PSYCHIATRIA ET NEUROLOGIA JAPONICA

Statistical Compilation

Trend in the Suicide Rate Following the Great East Japan Earthquake: An Eight-year Follow-up Study in Miyagi Prefecture

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Abstract

The devastating Great East Japan Earthquake (GEJE) and tsunami disasters led to the mandatory evacuation of thousands of residents of the affected region. Consequently, evacuees were forced to live under very stressful conditions while at the same time facing the loss of their relatives, houses and jobs, and having to adjust to new circumstances. In our previous study, we found that there was a delayed increase in the male suicide rate in the affected area 1.5 years after the GEJE. In the recovery phase following the earthquake, a number of policy changes (such as the termination of the provision of free temporary housing to the evacuees) may have worsened the already fragile mental health of the evacuees and increased the incidence of suicide. However, despite such changes in environmental factors in the recovery phase following natural disasters, long-term monitoring of suicide rates has been limited. This study sought to monitor the suicide rate in the affected area of Japan during the recovery phase after the GEJE. The study had a descriptive design, and monitoring subjects were selected from the 14 municipalities in the coastal area of Miyagi Prefecture. Monthly suicide data were collected each municipality in Miyagi Prefecture, for the period March 2009 to February 2019. The suicide rate in the affected area was compared to the non-affected area using

a time-series analysis (12-month moving average). Although the increasing suicide rate was relatively small compared with the first increase the rates at 1.5 years after the GEJE (from 16.6 to 22.0/100,000 populations), there was a tendency to re-increase the rates gradually from 15.6 in June 2016 to 17.9 in January 2019, when the provision of free temporary housing was terminated. According to gender analysis, the male suicide rates increased around June 2016, and female rates showed a delayed increase about 1.5 years later than males. Although the specific reasons for the increase in suicide rates in the recovery phase were not determined, the termination of the provision of free temporary housing may have had an impact, according to our findings. The provision of temporary housing was terminated in stages, starting from June 2016, and this increased the financial hardship faced by needy evacuees. Moreover, re-separation and cutting of social ties made between the evacuees living in temporary housing may have also been a factor. Therefore, our findings suggest that careful monitoring of suicide rates, even in the recovery phase following a natural disaster, is important. We hope that our findings will be used to guide future policies regarding mental healthcare, both in the affected area following the Great East Japan Earthquake and in relation to future disasters.

Keywords: Great East Japan Earthquake, suicide, disaster mental health, descriptive epidemiology

Introduction.

The Great East Japan Earthquake, which occurred in March 2011, was the largest earthquake in recorded history, with a maximum seismic intensity of 7 on the Richter scale and a magnitude of 9.0 on the Richter scale, and a huge tsunami that caused extensive damage mainly in coastal areas. As a result, more than 123,000 residents of Miyagi Prefecture were forced to evacuate to temporary housing. Previous studies reported that the suicide mortality rate increases for a certain period of time after a large-scale disaster due to the experience of the disaster and the increased mental stress caused by the changes in living environment caused by evacuation[7)30)]. A previous study on the trend of suicide mortality in coastal cities and towns in Miyagi Prefecture during the three years after the Great East Japan Earthquake reported that the suicide mortality rate among males increased

1.5 years after the earthquake19). During the reconstruction period of the Great East Japan Earthquake, the environment surrounding the affected population changed markedly due to the re-segregation of the community following the relocation to new living locations, such as public housing for reconstruction, and the termination of economic support such as the end of temporary housing. However, there are only a limited number of studies that have monitored suicide mortality rates in disaster-affected areas during the post-disaster recovery period22). In this study, we examined trends in suicide mortality rates in 14 cities and towns that provided temporary housing in the tsunami-affected coastal areas of Miyagi Prefecture, focusing on the period after May 2016, when the provision of temporary housing began to end. In addition, we conducted long-term monitoring of suicide mortality rates in the disaster-affected areas for eight years after the earthquake to obtain basic data for suicide and mental health measures.

I. Method

The survey period was between March 2009 and February 2019. We used the National Police Agency's tentative monthly suicide statistics (suicide date and place of residence). Fourteen cities and towns were selected as the target area (coastal areas): Miyagino and Wakabayashi wards of Sendai City, Ishinomaki City, Shiogama City, Kesennuma City, Natori City, Tagajo City, Iwanuma City, Higashimatsushima City, Watari Town, Yamamoto Town, Shichigahama Town, Onagawa Town, and Minamisanriku Town (Figure 1)1). The 12-month moving average was used to smooth out the trend of the suicide mortality rate, as the number of suicides per month in the study area was small (fluctuating between 2 and 15 for males and between 0 and 10 for females) and to exclude the effect of seasonal variations. For the examination of suicide mortality rates in coastal areas by age group, two-year moving averages were used for smoothing. In both methods, the control was the inland areas of Miyagi Prefecture, and comparisons were made with cities and towns in the coastal areas. The population used to calculate the suicide mortality rate was based on the Basic Resident Ledger. We used a single regression analysis of the monthly number of occupants of temporary housing (the total number of occupants of emergency temporary housing, private rental housing, and other temporary housing, calculated by comparison with the same month of the previous year) published by the

Earthquake Disaster Relief Office of Miyagi Prefecture. In Iwanuma City, Sendai City, Shichigahama Town, Watari Town, Tagajo City, and Yamamoto Town, residents were given temporary housing until 2016 (five years). On the other hand, in Shiogama City, Minamisanriku Town, Kesennuma City, and Higashimatsushima City, residents were given temporary housing until 2017 and Ishinomaki City, Natori City, and Onagawa Town were given temporary housing until 2018. In addition, each municipality established special extension measures for those who were unable to move into their new homes due to construction schedules.

