Review

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Overview of the characteristics of and responses to the three waves of COVID-19 in Japan during 2020-2021

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SUMMARY The first case of COVID-19 in Japan was reported on 16 January 2020. The total number of the infected has reached 313,844 and the number of deaths has reached 4,379 as of 16 January 2021. This article reviews the characteristics of and responses to the three waves of COVID-19 in Japan during 2020-2021 in order to provide a reference for the next step in epidemic prevention and control. The Japanese Government declared a state of emergency on 7 April 2020, which suppressed the increase in the number of the infected by curtailing economic activity. The first wave peaked at 701 new cases a day and it decreased to 21 new cases on May 25 when the state of emergency was lifted. However, the number of the infected increased again due to the resumption of economic activity, with a peak of 1,762 new cases a day during the second wave. Although the situation was worse than that during the first wave, the government succeeded in limiting the increase without declaring a state of emergency again, and that may be attributed to a decrease in crowd activities and an increase in the number of inspections. During the third wave, the number of the infected continued to exceed the peak during previous waves for two months. Major factors for this rise include the government's implementation of further policies to encourage certain activities, relaxed immigration restrictions, and people not reducing their level of activity. An even more serious problem is the bed usage for patients with COVID-19; bed usage exceeds 50% not only in major cities but also in various areas. On 7 January 2021, 5,953 new cases were reported a day; this greatly exceeded the previous peak, and the state of emergency was declared again. Although Japan has been preparing its medical system since the first wave, maintaining that system has imposed a large economic burden on medical facilities, hence stronger measures and additional support are urgently needed to combat COVID-19 in the coming few months.

Keywords COVID-19, pandemic, epidemic, wave, Japan

1. Introduction

The COVID-19 outbreak is characterized as a global pandemic. According to the weekly epidemiological update released by the World Health Organization (WHO) on 29 December 2020, the total number of the infected had reached 79,231,893 and the death toll had increased to 1,754,754 globally (*1*). Every country is implementing its own measures to control the number of the infected (*2-8*). Although the number can be limited by temporary lockdowns or prohibitions on going out, the number of the infected has increased again as control measures are lifted.

Japan is one of the countries where the number of deaths per capita has remained low, but like in other countries there are signs of an increase in the infected as economic activity increases after restrictions are lifted. The first case of COVID-19 in Japan was reported on 16 January 2020. The number of the infected was almost 0 for one month, but that number gradually increased and it rose substantially starting in the middle of February. Afterwards, the number of the infected reached three peaks. On 31 December 2020, Japan reported 3,851 new cases (*9*), the highest daily tally over the past year. On 7 January 2021, 5,953 new cases were reported (*10*); this greatly exceeded the previous peak, and Japan issued a state of emergency again for the next 31 days (from 8 January to 7 February 2021) (*11*). The total number of the infected has reached 313,844 and the number of deaths has reached 4,379 as of 16 January 2021 (*12*).

Figure 1 shows the number of the infected in Japan from 16 January 2020 to 16 January 2021. There have been three waves of substantial increases in the number of the infected so far, and the national government and

