ORIGINAL ARTICLE

A Statistical Analysis and Comparison of the spread of Swine Flu and COVID-19 in India

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ABSTRACT

Introduction: The world is currently experiencing the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [COVID-19], however, this is not a new phenomenon; it occurred in 2009-2010 in the form of novel influenza A. (H1N1). The H1N1 virus primarily afflicted people between the ages of 26 and 50, but SARS-CoV-2 primarily afflicted those over the age of 60, increasing the number of deaths owing to their weakened immunity. The report provides a case study of the impact of H1N1 and SARS-CoV-2 in India. **Methods:** Data is obtained from The Hindustan Times newspaper, GoI press releases and World Health Organization (WHO) reports. **Results:** The incidence rate was initially low and it was only by the 10-15th week that it started increasing. There is an initial upward trend before levelling out followed by a second wave and third wave. COVID-19 exhibited a steeper growth, where the steps taken by the Government were ineffective leading to higher death cases. Kerala was affected due to the travellers returning from the Middle East, while Maharashtra and Delhi saw large incidence rates due to the migrant influx and communal gathering. **Conclusion:** The most effective and practical approach is to test the symptomatic patients and aggressive testing to contain the transmission. Awareness campaigns to educate the public about social distancing and personal hygiene is more practical. There is still scope of improvement with regards to the public health care support, preparedness and response. Lockdown measures could have been avoided if the initial screening was conducted properly.
Malaysian Journal of Medicine and Health Sciences (2022) 18(6):92-99. doi:10.47836/mjmhs18.6.14

Keywords: Corona virus, COVID-19, Swine flu, H1N1, Pandemic, SARS-CoV-2

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INTRODUCTION

Pandemics in the past, such as the Spanish flu of 1918, the Asian flu of 1957, and the Hong Kong flu of 1938, varied in scope and severity (1). Swine flu was the first pandemic of the twenty-first century, first identified in April 2009 on the border between Mexico and the United States of America (USA) and impacting over 1.7 million individuals in over 170 nations (2). The H1N1 swine-origin influenza virus has undergone triple re-assortment, including genes from avian, swine, and human viruses (3). COVID-19, caused by a new coronavirus strain known as severe acute respiratory syndrome coronavirus 2, was first identified in late December 2019 in Wuhan, Hubei Province, China (4). By March 2020, it had reached epidemic proportions, infecting over 0.3 million individuals worldwide and killing around 12000 people (5).

Swine flu had an incubation period of 1-7 days, whereas COVID-19 had an incubation period of 1-14 days, with a mean length of 5-7 days (6), with transmission beginning 1-2 days after the onset of symptoms (symptomatically or asymptomatically). Both viruses are spread by droplets and need a distance < 6 feet between the source and the affected individual. The early symptoms are similar such as fever, cough, sore throat, headache, joint pain, fatigue, dyspnoea, and myalgia, as well as gastrointestinal symptoms (vomiting, diarrhea) (6,7). The leading cause of death is respiratory failure, followed by pneumonia, high fever with neurological sequelae, dehydration, and electrolyte immobilization. The clinical signs of the 2009 pandemic swine flu were identical to seasonal influenza (3). Several studies have found that the prevalence of H1N1 is greater in the younger population (those under the age of 20-50) (8–11). Isolation, social distance, respiratory etiquette, use of facial masks, hand cleanliness, and antiviral medicine usage are the major treatments, with the diagnosis typically based on RT-PCR, viral culture, or the development of neutralizing antibodies (2).

Flu epidemics are known to occur every 6-10 years that exposes the world population to a new influenza strain, resulting in increased or decreased morbidity or death (11). India recorded its first swine flu case in May 2009, while the first case of COVID-19 was reported on January 30, 2020. Between 2009-10, India was sixth among impacted nations with 47840 cases recorded and 981 deaths (12). There were three waves (May-October 2009, November-May 2010, and May-August 2010) (13). India is now rated 2nd (as of March 2022) in terms of risk ranking for COVID-19, with over 42 million cases. Learning from past pandemics is essential for preparing for the next one and reducing human and economic losses.

