Excess All-Cause Deaths during Coronavirus Disease Pandemic, Japan, January–May 2020[1]

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To provide insight into the mortality burden of coronavirus disease (COVID-19) in Japan, we estimated the excess all-cause deaths for each week during the pandemic, January–May 2020, by prefecture and age group. We applied quasi-Poisson regression models to vital statistics data. Excess deaths were expressed as the range of differences between the observed and expected number of all-cause deaths and the 95% upper bound of the 1-sided prediction interval. A total of 208–4,322 all-cause excess deaths at the national level indicated a 0.03%–0.72% excess in the observed number of deaths. Prefecture and age structure consistency between the reported COVID-19 deaths and our estimates was weak, suggesting the need to use cause-specific analyses to distinguish between direct and indirect consequences of COVID-19.

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) first appeared in December 2019 in Wuhan, China, and has rapidly led to a global pandemic (*1*). Globally, accurate figures on deaths caused by coronavirus disease (COVID-19) have been difficult to obtain because of limited availability and quality of virus testing (*2*,*3*) (Y. Yang et al., unpub. data, https://www.medrxiv.org/content/10.1101/2020.02.11.20021493v2); it is generally accepted that many deaths caused by COVID-19 have not yet been recorded (*4*). Lockdown measures are in place in many countries and regions around the world, but such measures can lead to reduced access to health services, exacerbating chronic diseases and delaying response to acute diseases (*5*). Access to hospitals for elective surgery may also be hampered by the collapsing medical system associated with the increased number of COVID-19 patients (*6*). The cause of death, especially among elderly persons in care homes or living alone, may not be adequately diagnosed or even recorded during a pandemic situation (*7*).

When comprehensive testing is lacking, the mortality burden of a new pandemic is commonly estimated by an increase in the number of deaths that is greater than would be expected under normal circumstances (e.g., in the absence of a pandemic)—the so-called excess-death approach (*8*,*9*). This approach can be applied to specific causes of death directly related to the pathogen, such as for pneumonia or other respiratory diseases, or to other categories of death that are directly or indirectly affected by a pandemic. For example, excess-death methods have been used to quantify formal underestimation of the mortality burden of COVID-19 in many heavily affected countries (*10*–*17*).

The early and comprehensive response to the COVID-19 pandemic in Japan probably enabled the

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[1]A part of the estimates of excess all-cause deaths through May 2020, including those for all ages, reported in this article was also reported on the website of the National Institute of Infectious Diseases in Japan on August 31, 2020 (https://www.niid.go.jp/niid/ja/from-idsc/493-guidelines/9835-excess-mortality-20aug.html).

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country to avoid the severe epidemics experienced in Europe; as of September 2, 2020, a total of 68,392 COVID-19 cases and 1,296 related deaths had occurred in Japan (*18*). Nonetheless, despite an effective response, in early April as cases began to increase rapidly, the health system began to experience pressures similar to those in other countries, and the government declared a state of emergency (*19*). Perhaps uniquely among global movement restrictions, in Japan, these restrictions were completely voluntary, with no legal force; routine healthcare functions continued, including elective surgery and outpatient services for nonurgent health issues. Given the relatively limited spread of the epidemic in Japan and the voluntary nature of the lockdown, it is possible that the pattern of excess deaths in Japan differs from that in other countries. To provide insight into the mortality burden of COVID-19 in Japan, we estimated excess deaths from all causes during each week from the early COVID-19 outbreak in Japan, January–May 2020, by prefecture and patient age. Ethics approval was granted by the ethics committee of the National Institute of Infectious Diseases (authorization no. 1174).

Methods

Data

For this study, we used mortality data from the Vital Statistics System of Japan, which compiles the Vital Statistics Survey data prepared by each municipality under the Family Registration Law and the Provisions on the Notification of Stillbirths (*20*). Vital statistics are divided into 3 major types: annual vital statistics, monthly vital statistics, and prompt vital statistics. Annual vital statistics are compiled for 1 year (January–December) from the monthly vital statistics and are published around September each year. Monthly vital statistics are published ≈5 months after the month in which the survey forms are collected from the municipalities. Prompt vital statistics are published ≈2 months after the month of survey form collection.