The present study falls under the category of descriptive epidemiology, which uses only information that has already been made anonymized. Therefore, the "Ethical Guidelines for Epidemiological Studies" (notified by the Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Health, Labour and Welfare), which stipulate respect for the dignity and human rights of individuals and protection of personal information, are not applicable.

II. Results

1. Using 12-month moving averages (Figure 3a, b)

The number and rate of suicide deaths in coastal areas, inland areas, and nationwide are shown in Table 1. The monthly suicide mortality rate using the 12-month moving average in the coastal areas significantly decreased in the period 1.5 years after the earthquake from 23.4 at the time of the earthquake to 16.1; however, it increased to 22.0 (per 100,000 population) over the next year or so. The suicide mortality rate increased gradually from 15.6 in June 2016 to 17.9 (per 100,000 population) in January 2019. The rate increased after May 2016, when the provision of temporary housing began to end; however, it was smaller than the increase in the first two years after the earthquake. In the second half of 2017, the suicide mortality rate, which had been lower than that of the inland areas, increased and remained higher than that of the inland areas after that.

In terms of sex, the suicide mortality rate for males was generally similar to that of the nation as a whole. After the earthquake, the suicide mortality rate declined for 1.5 years; however, after that it increased around May 2016 and exceeded the national level, when the provision of temporary housing began to end. The rate went from lower than that of inland areas to a higher level. A similar trend was observed in the females, as the rate also began to rise around 1.5 years after the earthquake; however, it then remained lower than

the national level, but began to rise around December 2017.

2. Examination by age group (Table 2a, b)

The suicide mortality rate by age group in the coastal areas is shown in Table 2a, b. The suicide mortality rate in the age group of 40-70 years old decreased significantly compared with the pre-earthquake period, and the trend was similar to that in the inland areas. In the inland areas, the suicide mortality rate in the 30s age group decreased compared with that before the earthquake, while that in the coastal areas remained almost unchanged compared with that before the earthquake. For males, there was no downward trend in the 30-39s age group in the coastal area compared with the inland areas, which was observed in the other age groups. For females, the age group of 80 years and older in the coastal area remained lower than that in the inland areas, but the trend was not as consistent and pronounced as that for the males.

3. Changes in the number of temporary housing residents (Figure 4a, b)

Figure 4a shows the number of temporary housing residents who evacuated to emergency temporary housing, private rental housing, and other temporary housing. The number of temporary housing residents has been decreasing over the years, and the number of residents at the beginning of the provision of temporary housing was large, so it was difficult to distinguish changes after the provision of temporary housing ended. As a result, since May 2016, when the provision of temporary housing began to end in Iwanuma, Sendai, Shichigahama, Watari, Tagajo, and Yamamoto, the decrease in the number of temporary housing residents was larger than the previous month. In May 2018, when the provision of the service was terminated in Ishinomaki City, Natori City, and Onagawa Town, the decrease was larger than in the previous month. We conducted a simple regression analysis of the percentage decrease in the number of residents compared with the same month of the previous year for the following periods: (1) April 2013 to April 2016, (2) May 2016 to April 2018, and (3) May 2018 to May 2019, for which data were available. As a result, the basic statistics were: 1) a mean change of -23.6% with a standard deviation of 5.9 for the 37-month period from April 2013 to April 2016, 2) a mean change of -55.4% with a standard deviation of 8.1 for the 24-month period from May 2016 to April 2018, and 3) a mean change of -85.5% with a standard deviation of 6.5 for the 13-month period from May 2018 to May 2019. Univariate regression

showed that the regression coefficients gradually increased to -0.487, -1.157, and -1.660 in each period, and the number of temporary housing residents gradually decreased in line with the end of the provision of temporary housing.