The aims of this paper was to present a comparison of the growth of swine flu from May 2009 (detection of 1st case in India) –December 2010 (81 weeks) and COVID-19 from January 2020 (detection of 1st case in India) – August 31, 2021 (81 weeks) and to seek an understanding of the effectiveness of the measures taken by the Government of India (GoI) and the spread of the diseases.

MATERIALS AND METHODS

The paper is arranged in the following section – Section 1 presents the research methodology which highlights the source of data and its procurement, followed by Section 2 where the statistical analysis of the pandemic is presented in an Indian context. State-wise infographics has been correlated with steps taken by the government to contain the pandemic and presented their perspective to the readers on the success or failure of the steps. To the best of the authors' knowledge, there has been no statistical analysis made that compares two different pandemics across different times. The purpose of the study is to observe and analyze any pattern in the manner in which the pandemics spread and cases are reported. Understanding the trend would enable us to be better prepared for any future outbreak of any similar kind of pandemic.

The data was obtained from various sources including The Hindustan Times daily, press releases by the GoI and World Health Organization (WHO) reports. It is however to be noted that there are discrepancies in the actual figures as put forward by the Press Release by the GoI and WHO, and the readers are advised to take the numbers as approximate values and not the actual value.

RESULTS

The pattern of death in the early stages of an epidemic can be used to predict the efficacy of any suppression or containment attempts. Figure 1 compares the cumulative number of tested cases, confirmed cases, and fatalities in India for swine flu and COVID-19 (Figure 1(a) and Figure 1(b), respectively) since the first case was reported in India. It can be observed that the trend in both cases are very similar, except that the spread of the COVID-19 virus was much faster through the community. A log scale depiction helps to highlight the nature of the epidemic's development (14) (Figure 1(c)). Once the illness spreads in the community and there is evidence of localized transmission, mitigating measures such as lockdown, sealing of specific portions, school closures, and a restriction on public mass meetings are necessary to limit the infection. The goal of community mitigation is to flatten the growth curve, and the form of the curve is determined by how quickly the illness spreads within the community. The faster it climbs, the steeper it falls, putting a strain on local and national healthcare systems and contributing to increased mortality rates. A flatter slope would stretch out the instances over a longer time, giving researchers more time to create better medicines and vaccinations.

The positivity ratio (confirmed cases: tested cases) and case fatality ratio (CFR- confirmed fatalities: confirmed cases) for swine flu and COVID-19 are depicted in Figure 2.

$$\text{Positivity Ratio} = \frac{\text{No.of confirmed cases}}{\text{No.of Test cases}}$$

$$\text{Case Fatality Ratio (CFR)} = \frac{\text{No.of deaths}}{\text{Total no.of confirmed cases}}$$

CFR seeks to assess the individual risk of mortality in infected individuals and is commonly used as an indicator for disease severity within the community (15). However, it is well acknowledged that during a pandemic, CFR is a poor predictor of illness mortality since it represents the severity of the disease in a certain location, period, and population, and hence varies over time depending on the treatment received.

The doubling rate (in weeks) for swine flu and COVID-19 is shown in Table I. The doubling time is denoted, (16):

$$\text{Doubling time} = \frac{\ln(2)}{\gamma}$$

where γ is the growth rate.

The doubling time is an indicator of the success of the government's actions in slowing the spread of the epidemic across the population; the longer the doubling period, the less transmission there is. Increases in the doubling time are interpreted as a flattening of the total