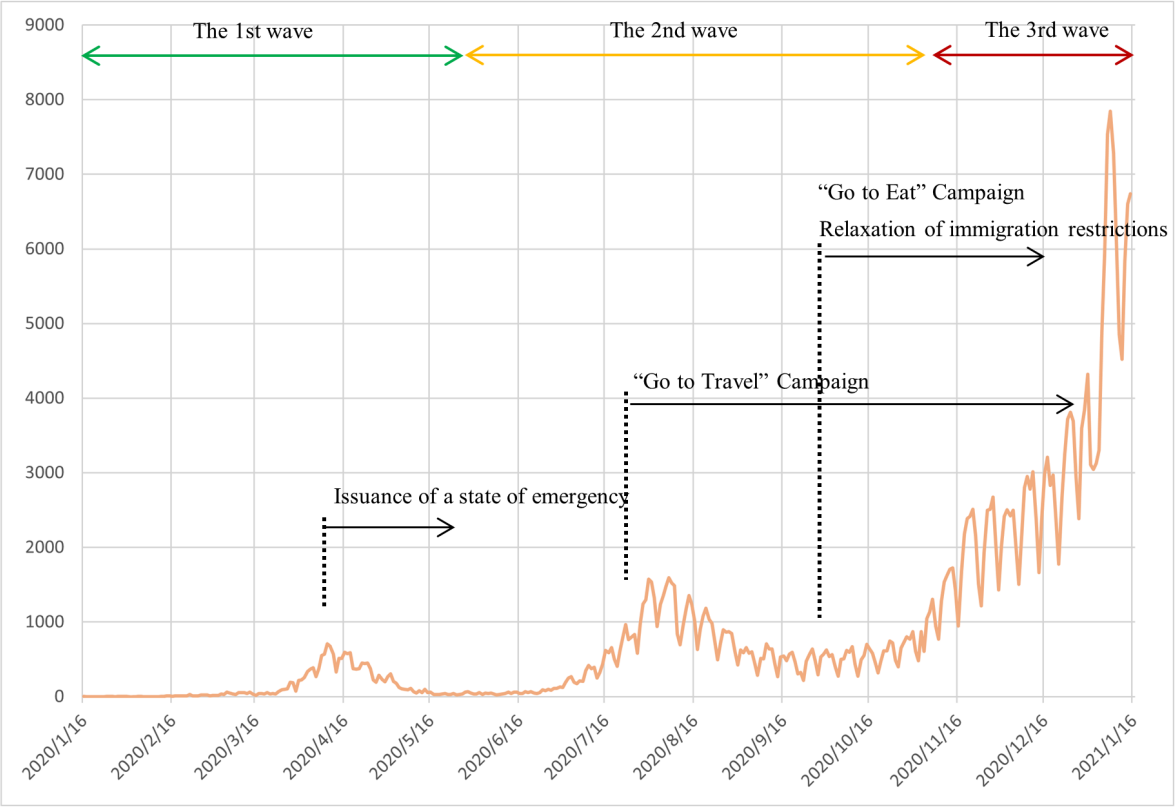

Figure 1. Number of people reported with COVID-19 from 16 January 2020 to 16 January 2021 in Japan. The first case of COVID-19 in Japan was reported on 16 January 2020. The total number of the infected reached 313,844 and the number of deaths reached 4,379 by 16 January 2021. On 7 April 2020, the Japanese Government declared a state of emergency; on 7 January 2021, the Japanese Government declared a state of emergency again. Data source: *https://www.mhlw.go.jp/stf/covid-19/kokunainohasseijoukyou.html#h2_1*

local governments have implemented different infection control measures during each phase. Japan has also implemented policies to mitigate the impact of those infection control measures on the Japanese economy. The current article summarizes the epidemic in Japan and measures implemented from 2020 to the present to provide a reference for the next step of epidemic prevention and control. Sections 2-4 summarize the countermeasures and economic measures implemented during each of the three waves of COVID-19 in Japan. Section 5 summarizes the usage of the medical system that Japan has built to combat COVID-19 and the impact of the disease.

2. The 1st wave of the outbreak in Japan

The first COVID-19 epidemic in Japan began in mid-February. At the time, there were fewer than 30 infected per day, and there were only local outbreaks of the disease. Because of the limited number of the infected, the main measures implemented were investigation of potentially infected individuals, PCR testing, and segregation. COVID-19 poses a high risk to the elderly, and Japan, which has an aging society, focused on avoiding a shortage of medical resources and reducing deaths due to COVID-19.

Specific measures were the establishment of criteria for medical consultations and PCR testing if an individual had a fever (*13,14*). In addition, the decision was made to close schools in late February (*15*). Japan also called on the public to wear masks, telework, shift work hours, refrain from holding events, and avoid contact with other people in order to reduce transmission (*16*). After the government's announcement, some companies switched to telework. As a result, the number of subway passengers during commuting hours in March in Tokyo decreased by up to 24% compared to January (*17*). Figure 2 shows changes in the percentage of commuters during commuting hours in Tokyo. In addition, immigration restrictions were imposed to prevent an influx of infected people from overseas.