III. Discussion

1. Trends and background of suicide mortality in the recovery period after the Great East Japan Earthquake

Suicide mortality rates in the acute, medium-, and long-term periods following large-scale disasters, including the Great East Japan Earthquake, have been examined in previous studies such as the Great Hanshin-Awaji Earthquake in 1995,16), the Taiwan Earthquake in 1999,14) the Niigata-Chuetsu Earthquake in 2004,4) and trends in evacuation areas following the Great East Japan Earthquake and nuclear power plant accident18)19). Moreover, previous studies after the Great East Japan Earthquake and the evacuation zone after the nuclear power plant accident19) reported that the number of people who were affected by disasters increased after a certain period of time (one to two years), which is consistent with the results of the present study. It has been reported that the honeymoon period15), in which survivors are united by a strong sense of solidarity as they share the experience of a large-scale disaster and surviving it, and the strengthening of ties with the community due to the disaster16) may decrease the suicide mortality rate for a certain period of time. However, during the disillusionment period5), which lasts more than a year (sometimes several years) after the disaster, it has been reported that a "scissors gap" occurs between those who are making progress toward recovery and those who are left behind5). Thus, while the disaster area as a whole is making progress toward recovery and measures to rebuild the lives of disaster victims are underway, the recovery of disaster victims is delayed as a result of prolonged exposure to the stress caused by the marked changes in their living environment and posttraumatic stress disorder (PTSD), depression, alcoholism, and withdrawal. Some survivors continue to suffer from such psychiatric conditions5). The sense of isolation and helplessness caused by the "scissors gap" among disaster victims during the disillusionment period and the resulting deterioration in mental health may have contributed to the increase in suicide mortality.

The suicide mortality rate of the males and females in these areas has been higher than the national level since 2015, when the evacuation order was lifted. For females, the suicide mortality rate rose sharply in December

2017, after the lifting of the evacuation order, to the highest level since the disaster[22]. On the other hand, the suicide mortality rate for males began to rise from its previous downward trend around May 2016, when the provision of temporary housing began to end. The trend in Miyagi Prefecture was similar to the situation in the evacuation zone of Fukushima Prefecture, including the fact that the rate of increase was delayed for women.

The next section discusses the background of the increase in the suicide rate, although the causes cannot be clarified. Since the increase in the suicide mortality rate coincided with the end of the provision of temporary housing, our findings suggest that the increase was due to the end of financial support, such as the provision of temporary housing, and the separation of the community that had been established in the temporary housing.

In previous studies, it has been reported that men are more affected by a worsening economic situation and are more likely to have risk factors for suicide. As for the economic situation in the region as a whole, the effective ratio of job offers in Miyagi Prefecture has continued to increase since the earthquake, similar to that of the nation as a whole[9][11], and the number of corporate bankruptcies has not increased drastically[26]. Thus, this suggests that there has been no largescale deterioration in the economic situation in the prefecture as a whole. The termination of economic support, such as the termination of temporary housing provided free of charge under the Disaster Relief Act, may have had an impact on the survivors and may have worsened their mental health.

In addition to the termination of economic support, it is necessary to consider that social capital, such as social networks and relationships of trust among local residents, decreased when people moved to new living locations. In previous studies conducted after the Great East Japan Earthquake, it has been reported that social networks play an important role in mental health and that high social capital is useful for maintaining mental health[12][27]. After the Great East Japan Earthquake, social networks were separated by temporary housing and there were efforts to foster ties among evacuees in temporary housing through activities such as exercise classes, health classes, and salons. However, as shown in Figure 4b, the number of temporary housing residents decreased remarkably after the provision of temporary housing was terminated, and the community that had been built in the temporary housing may have separated again.

While the suicide mortality rate

decreased in other age groups after the earthquake, it remained almost the same in the 30s age group as before the earthquake. Although the direct relationship between the two has not been clarified, it has been reported that the workload in workplaces, including civil servants, increased immediately after the disaster, and there was a resulting deterioration of mental health2)20)25). Although this is a nationwide situation, the proportion of employees working 60 hours or more per week is highest among people in their 30s and 40s among all age groups10). Therefore, the direct response to the disaster and the increase in workload related to the disaster may have worsened their mental health. In addition to this background, a survey conducted in 2018 in Iwate Prefecture, which was also affected by the Great East Japan Earthquake, showed that the younger the age of the respondents, the higher the percentage of those who still had loans for houses and cars lost in the disaster6). Although this report was based on the situation in Iwate Prefecture, it is possible that the same situation is occurring in the coastal areas of Miyagi Prefecture. Thus, in addition to the increased financial burden caused by the earthquake, the financial burden caused by the termination of temporary housing may have had an impact.

On the other hand, in the age group of 40-70 years old, the suicide mortality rate has been decreasing almost consistently since the earthquake. The continuous increase in the ratio of effective job offers9)11), the economic situation reflected by the low level of corporate bankruptcies25), and the exemption of partial payment of National Health Insurance for disaster victims13)17) may have influenced the decrease in the suicide mortality rate after the earthquake.

2. The focus of support for disaster victims in the reconstruction period

In previous studies conducted after major disasters, it has been reported that the nature of the difficulties faced by disaster victims was not limited to temporary problems caused by the disaster, but by problems such as economic deprivation29). A previous study reported that unemployment and economic difficulties due to the Great East Japan Earthquake interfered with the recovery of mental health of the victims in Fukushima Prefecture21). Therefore, in addition to psychological support, there is a need for economic support and employment support for evacuees in need14)23). In addition, moving to a new living location, such as public housing, during reconstruction may have caused a separation of community ties and social networks,

which in turn may have increased suicide mortality. In addition to immediate community support, it has been reported that bridging social capital and linking social capital may lead to the process of overcoming disasters and revitalizing communities from a long-term perspective3). The isolation of elderly people in public housing for reconstruction after the Great Hanshin-Awaji Earthquake24)28) has also highlighted the issue that, even after moving to a new living base, it is important to build a network not only among affected residents, but also with existing local communities and organizations. In addition, it is necessary to continue to work on fostering "social capital", such as trust and human relationships, among local residents at various levels.