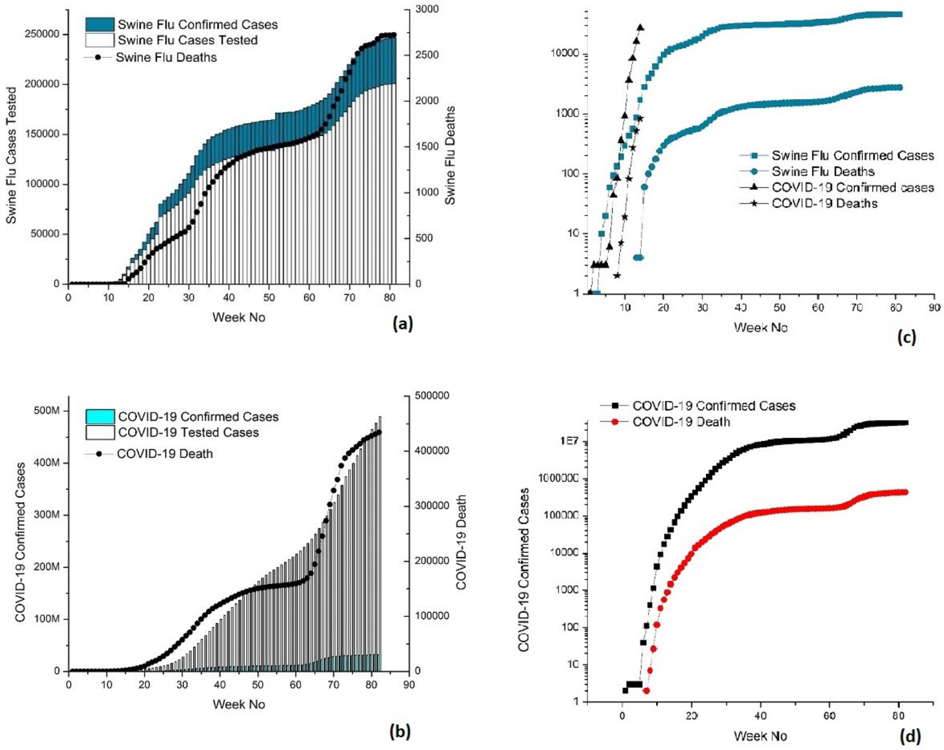


Figure 1: Comparison of the no. of tested cases, confirmed cases and deaths during (a) swine flu and (b) COVID-19 in India for 81 weeks and 16 weeks, respectively, showing an increased number of testing for COVID-19 and the same upward trend. It also suggests that COVID-19 is yet to reach the stabilization point, (d) Statistics on COVID-19 deaths shows similar trends as Swine Flu with much larger casualty.