Although these measures were implemented, the number of the infected per day exceeded three digits in early April. Therefore, the Japanese Government declared a state of emergency on 7 April (*18*). Many restaurants and companies complied with this order, reducing the time people spent outside their homes by reducing business hours and shifting to teleworking. A reduction of up to 68% in the number of subway passenger during commuting hours in April and May indicates that many people have complied with the state of emergency (*17*). The state of emergency limited the increase in the number of the infected from May, and on 25 May the number of new reported cases decreased

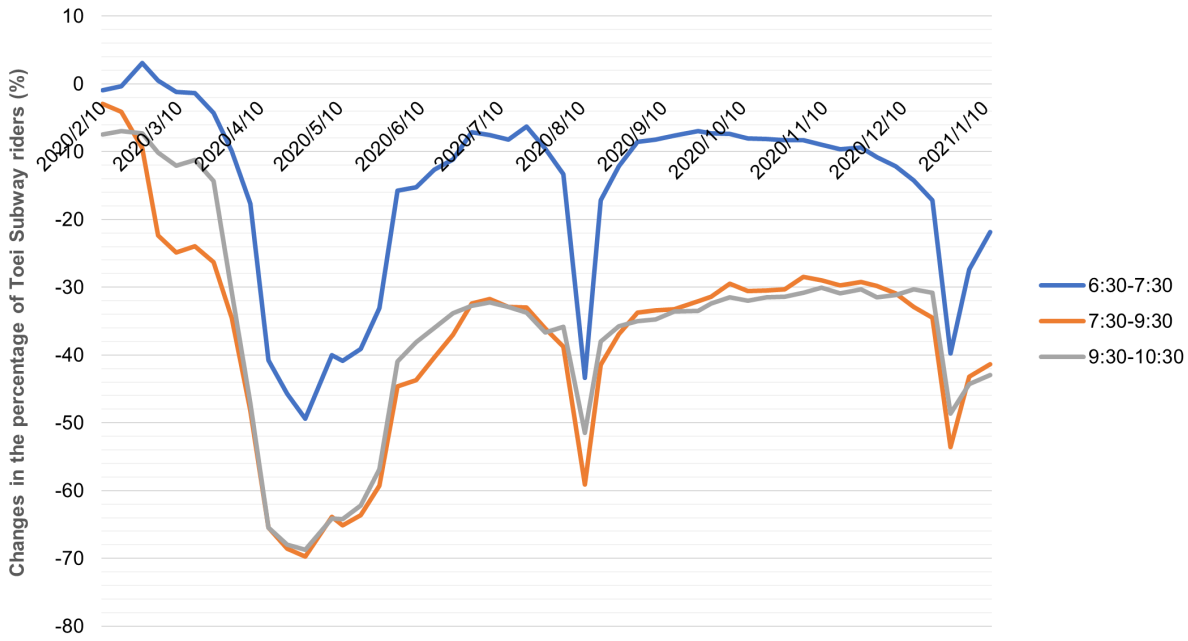

Figure 2. Changes in the percentage of Toei Subway riders during commuting hours based on the average number of riders from 10 February 2020 to 14 January 2021 in Tokyo. The number of subway passengers during commuting hours decreased significantly during the first wave. The number of commuters decreased in response to the rapid increase in the number of infected during the second wave. However, there was no decrease in the number of commuters during the third wave. Data source: *https://stopcovid19.metro.tokyo.lg.jp/cards/predicted-number-of-toei-subway-passengers*

to 21. In response to this calm, the government lifted the state of emergency (*19*) and people resumed their activities to dispel the economic consequences of the state of emergency.

3. The 2nd wave of the outbreak in Japan

The second wave was a very characteristic phase compared to the first wave, and although the peak in the number of the infected was larger than that during the first wave, it subsided without measures such as a state of emergency. The state of emergency was lifted on 25 May, and the national and local governments began to resume full-scale economic activity in order to recover from the effects of the decline in economic activity due to restrictions. Schools, which had been closed, were reopened (*20*) and the restrictions on nighttime business by restaurants were lifted in Tokyo (*21,22*). As these activities resumed, the number of people during commuting hours in Tokyo increased and reached the usual level for March. Many of the people were shifting from activities at home to going out.