3. Limitations of the Study

In this study, we used data from the National Police Agency's suicide statistics of provisional numbers of suicides by month (date and place of residence), which are based on the place of residence at the time of the suicide. If suicides occur after evacuation or relocation to an inland municipality, they are recorded as inland deaths. Therefore, there is a possibility that the results are underestimated. Second, the examination of the causes and motives of suicide was limitaed. Suicide statistics can provide information on the causes and motives of suicide. If the number of suicide deaths collected by the municipality was mostly zero or one. The information were not open because of individual information protection. Finally, we examined the trend of the suicide mortality rate by focusing on the end of the provision of temporary housing, and found that the suicide mortality rate began to increase at the same time as the end of the provision of temporary housing and the decrease in the number of temporary housing residents, but as we were unable to derive a causal relationship from these results, there are certain limitations to the interpretation of the results. In addition, as shown in Figure 2, even in coastal municipalities, the deadline for the provision of temporary housing differs depending on damage and reconstruction status, so it is important to note that the provision of temporary housing ends in stages.

Conclusion.

There are only a limited number of reports on monitoring suicide mortality in disaster-affected areas during the recovery period after a large-scale disaster. In addition to other disaster-stricken areas after the Great East Japan Earthquake, the results of this study can be used as basic data for suicide and mental health measures

following disasters. As the suicide mortality rate may increase when the support system for disaster victims, such as the provision of temporary housing, comes to an end, it is necessary to provide support activities for disaster victims, specifically psychological support as well as economic and employment support, for those in need, and to continue and strengthen efforts to foster "social capital", such as trust and human relationships, among local residents. Based on these findings, the city of Sendai formulated a "Suicide Prevention Plan" in 2019, focusing on the victims of the Great East Japan Earthquake, and will revise the "Sendai City Post-Disaster Psychological Care Action Guidelines".

There are no conflicts of interest to be disclosed in relation to this paper.