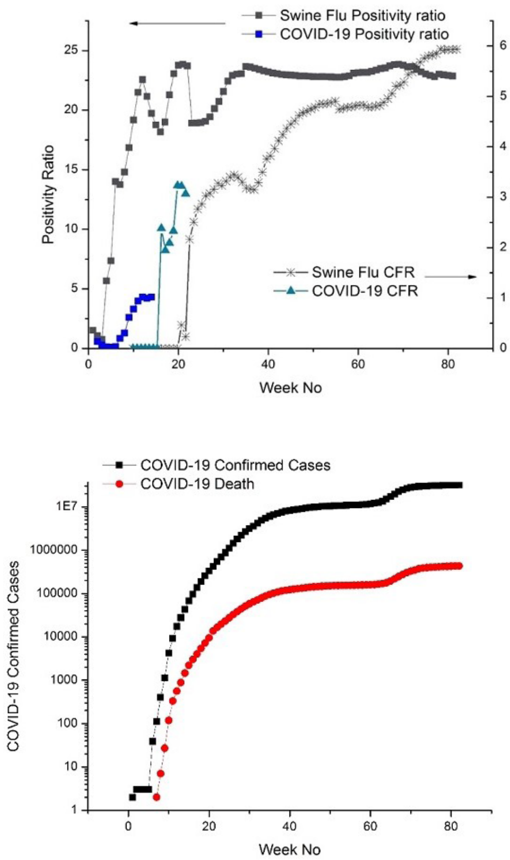


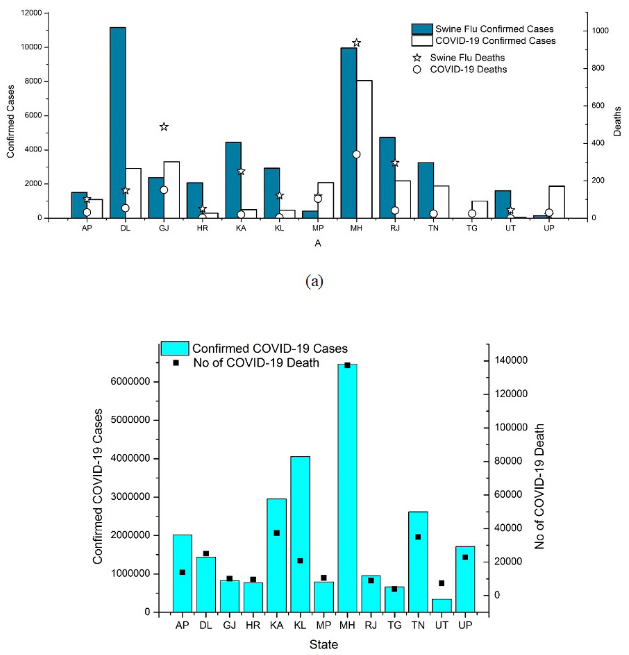
Figure 2: Comparison of the positivity ratio and CFR for swine flu and COVID-19 which shows that due to improved awareness and infrastructure there is increased testing for COVID-19, (b) Case Fatality ratio for COVID-19 showing similar trends as Swine flu but with a greater spread.

Table I: Doubling time (in weeks) for swine flu and COVID-19 in different phases of their growth, showing how COVID-19 is doubling much faster than swine flu.

	Week(s)	Average Doubling time (in weeks)
Swine Flu	4-20 (phase 1)	~ 2
	20-40 (phase 2)	11
	40-till end (phase 3)	52
COVID-19	1-9 (before lockdown)	1 (7 days)
	9-14 (post lockdown)	0.78 (~5 days)
	Overall (1-14)	0.80 (~6 days)

number of instances, however, this is not necessarily the case. Post the early phase, changes in a novel infectious disease's growth rate offer a reliable indication of transmission rates (17). If during the early stages, the doubling of new cases remains constant, there has been no substantial changes in the underlying transmissibility. Variation of the growth rate due to the efficacy of the preventive methods reflects in the doubling time (18). Swine flu is depicted in three phases: phase 1 (weeks 4- 20), phase 2 (weeks 20-40), and phase 3 (weeks 40-80) to determine if the doubling rate was growing or decreasing. The GoI issued the lockdown for COVID-19 on March 24 (9th week), which was prolonged by two weeks owing to an increase in the number of cases. The doubling time for COVID-19 was examined in two stages: before and during the lockdown. If the lockdown had been effective, the doubling time for disease transmission inside the population would have been reduced, but this was only achieved by the slimmest of margins.

Figure 3 depicts the state-by-state distribution of confirmed cases and deaths, with the lower limit set at 1000 confirmed cases (as of 17 May 2020) for either swine flu or COVID-19 (data upto August 2021), or both. Sikkim and Lakshadweep were the only Indian states with no swine flu infections, and while Sikkim had no COVID-19 casualties, Lakshadweep began receiving cases later in the lockdown (post 26 April 2020).



(a)

(b)

Figure 3: : State-wise comparison of confirmed cases and no. of deaths (lower limit: 1000 confirmed cases) for swine flu and COVID-19. Sikkim, Lakshadweep showed no cases during both pandemics. Note: Telangana (TG) was not formed from AP in 2009-2010 and even then AP had fewer cases of swine flu. (b) Statewise Statistics on the spread of COVID-19 in various states across the country.

