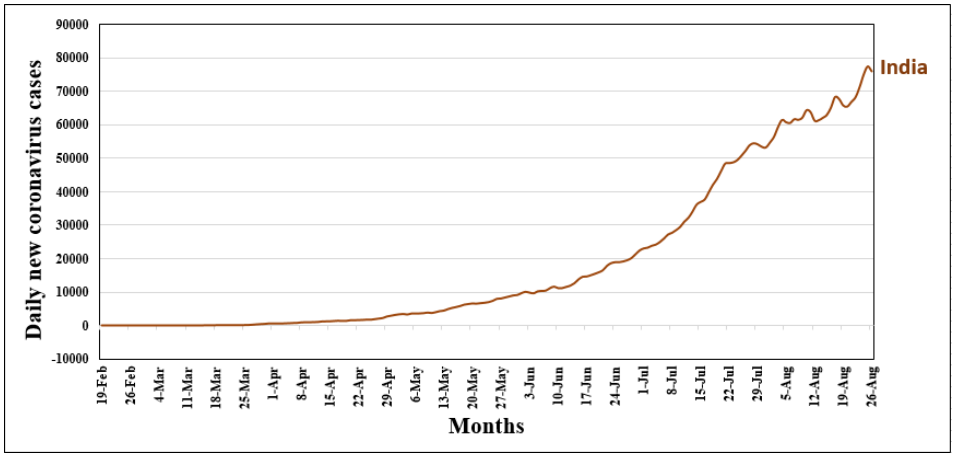
8-Jul
15-Jul
22-Jul
29-Jul
5-Aug
12-Aug
19-Aug
26-Aug
Months

(d)


Daily new coronavirus cases
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
-10000
India
19-Feb
26-Feb
4-Mar
11-Mar
18-Mar
25-Mar
1-Apr
8-Apr
15-Apr
22-Apr
29-Apr
6-May
13-May
20-May
27-May
3-Jun
10-Jun
17-Jun
24-Jun
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15-Jul
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5-Aug
12-Aug
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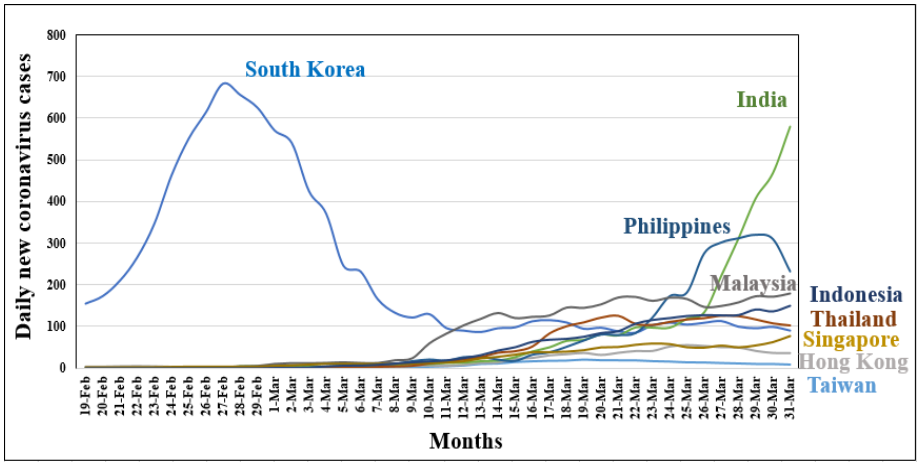
26-Aug
Months

(e)



(f)

Figure 1: Variability of Covid-19 spectrum from 19 February to 26 August 2020.

3. IMPACT OF LATITUDE ON POPULATION MORTALITY AND ITS VARIABILITY

In Panarese and Shahini (2020), higher population mortality from coronavirus observed in northern latitude with highest in Italy and exhibiting the population mortality with decreasing north south gradient based on mortality data of 02 April 2020 for 108 countries.Northern latitudes are associated with vitamin D deficiency for higher population mortality due to low ultraviolet exposure in the northern countries. In Jonathan et al. (2020), when population mortality plotted against the latitude for 130 countries based on mortality data of 15 April 2020 showed marked variation in mortality between different countries that lie below the latitude of 64°N of the hemisphere.