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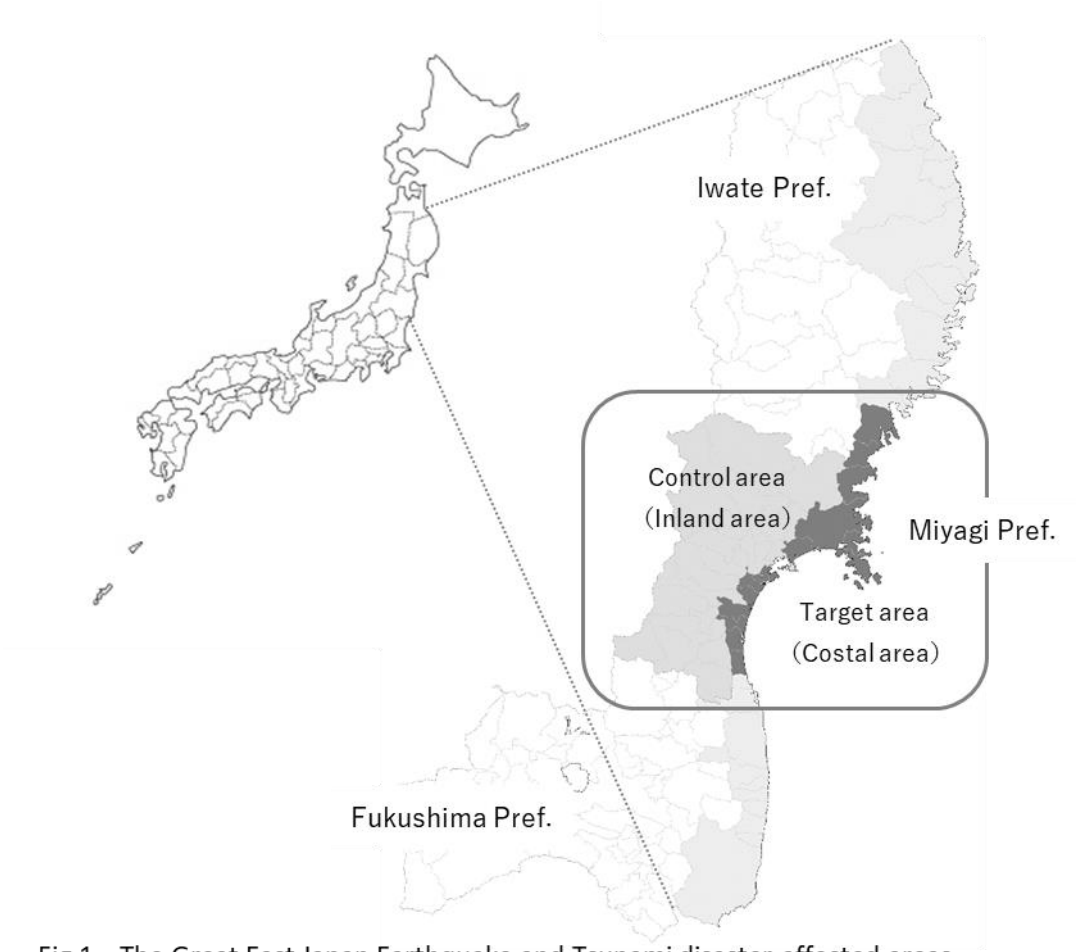
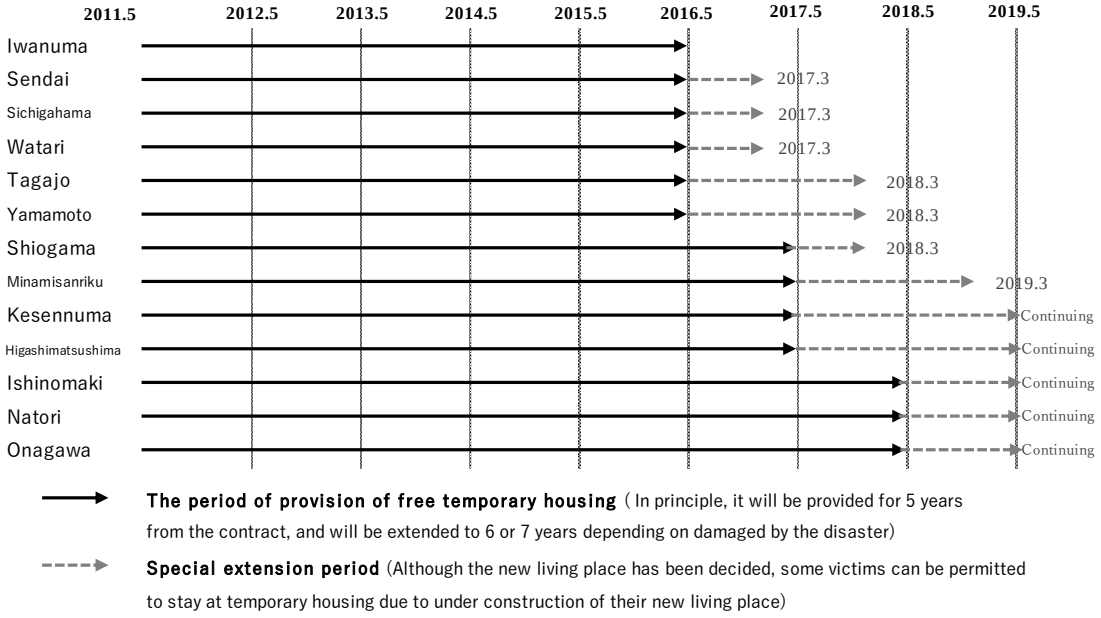
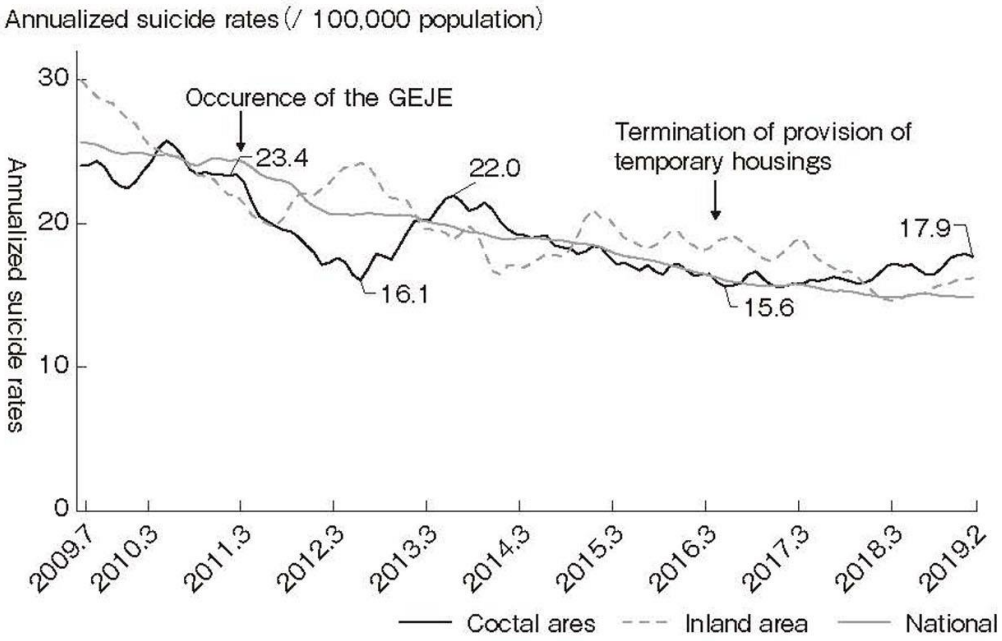