DISCUSSION

For both pandemics, the number of cases was initially modest, and it wasn't until the 10-15th week that it began to rise. The initially modest increase might be an artefact of the testing approach, which confined testing to visitors from high-risk nations and their direct connections, or it could be the utter absence of testing. Both pandemics demonstrate an initial increasing tendency in terms of growth and mortality cases before levelling off, as observed in the case of swine flu. Due to the low temperature, a second and third wave of swine flu was detected around the 20th and 60th week, respectively (11). Due to the capacity of the virus particle to survive longer at colder temperatures, lower ambient temperature has been commonly connected with influenza seasonality (13). Overcrowding during the winter months contributes to the virus's spread. COVID-19 has a higher growth curve for both confirmed cases and deaths, and the stability curve has yet to be achieved, implying that the curve will continue to climb. If the rate of development is not slowed throughout the summer, the number of cases will skyrocket during the rainy and winter seasons. As shown in Figure 1(b), there has been an increase in the number of COVID-19 screenings since the outbreak began, implying stronger infrastructure to cope with the pandemic as well as proactiveness on the part of state and federal administrations. India grew at a slower rate than the United States, Italy, and France (19). As shown in Figure 1(c), the time it took for the number of deaths to reach 500 was around 25 weeks for swine flu and 13 weeks for COVID-19, respectively. The number of new cases every week is increasing, indicating a significant increase in the number of patients until the 20th week. The curve for swine flu flattens after 25 weeks, indicating that the actions implemented were gradually yielding benefits with a slower growth rate. A small rise occurs at the 20th and 60th weeks, which correspond to the second and third waves mentioned above. The number of confirmed cases in COVID-19 continues to rise and has surpassed the total number of cases seen throughout the whole swine flu epidemic in less than one-sixth of the period. The number of deaths for COVID-19 is likewise rapidly growing, with no clear endpoint in sight, however, the graph shows hints of a modest upward trend. One reason for the high fatality rate might be because the measures put in place have been unsuccessful thus far, or the effect has yet to be quantified. This, in turn, might be attributed to communities' carelessness in arranging public events, which effectively nullified the effect of the lockdown.

The positivity ratio for swine flu was calculated to be around 20-25% which is close to the ones reported in the literature (20). The number of cases started increasing around the 12th week (August 2009) which shows that the viral strains becomes active again due to favorable climatic conditions such as ambient humidity, and absence of dry air. As per Figure 2, the CFR for swine flu was calculated to be ~6% at the end of 2010 which is similar to published reports (15, 20, 21, 22) and though it is higher than other countries, it is expected that the actual CFR is lower. Cross-country comparisons of CFR provide information on national and international standing and recognizing the health system performance. The CFR for COVID-19 (~ 3.1%) confirms the severity of the pandemic in India, which is much less than the global CFR (~7.25%), with France (~18.22%), the United Kingdom (~15.93%), Italy (~13.51%), Spain (~11.17%), Iran (~6.33%), USA (~5.66%), China

(~5.53%), Iraq (~4.88%), Germany (~3.66%) having higher CFR than India, and Japan (~2.64%), South Korea (~2.26%), New Zealand (~1.61%), Australia (~1.21%), Middle East countries (~0.53-0.83%), and Singapore (~0.1%) having a lower CFR which highlights the proactiveness of the respective governments to contain the pandemic (source: European Centre for Disease Prevention and Control (ECDC)). Population plays a critical role in the ability of the government to initiate any programs to stop the spread of the pandemic – the higher the population, the more difficult it becomes for the programs to be effective. Several reports confirm that the CFR for COVID-19 is less than Bird flu, Ebola, SARS and MERS but the highly infectious nature and asymptomatic occurrences raise concerns among the public (23).

During the initial days of swine flu, there was widespread transmission with the doubling time ~ 14 days. Similar reports have been published where the doubling time was observed to be 9.9 days (June-August 2009) (24). This was followed by a levelling of the pandemic where the rate of increase of new cases decreased, resulting in an increased doubling time which implies that the spread of the virus within the community was being contained. A similar trend in the doubling time for COVID-19 was reported in (16) where the doubling time before the lockdown (05-March – 22-March 2020) was above 4 and post-lockdown (23-March – 06-April 2020), it drops down to below 3. The predicted susceptible-infectious-recovered (SIR) model predicted a doubling time of approximately 4.8 days (19), <5 days (25) for the period between March-April 2020. The doubling time has been reported to be 4-5 days in the initial days (26), 6.4 days (27), (28), 7.4 days (~8 weeks) and ranging from 2.9-7.31 days depending on selected studies in China (29). South Korea is one of the most effective examples of successful approaches such as mass testing and patient tracking, and as a consequence, the doubling time has gradually improved over the last decade. The doubling times were calculated around 4.3 days (30) which is close to the calculated data. According to the GoI, the doubling time of cases was about 3 days before lockdown, but it has climbed to 6.2 days after lockdown (31). It is believed that the effect of the lockdown was greatly mitigated by two major activities recorded in India: the migration of labourers to their various states and a religious festival held in New Delhi from 1-21 January 2020 (16). Almost 9000 people attended the meet and have been traced to Maharashtra, Karnataka, TN, AP, and UP and with over 4291 confirmed cases and 27 deaths linked to the above events, the religious congregation has contributed 36% to the COVID-19 scenario in India. The organizers received widespread criticism across various communities for holding the congregation, though their justification was that the congregation was held before the lockdown was announced. The GoI was also criticized with their handling of the immigrant issue where several immigrants had to walk thousands of miles to reach home in the absence of daily income and public (intra- and inter-state) transportation.