According to the Family Registration Law, a notification of death must be submitted to a municipal office within 7 days of the day on which the person's death was confirmed. The notification must be submitted by a relative or a person who lived with the deceased or, in some cases, by landlords, house managers, or persons with similar roles. For the Prompt Vital Statistics report, data for a given month are based on death notifications reported to the municipality by the 14th of the following month. In other words, a death notification reported on or after the 15th with a death date of the previous month is placed in the dataset for the current month, not the previous month. For example, if a death notification is reported by February 14 with a death date of January 20, the data will be included in the January Prompt Vital Statistics report, but if the death is reported on February 15, it will be included in the February Prompt Vital Statistics report, referred to as a reporting delay. The delay in reporting deaths addressed in this study refers to any delays between the death confirmation process to submission of the death notifications to the municipal offices, perhaps depending on where the death occurs. The observed numbers of deaths in the Prompt Vital Statistics report were adjusted for this reporting delay up to 3 months to avoid a possible undercount of observed deaths. We used these adjusted data in our excess deaths analysis.

For this analysis, we used data from 2012 on (including the last few days of 2011 for weekly analysis purposes): Annual Vital Statistics report for 2011–2018, Monthly Vital Statistics report for 2019, and Prompt Vital Statistics report for January–May 2020. The target population was all persons who had resident cards and died in Japan, regardless of nationality. However, the analysis excluded those who died abroad, those who were staying in Japan for a short time (without a resident card), and those whose place of residence or date of birth was unknown. Our data did not include cause-of-death information; only age at death and place of residence (prefecture) were available for analysis.

Excess Deaths Analysis

To estimate excess deaths in Japan, we used the Farrington algorithm, which is commonly used to estimate excess deaths and is used by the US Centers for Disease Control and Prevention to estimate excess deaths associated with COVID-19 (*21*). The Farrington algorithm uses a quasi-Poisson regression (a generalized linear model accounting for overdispersion) to estimate the expected number of deaths per week. The algorithm is designed to limit the data used for estimation: the expected number of deaths at a certain week t is estimated by using only the data during $t - w$ and $t + w$ weeks of years $h - b$ and $h - 1$, where w and b are predetermined parameters and h is the year of t, referred to as the reference period. Data for a period of 1 year that is not included in the reference period are divided equally and included in the regression model as dummy variables, which enables the model to capture seasonality. Thus, the regression model is $\log(E(Y_t) = \alpha + \beta t + f^T(t)\gamma_{f(t)}$, where Y_t is the number of deaths at a certain week t, α and β are regression parameters, $\gamma_{f(t)}$ is a regression parameter vector representing seasonality, and $f(t)$ is a vector of

dummy variables that equally divides the time points outside the reference period.

In this study, we divided the data into 9 periods, as was done in a previous study (*21*). More details can be found elsewhere (*8*,*9*). In our study, we considered data up to 5 years ago ($b = 5$) and used data for 3 weeks ($w = 3$) before and after a certain point as the reference period, as was done in previous studies (*21*,*22*). We checked for overdispersion by comparing mean and variance of weekly deaths and used an overdispersed Poisson model where significant overdispersion was found after a regression-based (1-sided) test for overdispersion in the Poisson model (*23*). Also, as a sensitivity analysis, we changed the reference period to confirm the robustness of the results based on combinations of $b = 3$ or 4 and $w = 2$ or 4.

The model estimation was stratified by prefecture and age group (all ages, <25 years, 25–44 years, 45–64 years, 65–74 years, 75–84 years, ≥85 years). Age group was determined by considering the age structure and the number of persons sufficient for analysis. All age estimates (for all persons) do not add up to age group–specific estimates. The conversion from daily data to weekly data is based on the epidemiologic week of the National Institute of Infectious Diseases' Infectious Diseases Weekly Report (*24*).

Number of Excess All-Cause Deaths

On the basis of the model equation shown in the previous section, we estimated the expected number of all-cause deaths per week and the associated 95% upper bound of the 1-sided prediction interval, which is an indicator of uncertainty. We set these 2 thresholds (point estimate and upper bound) for excess death according to previous studies (*21*). We report the range of differences between the observed number of all-cause deaths and each of these thresholds as excess deaths.