People do not receive adequate sunlight to maintain vitamin D levels during winter in countries situated beyond the latitude of 35°N. All countries that lie below the latitude of 35°N showed relatively low population mortality with the correlation coefficient of 0.53 between mortality and latitudes(Jonathanet al., 2020). Further, the potential impact of immune-modulating therapies and importance of nutrition particularly vitamin D is highlighted, which is important in regulating and suppressing the inflammatory cytokine response of respiratory epithelial cells as well as preventing the cytokine storms and subsequent Acute Respiratory Distress Syndrome (ARDS) that is commonly the cause of mortality from coronavirus (Panarese and Shahini, 2020; Jonathan et al., 2020).

In Verma et al. (2020), relatively low population mortality from coronavirus is observed for countries situated at latitudes between 38°N and 35°S based on population mortality from 15 April, 26 April, 3 May, 13 May, 22 May and 08 June 2020, for 28 countries including the southeast Asian region that lie below the latitude 60°N as shown in Figure 2(a). Higher correlations is observed for the impact of latitudes on population mortality due to continuance of multiple peaks for countries at the same latitudes during these periods with increased population mortality (Verma et al., 2020), which supports Vitamin-D as factor for lower mortality as observed (Jonathan et al., 2020;

Panareseand Shahini ,2020). Spatial big data analysis of the variability factor of population mortality from 15 April to 8 June 2020 for 28 countries as depicted in Figure 2(b) shows that the significant variation of temporal variability factor of population mortality for Russia, India, Egypt, Saudi Arabia, Mexico, Philippines, Panama, Colombia and Peru determines the severity of the outbreak, which depends on the spectrum of daily new cases, healthcare infrastructure and design of the measures and geo-spatial supply chain management to control the outbreak by the concerned countries, and is independent of the impact of the latitude or vitamin-D (Verma et al., 2020).

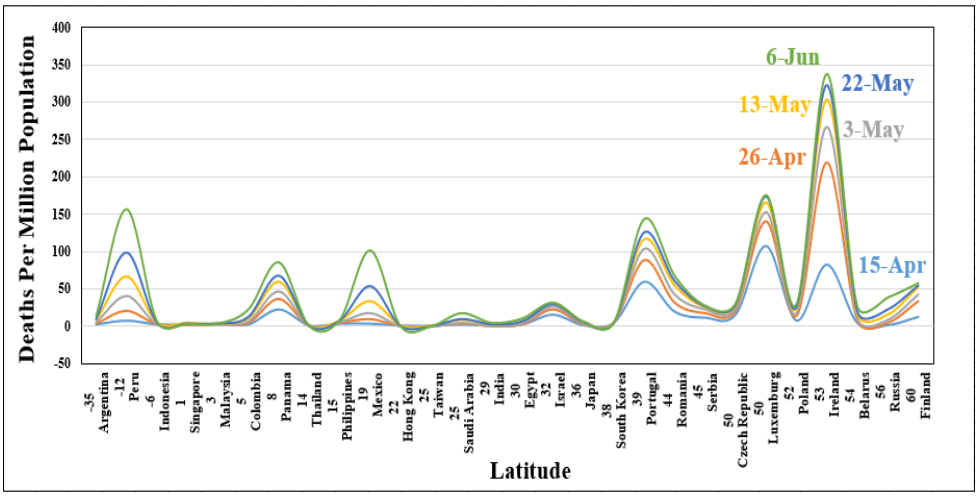


Figure 2(a): Variation of population mortality for 28 countries between latitude 60 °N and 35 °S.

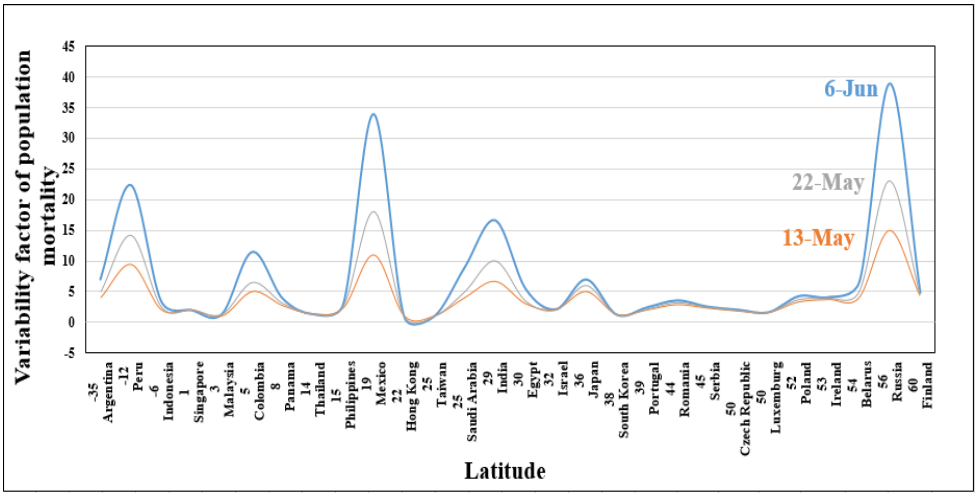


Figure 2(b) : Variation of variability factor of population mortality for 28 countries.