Fig 1. The Great East Japan Earthquake and Tsunami disaster-affected areas

Fig 2. The period of provision of temporary housing in the affected areas





Annualized suicide rates: monthly number of suicide cases/ population* 100,000* 12

Fig 3a The trend of suicide rates in costal and inland area (12-month moving average, 2009.7-2019.2) (Total)

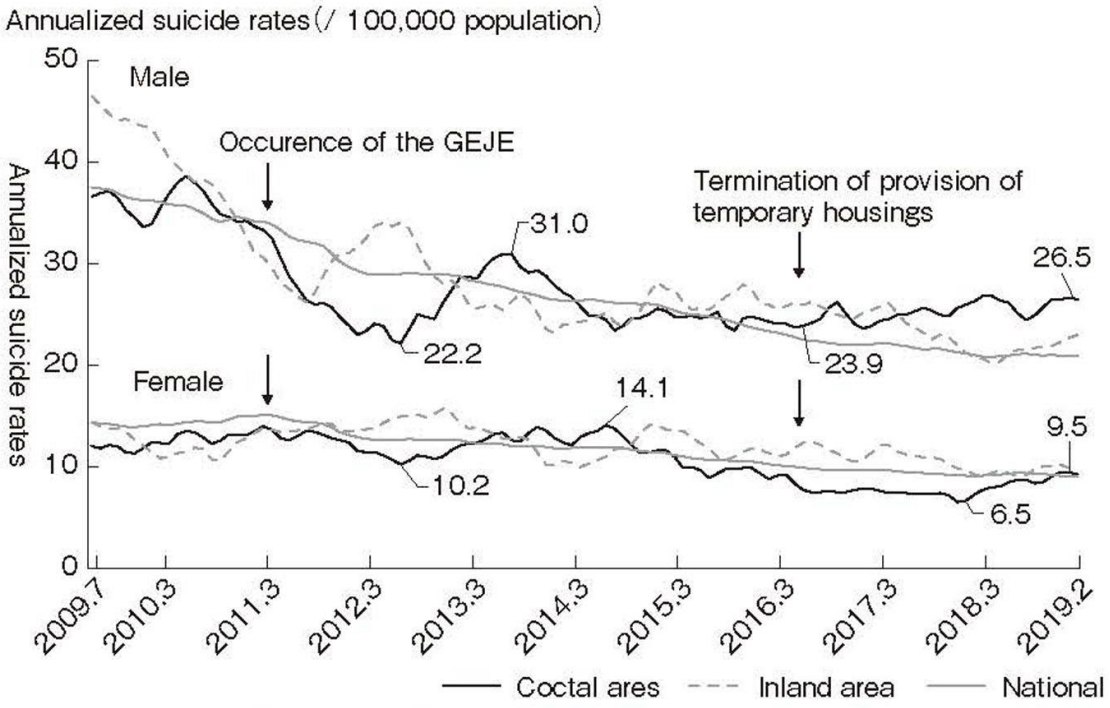


Fig 3b The trend of suicide rates in costal and inland area (12-month moving average, 2009.7-2019.2) (By gender)