There were fewer than 100 infected per day for one month after the state of emergency was lifted. As predicted by several simulations based on SIR models (*23-25*), the number of the infected increased at a stretch from the end of June once activities resumed, and the number of the infected per day exceeded 1,000 in late July. The number of the infected per day peaked during the second wave at 1,762, a number greatly exceeded the peak of 701 during the first wave. Although the situation was worse than that during the first wave, the government did not issue a state of emergency again, and some municipalities only called for restaurants to reduce their business hours starting in August in response to local outbreaks (*26,27*). Although major measures to control COVID-19 were not implemented, the number of the infected per day gradually decreased from mid-August. This is a major feature of the second wave. Observing the changes in the number of people commuting during commuting hours (Figure 2) indicates that the number of people commuting peaked from early July to mid-July and gradually decreased starting in late July. However, the decrease was slight, and by early August the number of people commuting decreased to the level in mid-June. In mid-August, however, the number of commuters decreased. This was because many companies closed during the Obon festival, which is a long holiday in Japan. Observing the decrease in the number of the infected in terms of changes in activity indicates that some people refrained from leaving their homes in mid-July, when the number of the infected per day reached about 700. As of the beginning of August, the increase in the infected began to decrease. In addition, the number of the infected decreased significantly because of the Obon festival since many people were less active.

The second wave subsided by early September, and the number of the infected per day had decreased to about 500. The number of commuters increased to the same level as in early July, when the number of the infected during the second wave began to increase. Unlike the second wave, however, the number of the infected did not

increase sharply again. There was no significant change until the end of October, and the number of the infected per day was constant. The reason why there was no increase like that during the second wave is presumably because of increased PCR testing. As of June, about 2,000 people per day were tested in Tokyo, but in July, when the number of the infected increased, 4,000 people per day were tested; since August, 6,000 people have been tested per day (*28*). The extensive testing at that time – when the infected decreased because of the temporary drop in activity caused by the Obon festival – was able to detect the infected early and to eliminate the chance of them transmitting SARS-CoV-2 to others. As a result, the increase in the number of the infected was kept to a certain level, and that was maintained until the end of October.

4. The 3rd wave of the outbreak in Japan

During the third wave, the number of the infected has increased since early November 2020, and as many as 3,000 new cases were reported on 16 December. During this wave, the number of the infected increased for some reason, as it did during the early stage of the second wave. Unlike during the second wave, there are no signs that the increase in the number of the infected during this third wave will decrease in December, which is more than a month after the increase in the number of the infected. The government did not declare a state of emergency, and local governments only called for reduced business hours and limited activities (*29,30*). These orders to reduce business hours were implemented starting in December, one month after the infection began to increase, as occurred during the second wave. The order had no significant effects, and the number of the infected increased.

One of the major factors behind the continuous increase in the number of the infected during the third wave is that people had not reduced their level of activity. During the second wave, the number of commuters decreased in response to the rapid increase in the number of the infected, but there was no decrease in the number of commuters during the third wave, as shown in Figure 2. The number of commuters remained about the same as the number of commuters in October even though the number of the infected increased sharply. In September and October, about 500 infected were reported every day, so people seemed inured and they continued their activities even though the number of the infected increased rapidly. In addition, there was no opportunity for a temporary decrease in activity because of no long holidays like the Obon festival. In Tokyo, about 8,000 people per day were tested starting in November. Testing is increasing, but it is not sufficient to limit the increase in the number of the infected, and a larger number of people might be infected than during the second wave. That said, increased testing does not appear to be sufficient if it is not effective in reducing crowd activities.

