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Introduction

It is generally believed that more people will commit suicide during times of social crisis when they face a difficult situation; however, the reality is not that simple. It is well-known that the suicide rate decreases during a war despite the adverse situation (Thomas et al., 2010). Many studies show that an economic crisis leads to an increase in the suicide rate, but this impact varies depending on the particular economic crisis and the country (Chang et al., 2013; Huikari et al., 2019). It has previously been reported that the suicide rate among residents in the areas affected by the Great East Japan Earthquake was lower than in the areas not affected by the earthquake (Masaki et al., 2018). One study showed that male suicide rates in the affected areas increased significantly immediately after the earthquake, whereas female suicide rates declined slightly during the first year after the disaster (Orui et al., 2018). Another study reported an increase in post-earthquake suicide rates among women, and a decrease in these rates among men (Orui et al., 2014). A report showed that the suicide rate in the disaster area after the earthquake (which occurred at a time when the suicide rate in the entire country was on the rise) was relatively lower than that in the other areas (Chen et al., 2016). In light of these findings, it can be concluded that, when observing changes in the suicide rate during a social crisis, it is important to consider factors such as gender and region.

The 2019 coronavirus pandemic (COVID-19) is a rare catastrophe in recent years that has had a long-term effect on people worldwide. Several reports have already been published on the changes in the suicide rates during the COVID-19 pandemic. At the beginning of the pandemic, it was reported that there was no increase or decrease in the suicide rate in Japan (Isumi et al., 2020; Leske et al., 2021). Some studies even reported a decline in the suicide rate during the early stages of the pandemic (Anzai et al., 2021; Faust et al., 2021). However, later, a decrease and subsequent increase in the suicide rate, as well as a remarkable increase in the suicide rate among women have been reported during the pandemic (Nomura et al., 2021; Sakamoto et al., 2021; Tanaka and Okamoto, 2020).

Comparing the transition of the suicide rate after another social crisis with suicide rate transitions during the COVID-19 pandemic and clarifying the characteristics of the current pandemic can provide useful guidelines on how to deal with this increase in the suicide rate. Even within a single country, the proportion of people infected with COVID-19 and the mortality rate vary greatly depending on the region. Examining whether changes in the suicide rate during the pandemic differ by region may also provide useful insights into suicide countermeasures during this period.

Therefore, in order to develop and implement more effective suicide countermeasures in the future, this study compared the changes in the suicide rate after two major social crises in Japan, by gender and region. We observed the transition of the suicide rate after the Great East Japan Earthquake, which occurred on March 11, 2011, and during the COVID-19 pandemic.

Materials and Methods

Study design and data sources

This was a descriptive epidemiological study of suicide rates during social crises in Japan. Since the Great East Japan Earthquake occurred on March 11, 2011, we observed the monthly suicide rate in 2011 in order to determine the changes in the suicide rate after the earthquake. To clarify the annual suicide rate during the COVID-19 pandemic, we observed the monthly suicide rate in 2020. We used monthly

suicide data published by the National Police Agency (National Police Agency, Japan).

Measures

Japan's suicide rate is believed to be influenced by a variety of unexplained factors, which can change rapidly over the course of a year. In the years prior to the social crises analyzed in this study, 2010 and 2019, women accounted for less than half the number of suicides as men, at 29.7% and 30.2%, respectively. Therefore, if the difference in the rate is evaluated, the degree of change in the suicide rate among women may be overlooked. We decided to analyze rate ratios rather than rate differences in order to observe the changes in suicide rates during social crises. We used the ratio of the suicide rate in the year of the social crisis to the average regional suicide rate in the three years prior to the crisis year as an index to compare the characteristics of the increase or decrease in suicide rates by region. The suicide rate ratio during the crisis—the monthly suicide mortality rate in the year of the crisis divided by the average suicide mortality rate in the three years before the crisis—was used as the indicator.