3.1 Population Mortalityand its Variability for Southeast Asian Region

Figure 3depicts the variation of population mortality from Covid-19 for 11 countries of the Southeast Asian region that lie between latitudes 38°N and 6°S based on population mortality data from 15 April to 30 August 2020.There are marked variations in population mortality for India,

Hong Kong, Philippines and Indonesia during these periods, whereas South Korea, Taiwan, Vietnam, Thailand, Singapore and Malaysia showed non-significant variations in population mortality. The maximum marked variation of population mortality is observed for India amongst the Southeast Asian countries. The spectrum of daily new covid-19 cases depicted in Figure 4 shows maximum significant increase for India, which is followed by Philippines, whereas other countries shows non-significant increase of the spectrum of daily new cases from 15 April to 15 August 2020. This confirms that significant increase of the population mortality depends on the rise of spectrum of the daily new coronavirus.

Further, Figure 5 shows the temporal variation of variability factor of population mortality from 13 May to 30 August 2020 with respect to population mortality on 15 April 2020. It shows significant temporal variations of variability factor of population mortality for India, Hong Kong, Philippines and Indonesia in the southeast Asian region, whereas other countries such as South Korea, Taiwan, Thailand, Malaysia and Singapore showed non-significant temporal variations in variability factor of population mortality for more than 4 months. Further, Figure 5 shows that the temporal variation of variability factor of population mortality does not depend on the latitude of the countries supporting vitamin D factor, whereas the significant temporal variability factor of population mortality determines the severity of the outbreak for countries in spite of relatively lower relatively lower population mortality observed between latitudes 38°N and 6°S.

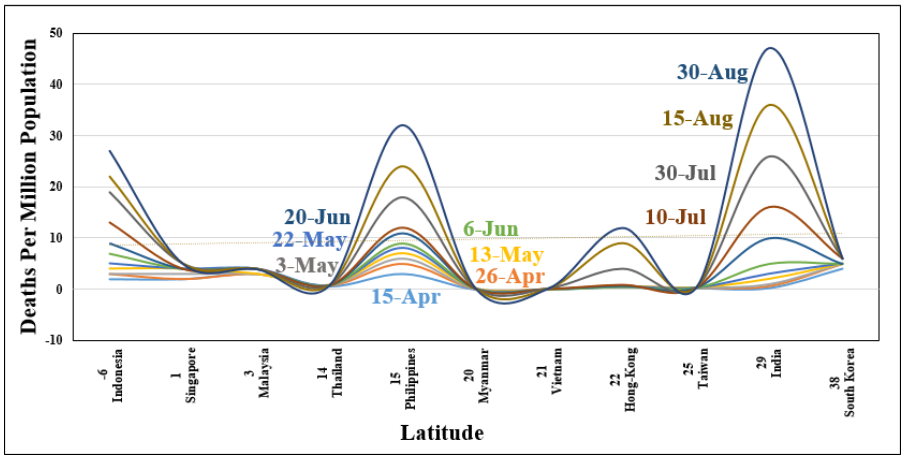


Figure 3: Variation of Population Mortality with Latitude for Southeast Asian Region