There are several possible causes for the increase in the number of the infected in Japan. One possible cause is "Go To" campaign, which encourages travel and dining out to encourage economic activity (*31*). As part of this campaign, the government will bear some of the costs when traveling or dining out. The travel campaign started on 22 July 2020. Travel to Tokyo was initially excluded from the campaign but it was included starting in October. The dining out campaign also started in October. As of October, when the campaign started in earnest, the number of the infected per day was constant, but the number of the infected per day started to increase in early November. Another possible cause is that Japan gradually relaxed immigration restrictions starting on 1 October 2020 (*32*). As of 1 October, 215,599 people had undergone PCR testing in airport quarantine; of those, a total of 951 tested positive (*33*). As of 31 December, a total of 403,864 people had been tested, and a total of 1,871 tested positive (*34*). As of 1 July, 76,268 people had undergone PCR testing in airport quarantine; of those, a total of 314 tested positive (*35*). In the 3 months before relaxed immigration restrictions (1 July – 1 October), positivity for SARS-CoV-2 was 0.46%; in the 3 months after relaxed immigration restrictions (1 October – 31 December), positivity for SARS-CoV-2 was 0.49%. Thus, there was little difference in positivity. The aforementioned factors cannot be definitively identified as the cause of the sharp increase in the number of the infected. However, policies to encourage activities may have disturbed the calm after the second wave subsided.

5. The impact of COVID-19 on medical facilities

The Japanese Government has implemented measures mainly intended to reduce the number of deaths. This section summarizes the medical system that Japan has built to fight COVID-19 and the impact of COVID-19 on medical facilities and workers. The Japanese Government began to prepare its medical system in March, when COVID-19 began to spread, in case the number of the infected peaked in the future. In order to prevent the transmission of COVID-19, Japan created dedicated wards for patients with the disease while securing dedicated accommodations for asymptomatic patients. As of 27 May, Japan had about 18,000 beds and about 19,000 rooms available nationwide for patients with COVID-19.

Figures 3 and 4 summarize bed usage for patients with COVID-19 and severe COVID-19 in Hokkaido, Kanto, and Kansai (*36*). Since peaks during the first and second waves were small and the waves were brief, the medical system had breathing room. During the third wave, however, the medical system was in crisis. During the third wave, there were more infected than