To obtain the national level of excess all-cause deaths for each week, we summed the observed and the expected number of all-cause deaths separately across all prefectures in each week and computed the weekly differences for the country. The total (cumulative) number of excess all-cause deaths in each prefecture during the COVID-19 pandemic was calculated by summing the excess all-cause deaths (with negative values set to 0) in each week, from the beginning of 2020 (December 30, 2019–January 5, 2020) through May 2020 (May 25–31, 2020). We calculated the national cumulative number of excess all-cause deaths for the given period by summing the prefecture-specific excess deaths, a method consistent with US Centers for Disease Control and Prevention methods used (*8*). Last, we defined the percentage of excess deaths during the COVID-19 pandemic as the cumulative number of excess deaths divided by the observed cumulative number of deaths.

Adjusting for Reporting Delays

The observed number of deaths in the Prompt Vital Statistics report may differ from the actual number of deaths because of delays in reporting deaths (i.e., fewer deaths in the Prompt Vital Statistics report than in Monthly or Annual Vital Statistics reports published later). We took into account the reporting delay of up to 3 months by calculating the reporting delay rate (deaths reported 1, 2, and 3 months behind) for each prefecture and then adjusting the observed number of deaths in the latest 3 months (March–May 2020). Thus, the observed number of deaths in March was adjusted for a 3-month reporting delay (such as June deaths not available in our data; similarly, those in April were adjusted for 2- and 3-month reporting delays and those in May were adjusted for 1-, 2-, and 3-month reporting delays (Appendix, https://wwwnc.cdc.gov/EID/article/27/3/20-3925-App1.pdf).

To verify the validity of this adjustment method, we compared the weekly observed number of all-cause deaths in February, based on the Prompt Vital Statistics report through May with no adjustment for the reporting delay, and those in February, based on the Prompt Vital Statistics report through April with adjustment for reporting delays in May. The proportionate differences were then calculated for each week of February 2020. The largest difference was observed in Tokyo Prefecture (January 27–February 2, 2020) and Fukuoka Prefecture (January 27–February 2, 2020) at 5 deaths (Appendix Table 1), and the largest proportionate difference was observed in Tottori Prefecture (January 27–February 2, 2020) at 0.694%.

Results

We calculated mean and variance of the outcome (i.e., no. deaths/week among age- and prefecture-combined populations) to test the overdispersion; on the basis of the results ($p<0.01$), we used the quasi-Poisson regression for analysis. The cumulative number of excess all-cause deaths of the 47 prefectures was 208–4,322 (0.03%–0.72% excess) (Table). Weeks with observed all-cause deaths exceeding the 95% upper bound of the 1-sided interval of predicted deaths from the beginning of 2020 through May 2020 were detected in 13 prefectures. The cumulative numbers of excess all-cause deaths (percent excess) over the period for the 13 prefecture were as follows: Ibaraki, 1–87, 0.01%–0.60%; Tochigi, 13–137, 0.14%–1.42%; Gunma, 31–146, 0.30%–1.43%; Saitama, 14–334, 0.05%–1.10%; Chiba, 51–253,

0.19%–0.94%; Tokyo, 32–330, 0.06%–0.63%; Toyama, 18–120, 0.32%–2.11%; Shizuoka, 2–109, 0.01%–0.59%; Aichi, 7–214, 0.02%–0.70%; Osaka, 6–277, 0.01%–0.69%; Nara, 21–107, 0.32%–1.65%; Tokushima, 4–71, 0.09%–1.64%; and Kagawa, 8–135, 0.15%–2.51%.

Of the 32 prefectures in which COVID-19 deaths were confirmed through end of May 2020, the observed number of all-cause deaths for all ages exceeded the 95% upper bound in 11 prefectures (34.4%, 11 of 32) for some weeks and the point estimates in all prefectures. Of the remaining 15 prefectures in which no deaths from COVID-19 had been confirmed, the observed number of all-cause deaths for all ages exceeded the 95% upper bound in 2 (13.3%) of the 15 prefectures for some weeks and the point estimate in 14 (93.3%) of the 15 prefectures. Only in Niigata Prefecture did the observed number of all-cause deaths for all ages not exceed the point estimates for the period.