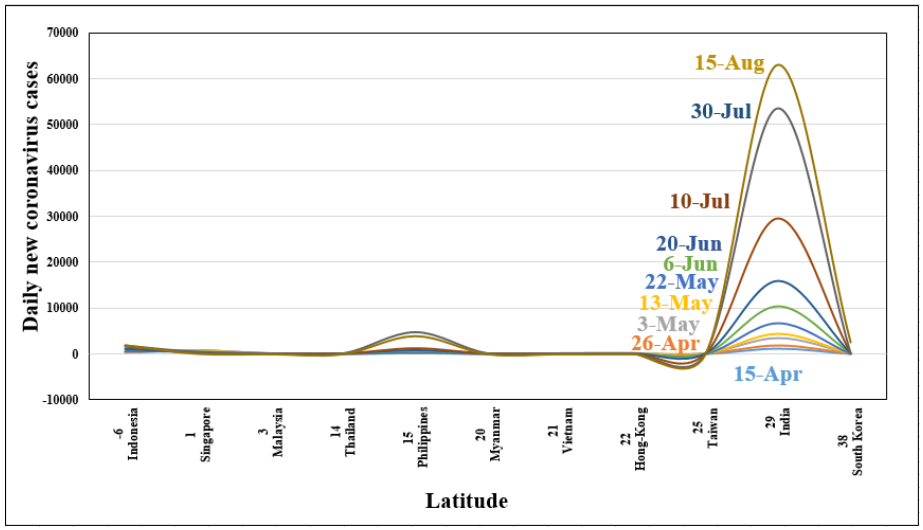


Figure 4: Variation of Daily New Coronavirus cases with Latitude for Southeast Asian Region

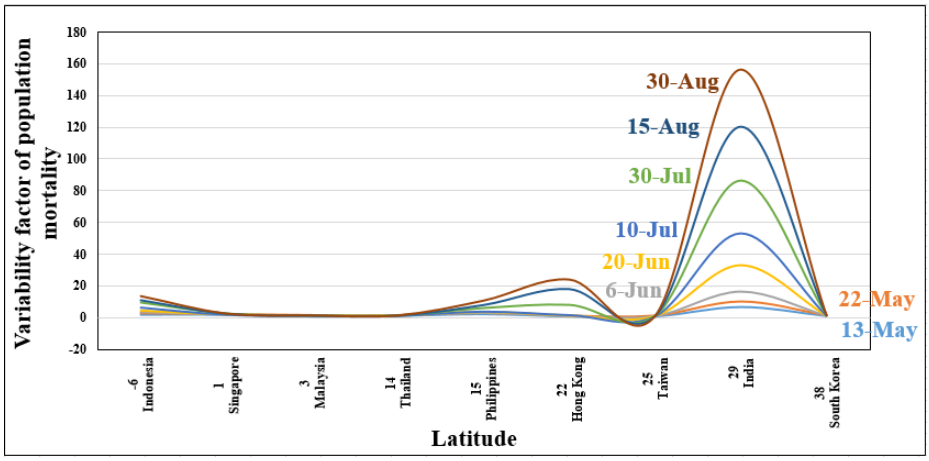


Figure 5: Variability Factor of Population Mortality with Latitude for Southeast Asian Region

4. CONCLUSION

The present study of spatial big data analysis of the daily new coronavirus case spectrum was carried out for 11 countries in the southeast Asian region situated at latitudes between 38 °N and 06 °Sof Hemisphere, such as South Korea, India, Taiwan, Hong Kong, Vietnam, Myanmar, Philippines, Thailand, Malaysia, Singapore and Indonesia. It is observed from the coronavirus spectrum that the spectrum of Thailand and Taiwan attained to recover from the outbreak after reaching the first peak of spectrum during March 2020, whereas Philippines, Indonesia and India is still stabilizing to reach towards first peak of the outbreak. Further, it is observed that South Korea, Malaysia and Singapore attained the first peak of the spectrum during February, March and April 2020 respectively, whereas second peak lower than the first peak of spectrum attained during August, May and July 2020, which confirms to successfully control the outbreak towards the

complete recovery stage. The spectrum of Vietnam and Hong Kong reached the first peak during March 2020 and second peak more than three times higher of first peak of the spectrum during July 2020 after attaining towards the complete recovery from March 2020. The present analysis of population mortality for countries that lie below the latitude 60 °N and 35 °Sdescribes relatively lower population mortality for countries that lie below 38°N confirming the impact of latitude on population mortality due to vitamin-D, whereas temporal variability factor of population mortality determines the severity of the coronavirus outbreak.(Jonathan et al., 2020; Panarese and Shahini ,2020;Verma et al., 2020). The analysis of population mortality data for 11 countries of the Southeast Asian region from April to August 2020 describes very significant population mortality higher than 25 for India, Philippines and Indonesia, which depends upon very high values of daily new cases for India, followed by Philippines and Indonesia. The maximum temporal variability of population mortality is found for India, which is followed by Hong Kong, Philippines and Indonesia from 15 April to 30 August 2020, confirming maximum severity of the coronavirus outbreak for India in the Southeast Asian region.

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