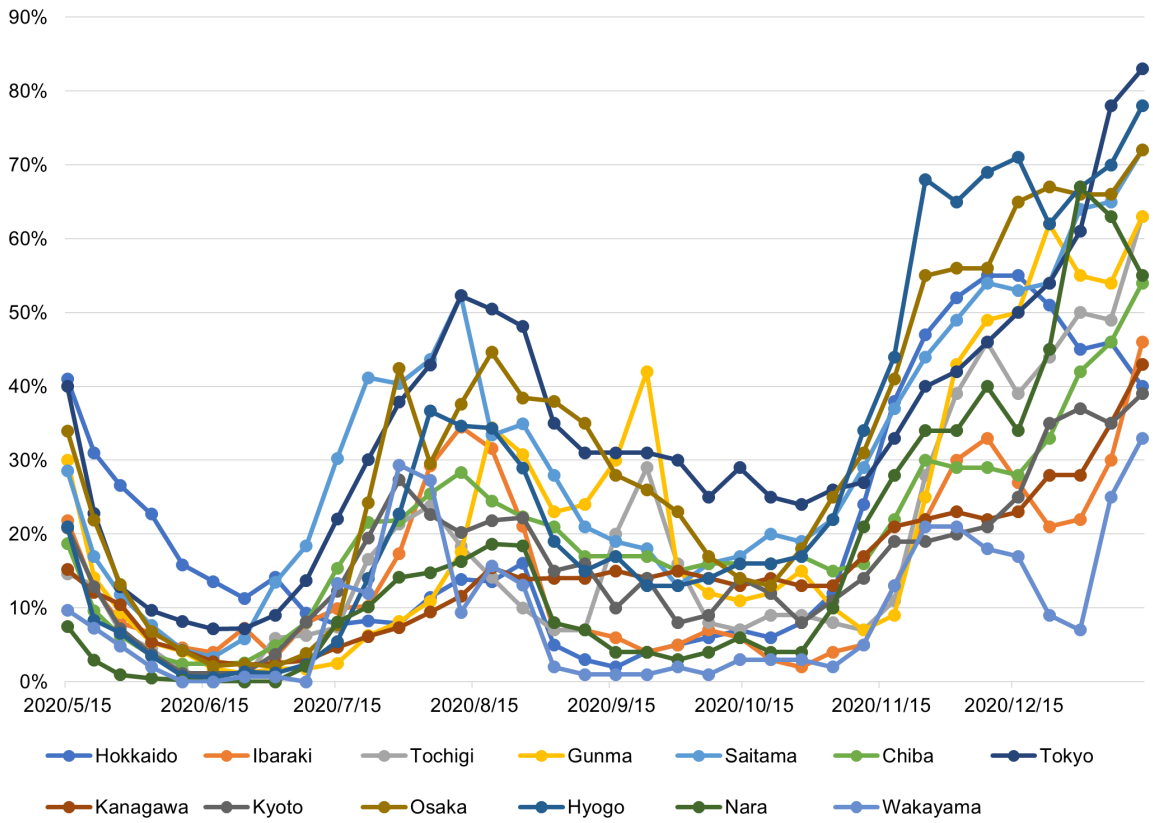

Figure 3. Bed usage rate in each region with respect to the number of beds allocated to patients with COVID-19. Data source: *https://www.mhlw.go.jp/stf/seisakunitsuite/newpage_00023.html*

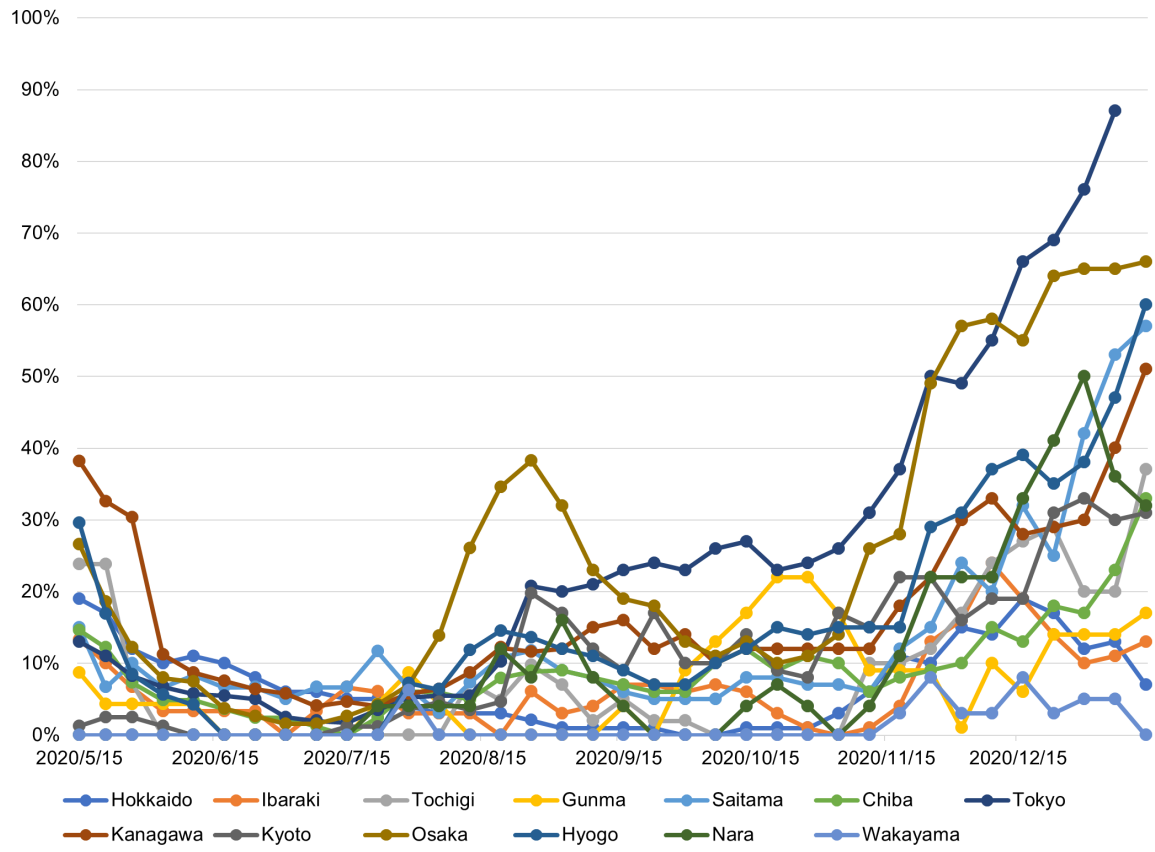

Figure 4. Bed usage rate in each region with respect to the number of beds allocated to patients with severe COVID-19. Data source: *https://www.mhlw.go.jp/stf/seisakunitsuite/newpage_00023.html*