The distribution of cases and mortality due to the pan-India pandemic was not uniform, indicating that the kind of strain or the immune response of the infected people in the area is important. Between 2010-2017, Maharashtra, Delhi, Telangana, Gujarat, Karnataka and Goa accounted for more than 68% of all cases, with Maharashtra, Gujarat, Rajasthan, Madhya Pradesh, and Karnataka reporting > 76% for all H1N1 deaths. Delhi and Maharashtra alone contributed ~50% of the total cases confirmed. Maharashtra and Gujarat had the highest number of deaths accounting for 51% of the total number of deaths. In the current scenario, Maharashtra, Gujarat and Delhi are also the leading states in COVID-19 having almost 56% of the total confirmed cases, and accounting for almost 65% of the total number of deaths. Rajasthan and Tamil Nadu are the other states which contributed a significant number of COVID-19 cases. Sikkim has not reported any case, and the northeastern states fare better than the rest of the countries with the 7 states contributing less than 1% of the total confirmed cases. A heat map with the average number of mean cases and deaths from H1N1 showed Punjab, Rajasthan, Gujarat, Maharashtra and Delhi as the hotspots with higher vulnerability (32). Kerala had one of the highest numbers of cases during the initial days due to the high number of travelers returning from the middle east – however, with proactive government measures including isolation, quarantining, and contact tracing, the number of confirmed cases has decreased with the state exhibiting the highest percentages of recovered cases (33). One of the potential reasons for the high number of cases in Maharashtra and Delhi is the influx of migrants as these form the largest urbanization centres in the country (34). As per the 2011 census, Kerala, Goa and Tamil Nadu have the highest population above the age of 65 years and hence are more vulnerable (35). UP and MP suffered the brunt of immigrants moving out of Delhi during the lockdown which might have been a cause for the high incident rate. Another reason for the increased number of cases is the increased testing done compared to the other states (36), for example, Maharashtra had conducted 35668 tests as of 12 April 2020, while Gujarat had conducted only 11715 tests. Because of the discrepancy in the number of tests conducted, there is a wide variation in the number of confirmed cases and deaths. The main contributing factor for the high number of cases in Tamil Nadu was Koyambedu (Chennai) market cluster with as many as 1500+ cases associated with the cluster. Gujarat is one of the most globalized states in the country besides Kerala and saw a large influx of people from abroad during January-March for trade and business, and mostly coming from Canada, USA, UK China which was hotspots for COVID-19. As per the GoI, the increased number of cases is also associated with comorbidities where the patients suffer from multiple ailments which makes them susceptible to the virus. The religious congregation held in New Delhi also contributed to the high number of cases in Ahmedabad, Surat and Vadodara. A nationwide lockdown was imposed but essential commodities like supermarkets, banks, dispensaries and hospitals were still open where the chance of contact infection was high with social distancing norms were not always followed (37).