Data analysis

The 95% confidence intervals for the ratio were calculated to determine any statistically significant increases or decreases in the suicide rate. The confidence interval was calculated using the formula for the relative risk confidence interval. We analyzed the suicide mortality ratio by region. For the earthquake, Japan was divided into four regions: prefectures that were affected by the earthquake, tsunami, or nuclear accident (3 prefectures); prefectures in contact with the three affected prefectures (7 prefectures); other prefectures that suffered some human casualties or damage to houses (12 prefectures); and prefectures that were not damaged or affected at all (25 prefectures). For the pandemic, Japan was divided into four regions: prefectures with a high mortality rate (10 or more deaths per 100,000 population; 14 prefectures) by September 30, 2020; medium mortality rate (4 or more and less than 10; 12 prefectures); low mortality rate (less than 4; 14 prefectures); and no deaths (7 prefectures). Statistical analyses were conducted using Excel 2019 for Windows (Microsoft, Redmond, WA, USA, 2019).

Ethical considerations

This study was conducted using publicly available data that did not include personal information, and therefore, an ethical approval from a review board was not required.

Results

After the earthquake, the suicide rate in March 2011 was 18% lower than the average mortality rate for the previous three years. It increased by 18% in May and 8% in June; increased mortality was particularly noticeable among women. The suicide rate began to decline after October 2011. The decrease in the suicide rate ratio after the earthquake was large in the affected and neighboring prefectures, but an increase in the suicide rate ratio after that was observed only in the prefectures where the damage was small and the prefectures where there was no damage (Table 1; Figure 1 and 2).

During the COVID-19 pandemic, a decrease in the suicide rate was observed from February to June

2020. The declines in April and May, when the first state of emergency in Japan was declared from April 7, 2020 to May 25, 2020, were significant at 20% and 18%, respectively. From July onwards, the female suicide mortality rate began to rise, and from October, the overall suicide rate, including both men and women, also began to increase. From June to September 2020, a second wave of the pandemic occurred in Japan. The rise in female suicide rates was significant, especially in October, with an increase of 70% (Table 2; Figure 3 and 4). October marked the beginning of the third wave of the pandemic, when the number of confirmed daily cases had begun to increase. The magnitude of decrease in the suicide rate ratio during the first state of emergency was large in the prefectures where there had been no deaths as of September 30, 2011. In the prefectures with high mortality rates for COVID-19, the suicide mortality ratio increased from August onwards. The increase in the suicide rate ratio from October to December was also large in prefectures with moderate to high COVID-19 mortality rates. The sharp increase in the suicide rate ratio in October was remarkable in prefectures with high COVID-19 mortality rates (Table 2).

Discussion

We observed trends in suicide rates during social crises in Japan. In the case of the Great East Japan Earthquake, the suicide rate increased for several months after an initial decline, and then began to decrease. In the case of the COVID-19 pandemic, the suicide rates first decreased and then began to increase. Since the pandemic has continued for a long time, it is expected that the suicide rate will continue rising. Based on our findings, the increase in suicide rates during social crises is higher and lasts longer among women.

In the affected areas after the earthquake, the suicide rate ratio decreased significantly, but a subsequent increase in the suicide rate was observed in the prefectures where there was little damage. Previous studies on suicide rates after the Great East Japan Earthquake have observed a decline in suicide rates in the affected areas (Chen et al., 2016; Masaki et al., 2018; Orui et al., 2015). There are reports that the suicide rate among men increased in the year of the earthquake (Orui et al., 2018), and conversely, that the suicide rate among women did not increase (Orui et al., 2014; Orui et al., 2018). In this study, we reconfirmed the decrease in the suicide rate in the disaster-affected areas; however, we observed an increase in the suicide rate in the areas that were less affected by the earthquake. Although the frequency of posttraumatic stress reactions and depression was reported to be high in the affected areas (Kino et al., 2020), the reason why the suicide rate ratio was not higher may be due to the fact that those who failed to escape the tsunami were those with suicidal tendencies; it may also be due to the activities of volunteers, supporters, and mental healthcare teams who came from all over Japan to support the survivors in the affected areas. In contrast, people whose daily lives were not greatly affected by the disaster may have learned about the tragedies and losses in the affected areas later, which may have impacted their mental health.