Table 1. Average monthly number of patients, amount of profit and loss for medical facilities that responded to a survey on the fiscal status of hospitals during COVID-19 pandemic (profit and loss is in units of 1,000 yen)

Items	April		May		June		July		August		September	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Total number of outpatients	9,181	7,418	8,994	6,801	8,934	8,287	9,941	8,797	9,424	8,289	9,049	8,587
Total number of inpatients	6,684	6,005	6,761	5,799	6,640	5,922	6,985	6,398	7,030	6,460	6,707	6,259
Profit and Loss (all hospitals with valid responses to the survey)	7,374	-42,279	20,102	-36,488	-32,745	-59,514	15,168	-7,691	24,207	2,400	-18,726	-10,646
Profit and Loss (hospitals not accepting patients with COVID-19)	6,159	-11,870	11,284	-8,553	-11,848	-21,435	7,120	-2,308	10,993	2,848	-7,221	-1,502
Profit and Loss (hospitals accepting patients with COVID-19)	9,685	-100,088	36,656	-88,932	-75,905	-138,161	35,299	-21,157	50,364	1,513	-43,816	-30,586

Data source: *https://ajhc.or.jp/siryo/20200806_covid19ank.pdf; https://ajhc.or.jp/siryo/20201112_covid19ank.pdf*

the peak number reported during the second wave. As of 16 December 2020, bed usage by patients with COVID-19 exceeded 50% in major regions such as Hokkaido, Gunma, Saitama, Tokyo, Osaka, and Hyogo. Even in late December, bed usage was on the rise in areas other than Hokkaido, and it is also increasing in other areas. If this continues, it will have a major impact on the medical system. Not only are usage rates rising in large cities such as Tokyo and Osaka but also in rural prefectures where many beds cannot be prepared. Despite its aim of reducing the number of deaths, Japan did not implement strong COVID-19 countermeasures during the third wave, leading to the current crisis. Stronger control measures need to be urgently implemented.

While medical facilities and staff have doing their utmost to combat COVID-19, they have also suffered financially and from fatigue. According to a survey of the fiscal status of hospitals (*37,38*) as shown in Table 1, the average number of outpatients and inpatients at responding medical facilities decreased by more than 10% in April and May, when the state of emergency was declared, compared to 2019. Although some outpatients returned in June after the state of emergency was lifted, the number of inpatients did not change significantly, and the number of outpatients decreased again in July and August during the second wave. The fiscal state of medical facilities has also deteriorated compared to the previous year, and medical facilities that accept patients with COVID-19 are losing significantly compared to medical facilities that do not. Hospitals that allocate beds to patients with COVID-19 had higher labor costs and higher medical costs compared to the same period last year. As with the number of outpatients, significant losses occurred in April and May during the state of emergency. The government has been providing assistance to medical facilities that accept patients with COVID-19 and healthcare that treat them since June (*39,40*). If, however, increased bed usage continues for a long time like it did in April and May, then it seriously impact medical facilities.

6. Conclusion

In Japan, peaks in COVID-19 infection were suppressed immediately during the first and second waves, but the number of the infected has exceeded the previous peaks for two months during the third wave. In addition, bed usage by patients with COVID-19 exceeds 50% not only in major cities but also in various areas. During the first wave, Japan implemented a major measure by declaring the state of emergency. Due to the large economic impact, Japanese government was not able to implement measures to significantly reduce people's activities subsequently, instead, the government initiated a campaign to support economic activity. During the third wave, bed usage by patients with COVID-19 is a pressing problem because of the unprecedented number of the infected. Although Japan has been preparing its medical system since the first wave, maintaining that system has imposed a large economic burden on medical facilities, hence stronger measures and additional assistance are urgently needed to combat COVID-19 in the coming few months.

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