Given the resource restraints in India, it is unreasonable to expect similar testing measures like those seen in South Korea (38), and the most effective and practical approach is to test the symptomatic patients and aggressive monitoring to contain the transmission, along with mitigation measures. The WHO declared swine flu a pandemic in April 2009, and the Government of India moved quickly to prevent H1N1 entrance and slow its spread within the population, to decrease case fatalities through diagnosis and antiviral treatment in designated facilities (39). From mid-April, all foreign travellers were checked at 18 international airports, and everyone with influenza-like symptoms was tested for infection. The overall fatality rate by December 2009 was 3.14%. In 2009, there were only 2 national laboratories where the virological tests were conducted which highlighted the necessity for more diagnostic centres. The GoI started awareness campaigns to educate the public about maintaining social distancing and covering the mouth when sneezing and personal hygiene. A vaccination drive was initiated in 2010 where public awareness was made through media outlets, however with time the campaign has virtually stopped. For 2015-2016, the CDC advised yearly influenza vaccination for everyone over the age of six months, which may have reduced the severity of the resurgent waves and following strains (13). Even in 2009, the CDC advised that healthcare workers who provide direct care to patients use gowns, gloves, face masks, disposable N95 respirators, and other protective equipment (40). The first indigenous swine flu Vaxiflu S33 and Nasovac was developed for children and adults in 2010. Oseltamivir, Tamiflu, Natflu and Starflu were also administered to suspect patients (41, 42). One of the reasons for the rapidity of the spread was that many people showed mild symptoms and never seek treatment. It has been seen that there is a sharp increase in the number of cases observed followed by an equally sharp decline. Even when the swine flu pandemic came back in 2015, people were affected with a death rate of over 6.63% compared to the global mortality of 0.02% (in 2009) (43). This was despite the claim of health officials of improved competency to deal with influenza outbreaks, such as improved diagnostic and treatment facilities, formulated guidelines. Free testing and vaccinations were provided for all patients with the state ensuring that there was adequate stock of vaccines, diagnostic tools, medication and masks. As expected, there was criticism of the crisis management with several activisms against the government. The number of swine flu cases increased in the months of July-December 2009 (44) which suggests that there might be a chance that the number of COVID-19 cases would also increase.

COVID-19 was declared a pandemic by WHO on 11 March and the initial screening is where it is believed that the current government was not proactive to curb the entry of the virus inside the country. The initial response of the GoI was to issue a travel ban to and from China, Korea, Iran, Japan, Italy, France, Spain and Germany (7) and those already having a travel history were quarantined for 14 days. Hence there was a surge of cases in Kerala where thousands of people from the middle east caused the transfer of the virus through the community. There was also the occurrence of religious congregations which caused increased cases. The government however can be credited for forcing the lockdown which did not happen earlier which caused the number of cases to be considerably reduced. An intense awareness campaign highlighting personal hygiene, social distancing, ban on the social gathering, contact tracing was initiated followed by lockdown from 24 March 2020. The national strategy to combat COVID-19 has been one of containment (quarantine, isolation, contact tracing, etc.) along with thermal screening at international airports, seaports, and advising people not to travel to countries that are hotspots for COVID-19 (5), which would work out if the pathogen has a slow transmission capacity (4).

There was generally a nationwide response during pandemics, but efforts faded immediately after the pandemic when political commitment and resources earmarked to bolster epidemic responses were moved to economic reconstruction. India's National Health Policy (2017) pledges 2.5% of GDP to health investment by 2025, which is much less than other developed countries (45). A National Pandemic Preparation Plans (NPPP) needs to be prepared along with a platform to monitor the state of preparation, provide policy guidance, and put sufficient resources into its operation. People-private partnerships should be promoted to make healthcare services more accessible to the general public. There's also the possibility of a socioeconomic relationship between the spread of both pandemics, which wasn't looked into in this study but will be in future research.

CONCLUSION

A large scale outbreak that spreads rapidly would take any country by surprise as seen in several European countries. There is still scope for improvement with regards to the preparedness and response for pandemics. There should be increased screening, surveillance, augmented outbreak preparedness and response as well as influenza vaccinations. The analysis conducted by this project suggests that the initial response to COVID-19 was unsatisfactory and hence subsequent strict measures such as lockdown had to be enforced. If the initial screening was properly done and efforts made to ensure that there was no religious congregation, the number of cases would have decreased drastically as predicted and the situation would not have been so dire. The lack of flu vaccination programs in the country also makes the general populace vulnerable to new viral strains. Strengthening the surveillance especially of overseas travellers should also be done more strictly. Investments in health sectors give significantly greater returns, thus public health must be elevated higher on the national development agenda.

ACKNOWLEDGEMENT

The authors wish to acknowledge the CHRIST (Deemed to be University), Bangalore, India for providing the computational infrastructure.

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