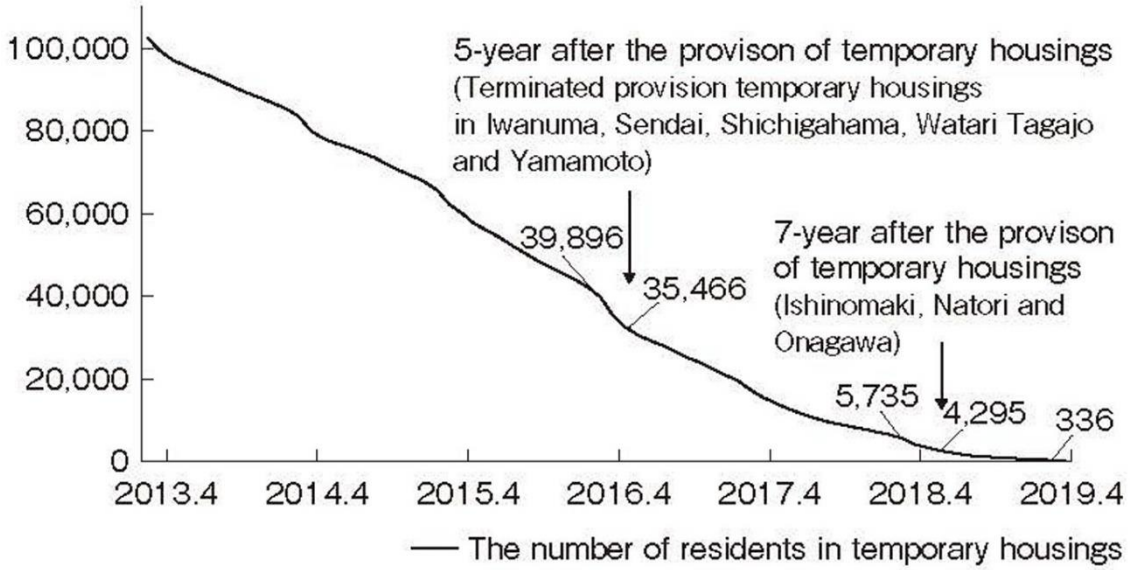


Fig 4a The trend of the number of residents in temporary housings

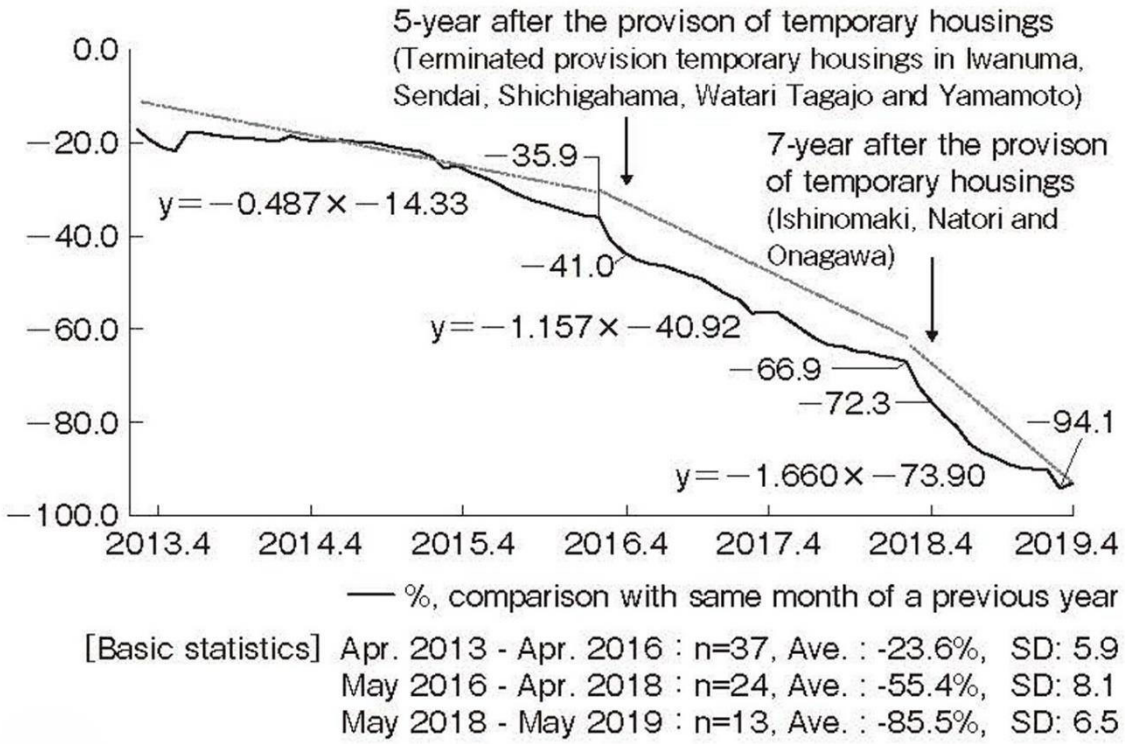


Fig 4b The trend of the number of residents in temporary housings (Comparison with same month of a previous year)

Table 1. Basic characteristic of monthly suicide cases and suicide rates (affected, non-affected areas, national) (March 2009- February 2019)

		Total			Male			Female		
		Median	Max.	Min.	Median	Max.	Min.	Median	Max.	Min.
Costal area	Suicide	14	28	6	10	21	2	4	10	0
	Suicide rates	18.6	36.1	8.0	27.2	55.5	5.5	10.4	26.0	0.0
Inland area	Suicide	23	48	8	17	30	4	7	18	0
	Suicide rates	19.8	41.2	6.7	28.9	53.1	6.9	11.6	30.0	0.0
National	Suicide	2,017	3,326	1,305	1,320	2,276	926	644	1,086	379
	Suicide rates	19.1	31.6	12.2	26.8	44.0	17.8	11.8	20.2	6.9

Table 2a. The trends of suicide rates in affected and non-affected areas (age category, total of men and women)