Sensitivity analyses in which the reference period was changed to confirm the robustness of the results

Table. Number of observed and excess all-cause deaths, and reported number of COVID-19 deaths, Japan, December 30, 2019–May 31, 2020*

Prefecture	No. all-cause deaths			No. COVID-19 deaths	No. tests
	Observed	Excess	Percentage		
Hokkaido	27,661	0–115	0.00–0.42	86	14,000
Aomori	7,713	0–36	0.00–0.47	1	850
Iwate	7,588	0–81	0.00–1.07	0	662
Miyagi	10,725	0–57	0.00–0.53	1	2,944
Akita	6,656	0–72	0.00–1.08	0	933
Yamagata	6,606	0–49	0.00–0.74	0	2,659
Fukushima	10,714	0–34	0.00–0.32	0	4,452
Ibaraki	14,443	1–87	0.01–0.60	10	4,628
Tochigi	9,623	13–137	0.14–1.42	0	3,871
Gunma	10,175	31–146	0.30–1.43	19	3,655
Saitama	30,426	14–334	0.05–1.10	48	20,735
Chiba	26,841	51–253	0.19–0.94	45	14,688
Tokyo	52,350	32–330	0.06–0.63	305	38,566
Kanagawa	36,174	0–89	0.00–0.25	82	9,446
Niigata	12,704	0–0	0.00–0.00	0	4,180
Toyama	5,689	18–120	0.32–2.11	22	3,144
Ishikawa	5,538	0–33	0.00–0.60	25	2,723
Fukui	4,045	0–47	0.00–1.16	8	2,631
Yamanashi	4,276	0–60	0.00–1.40	1	3,877
Nagano	11,148	0–29	0.00–0.26	0	2,714
Gifu	9,889	0–31	0.00–0.31	7	3,610
Shizuoka	18,554	2–109	0.01–0.59	1	3,521
Aichi	30,583	7–214	0.02–0.70	34	9,970
Mie	9,056	0–57	0.00–0.63	1	2,505
Shiga	5,606	0–65	0.00–1.16	1	1,856
Kyoto	11,814	0–84	0.00–0.71	17	7,933
Osaka	40,017	6–277	0.01–0.69	83	31,156
Hyogo	25,490	0–69	0.00–0.27	42	11,128
Nara	6,474	21–107	0.32–1.65	2	2,545
Wakayama	5,547	0–66	0.00–1.19	3	3,701
Tottori	3,156	0–44	0.00–1.39	0	1,338
Shimane	4,203	0–73	0.00–1.74	0	1,125
Okayama	9,493	0–75	0.00–0.79	0	1,705
Hiroshima	13,250	0–45	0.00–0.34	3	6,907
Yamaguchi	8,171	0–50	0.00–0.61	0	1,701
Tokushima	4,339	4–71	0.09–1.64	1	741
Kagawa	5,374	8–135	0.15–2.51	0	2,187
Ehime	7,913	0–50	0.00–0.63	4	2,074
Kochi	4,383	0–58	0.00–1.32	3	1,793
Fukuoka	23,346	0–77	0.00–0.33	26	12,634
Saga	4,412	0–53	0.00–1.20	0	1,417
Nagasaki	7,686	0–85	0.00–1.11	1	2,754
Kumamoto	9,340	0–43	0.00–0.46	3	3,924
Oita	6,279	0–52	0.00–0.83	1	3,988
Miyazaki	6,101	0–120	0.00–1.97	0	1,368
Kagoshima	9,309	0–59	0.00–0.63	0	1,859
Okinawa	5,334	0–44	0.00–0.82	6	2,863
Total	596,214	208–4,322	0.03–0.72	892	269,661

*The national-level cumulative number of excess all-cause deaths was calculated by summing the excess all-cause deaths of 47 prefectures (*25*).
COVID-19, coronavirus disease.

showed that, depending on the model parameter settings, weeks with observed all-cause deaths exceeding the 95% upper bound were also observed in additional prefectures, including Shiga, Shimane, Kochi, Fukuoka, Kumamoto, Oita, and Miyazaki (Appendix Table 2). As of the end of May 2020, deaths from COVID-19 had not been confirmed in Shimane and Miyazaki Prefectures.

The totals of excess all-cause deaths (percent excess) at the national level by age group were as follows: <25 years of age, 47–751 (1.61–25.76); 25–44 years, 66–1,302 (0.84–16.66); 45–64 years, 207–2,958 (0.47–6.67); 65–74 years, 143–2,959 (0.17–3.48); 75–84 years, 110–3,100 (0.07–1.86); and ≥85 years, 73–2,466 (0.03–0.85) (Appendix Table 3). Weeks with observed all-cause deaths exceeding the 95% upper bound for each age group were observed in 28, 23, 25, 25, 20, and 8 prefectures for these age groups, respectively. Weeks in which observed all-cause deaths exceeded point estimates were observed for all 47 prefectures and age groups.