It has been reported by many studies that a decrease in suicide rates was observed in the early stages of the COVID-19 pandemic, and then an increase in suicide rates was confirmed, especially among women (Anzai et al., 2021; Faust et al., 2021; Leske et al., 2021; Nomura et al., 2021; Sakamoto et al., 2021; Tanaka et al., 2021). In the current study, we too found that the suicide rate decreased during the declaration of the first state of emergency in Japan, and then increased, especially among women. We

observed the same trends in the suicide rate as the other studies. Moreover, an increase in suicide rates was observed even in the prefectures where no COVID-19-related deaths occurred. Subsequent increases in suicide rate ratios were greater and longer lasting in prefectures with higher COVID-19 mortality. Since we studied monthly suicide rate ratios, we were able to detect a sharp increase in the suicide rate ratio, most noticeable in women, in October 2020. The suicide rate ratio during the COVID-19 pandemic was larger and lasted longer than that after the Great East Japan Earthquake. This allows us to infer that the pandemic has had a significant psychological impact on the Japanese population as a whole (Ammerman et al., 2021; Brenner et al., 2020). The different trends in suicide rates observed in this study during the two major social crises may be due to the characteristics and duration of the social crises themselves. In the case of the earthquake, several types of areas may have experienced the earthquake differently. For example, some experienced visible damage, such as damage to houses, some received refugees from the disaster area, and some that did not experience either situation. In the case of an COVID-19 pandemic, there is no visible material damage, but people all over Japan are in a state of anxiety, not knowing when they will be infected by an invisible pathogen, and not knowing when the pandemic will end. This difference is thought to have led to the differences in the impact on the mental health of the Japanese people.

One reason for the higher suicide rate ratio among women in the months following the crisis of the pandemic may be related to the higher rate of job loss observed during the COVID-19 pandemic among women and the increased number of domestic violence cases during this period (Japan Broadcasting Corporation, 2020). Other hypotheses for the increase in suicide rates among women include the culturally held belief that women are more likely to feel lonely and that anxiety is heightened in female patients undergoing treatment for mental illness. There are currently no data to support either of these hypotheses.

Another possible reason could be that women are more easily influenced by celebrity suicides. It was reported that a famous 40-year-old actress committed suicide on September 27, 2020, leaving her nine-month-old child behind (Nikkei News Paper, 2020). It was speculated that the cause of the suicide may have been postpartum depression; this news may have had a psychological impact on many other women. In the weeks following this, from September to October 2020, the actress's name was searched on the Internet more than 23 million times. It is possible that the surge in women's suicide rates in October was related to the suicides of famous actresses, as celebrity suicide reports have been found to contribute to women's suicide rates. Compared to existing studies that show an increase of about 5%–13% in the number of suicides after a celebrity suicide report (Niederkrötenhaler, et al., 2020; Ueda et al., 2014), the 70% increase in the suicide rate seen among women in October 2020 is an extremely large one. It is possible that the synergistic effect of the fear that any citizen could become with the coronavirus disease and the suicide reports of famous celebrities brought about the extremely large increase in the suicide rate. In Japan, the COVID-19-related mortality rate is low compared to other countries; however, there has been a significant increase in the suicide mortality rate. Thus, there is an urgent need to promote measures to prevent suicide in such situations.

A major limitation of this study is that the cause of the increase or decrease in the suicide rate ratio could not be identified since a descriptive epidemiological method was used. However, in the midst of a

pandemic, it may be difficult to verify these reasons using advanced epidemiological methods, and therefore, we believed that it was first necessary to raise awareness of the increase in suicide rates.

Since it has been recognized that the impact of the COVID-19 pandemic on the mental health of the Japanese population as a whole is considerably larger than that of the Great East Japan Earthquake and may last longer, immediate suicide prevention measures are necessary. In this regard, we need to pay attention to the World Health Organization's guidelines on how to report the suicides of celebrities and entertainers (World Health Organization, 2017). In particular, measures to prevent suicide among women are urgently needed. Counseling as suicide prevention via social networking sites and other Internet-based services is needed, as during a pandemic, people are required to avoid human contact. In addition, in order to implement evidence-based suicide prevention measures, epidemiologic studies need to be conducted to identify the risk factors for suicide.

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Figure Captions:

Figure 1. Trends in the suicide rate ratio after the Great East Japan Earthquake

Figure 2. Trends in the suicide rate ratio after the Great East Japan Earthquake by region

Figure 3. Trends in the suicide rate ratio during the COVID-19 pandemic

Figure 4. Trends in the suicide rate ratio during the COVID-19 pandemic by region