		Total															
		Suicide rates (/100,000 population)															
		Coastal area								Inland area							
	Period	≤ 19	20-	30-	40-	50-	60-	70-	≥80	≤ 19	20-	30-	40-	50-	60-	70-	≥80
Pre-	2009.3-2011.2	3.2	18.4	23.8	32.9	41.0	33.0	23.8	26.0	3.5	26.8	31.0	34.6	39.3	31.7	30.1	36.4
	2010.3-2012.2	2.6	18.9	23.3	27.5	31.3	28.5	27.5	26.7	2.2	27.9	29.5	33.5	32.3	30.1	29.9	35.5
Post-	2011.3-2013.2	2.1	22.4	23.6	23.2	20.4	21.6	23.9	18.7	1.8	31.4	31.3	31.1	27.9	29.8	29.2	30.8
	2012.3-2014.2	1.9	27.3	25.4	28.4	21.0	18.8	20.8	18.3	2.2	27.0	27.9	25.0	27.3	26.6	26.1	23.6
	2013.3-2015.2	1.9	21.2	22.5	31.8	26.9	18.7	20.6	24.8	3.0	25.9	22.3	24.3	29.0	21.3	23.5	32.1
	2014.3-2016.2	2.5	15.2	20.7	26.3	28.4	17.8	19.8	18.6	2.8	23.4	21.0	24.6	26.7	18.3	23.2	36.7
	2015.3-2017.2	3.5	12.7	24.5	25.1	20.2	16.0	20.4	13.4	1.6	22.7	19.8	23.4	23.2	19.1	21.3	28.1
	2016.3-2018.2	3.5	11.2	20.8	24.6	21.4	14.2	21.3	15.1	2.0	21.5	21.6	19.7	22.3	16.5	20.1	25.6
	2017.3-2019.2	1.9	16.8	22.3	18.2	22.3	17.3	17.3	20.6	3.1	21.2	19.7	17.2	21.2	12.9	17.9	26.8

Table 2b. The trends of suicide rates in affected and non-affected areas (age category, men and women)

		Male															
		Suicide rates (/100,000 population)															
		Coastal area								Inland area							
	Period	≤ 19	20-29	30-39	40-49	50-59	60-69	70-79	≥80	≤ 19	20-29	30-39	40-49	50-59	60-69	70-79	≥80
Pre-	2009.3-2011.2	3.4	21.9	39.4	52.2	65.7	52.6	35.6	37.4	3.8	35.6	46.6	54.8	69.1	50.6	50.7	46.8
	2010.3-2012.2	2.3	25.4	31.7	39.2	44.0	43.7	43.8	48.7	1.7	36.1	41.4	51.4	51.3	46.8	48.7	37.4
Post-	2011.3-2013.2	2.4	27.6	30.4	32.5	25.7	30.3	34.3	35.3	1.8	41.1	40.9	48.5	39.0	42.5	38.3	28.7
	2012.3-2014.2	2.4	37.7	41.3	37.0	28.9	26.1	29.5	29.1	2.7	31.5	37.4	38.8	40.1	36.8	36.2	26.6
	2013.3-2015.2	3.0	30.6	34.6	39.9	35.3	23.4	26.6	37.2	3.9	32.3	31.3	32.8	41.1	27.9	31.8	39.2
	2014.3-2016.2	4.3	18.5	31.9	36.6	39.0	21.7	25.0	18.0	3.9	34.5	29.1	34.2	39.9	25.1	27.3	47.3
	2015.3-2017.2	5.5	19.7	40.7	40.5	29.7	21.4	27.4	12.9	1.2	34.7	28.1	35.2	33.4	26.5	24.9	43.1
	2016.3-2018.2	5.0	19.9	34.1	38.1	34.5	21.8	28.9	24.7	2.4	30.9	30.3	30.9	30.1	23.9	25.9	30.8
	2017.3-2019.2	2.5	23.3	36.0	28.0	37.1	24.7	25.2	37.1	4.0	28.3	31.0	28.5	32.9	19.5	21.5	20.1
		Female															
		Suicide rates (/100,000 population)															
		Coastal area								Inland area							
	Period	≤ 19	20-29	30-39	40-49	50-59	60-69	70-79	≥80	≤ 19	20-29	30-39	40-49	50-59	60-69	70-79	≥80
Pre-	2009.3-2011.2	3.0	14.8	7.6	13.0	16.3	14.5	14.5	20.2	3.2	17.9	15.1	14.4	9.8	13.5	14.2	31.0
	2010.3-2012.2	3.0	12.4	14.5	15.4	18.5	14.1	14.5	15.6	2.7	19.8	17.5	15.6	13.7	13.8	15.2	34.5
Post-	2011.3-2013.2	1.9	17.1	16.6	13.7	15.1	13.3	15.6	10.3	1.8	21.7	21.6	13.5	17.1	17.4	22.0	31.9
	2012.3-2014.2	1.3	16.7	8.9	19.5	12.9	11.8	13.8	12.6	1.6	22.4	18.3	11.1	14.7	16.6	18.1	22.0
	2013.3-2015.2	0.6	11.6	9.8	23.3	18.3	14.1	15.6	18.3	2.0	19.5	13.1	15.6	17.1	14.8	16.8	28.4
	2014.3-2016.2	0.6	11.7	9.1	15.5	17.6	14.1	15.5	19.0	1.6	11.9	12.7	14.8	13.5	11.7	19.9	31.2
	2015.3-2017.2	1.3	5.4	7.6	8.9	10.6	10.8	14.7	13.7	2.1	10.2	11.3	11.4	13.2	11.9	18.2	20.1
	2016.3-2018.2	2.0	2.2	6.9	10.3	8.1	6.8	15.0	10.0	1.7	11.8	12.7	8.2	14.6	9.3	15.3	22.8
	2017.3-2019.2	1.3	10.0	8.0	7.8	7.2	10.1	10.7	11.7	2.1	13.7	8.1	5.5	9.7	6.6	14.7	30.3