Weekly observed and expected number of all-cause deaths in 4 prefectures reflect the large number of reported COVID19 deaths as of the end of May 2020 (Tokyo, Hokkaido, Osaka, and Kanagawa) for all ages and by age group (Appendix Figure 1). For all age groups, weeks of excess deaths occurred in previous years, not only during the COVID-19 pandemic. Data for the other 43 prefectures and national-level data are also shown (Appendix Figure 2).

Discussion

Excess-death monitoring has been used to track influenza epidemics worldwide and to identify the high potential mortality burden of COVID-19 in some hard-hit countries. We used a similar approach to capture the overall mortality burden of COVID-19. Monitoring changes and trends in all-cause deaths provides insight into the magnitude of the overall mortality burden caused by COVID-19, both directly and indirectly, which was overlooked in the official number of COVID-19 deaths. Given the variability in testing intensity among prefectures, this type of monitoring provides valuable information about the social effects of a pandemic and the extent to which virus testing may miss deaths caused by COVID-19. Useful indicators of the severity of the pandemic may include syndromic endpoints such as COVID-19 deaths, outpatient visits, and emergency department visits for fever or other COVID-19–associated symptoms (*26*). However, in the absence of comprehensive testing for COVID-19, estimates of the number of excess all-cause deaths may be more reliable than the reported number of COVID-19 deaths, especially in areas where testing is not widespread, so as to assess the progression of a pandemic and the effects of interventions.

During January–May 2020, the 208–4,322 excess deaths in all 47 prefectures represented just 0.03%–0.72% of all deaths observed in Japan through May 31, 2020. Although a complete country comparison is not possible, given the different methods for estimating excess deaths in each country (*2*,*3*) (Y. Yang et al., unpub. data, https://www.medrxiv.org/content/10.1101/2020.02.11.20021493v2), the number of deaths caused by COVID-19 in Japan, which was ≈0.7 deaths/100,000 population as of May 31 (and 1.3 deaths/100,000 population as of October 31), is 10 to 100 times lower than that for many countries in Europe and for the United States (*27*), indicating the relative low overall mortality burden from COVID-19 in Japan. This low overall mortality burden probably reflects the benefits of Japan's rapid and comprehensive response to the COVID-19 pandemic, which began with voluntary restrictions of public events in mid-February 2020 (*28*).

The excess all-cause deaths that we report can be interpreted as the sum of the following scenarios: 1) COVID-19 was the primary cause of death; 2) although other causes were diagnosed as the primary cause of death, the actual cause of death was COVID-19; 3) COVID-19 was not diagnosed as the primary cause of death, but because of the effects of the COVID-19 epidemic, death was caused by other diseases. For example, persons may hesitate to visit a hospital because of the declaration of an emergency or self-restraint in going out, or their chronic disease may worsen because of lifestyle changes, resulting in death (*21*). On the other hand, if deaths from causes other than COVID-19 decrease under the pandemic situation (as may have occurred with deaths from traffic accidents and suicide [*29*]), excess deaths directly caused by COVID-19 may be offset by the negative portion of those deaths. In fact, traffic accidents in Japan had decreased because of decreased traffic volume resulting from stay-at-home requests by central and local governments, and it is possible that the number of deaths from injuries had decreased (*29*).

Weeks with observed all-cause deaths exceeding the 95% upper bound of the 1-sided prediction interval were observed for 13 prefectures, of which COVID-19 deaths have been confirmed for 11. On the other hand, COVID-19 deaths have been observed in 22 other prefectures where no all-cause excess deaths were observed, suggesting that COVID-19 deaths in these prefectures were not high enough to overcome natural weekly variations in mortality rates, that there may be an offsetting

reduction in deaths because of the indirect effects of the pandemic in these communities, or both.

According to Ministry of Health, Labour and Welfare data as of May 27, 2020, proportions of COVID-19 deaths were higher for persons in older age groups: 55.8% at ≥80 years of age, followed by 27.3% at 70–79 years (*30*). Although the officially reported number of COVID-19 deaths may not be free of bias (e.g., different likelihood of testing by age group), these data indicate that prefecture and age structure of the reported COVID-19 deaths were not consistent with our estimates, suggesting the need to distinguish between direct and indirect consequences of COVID-19 by using cause-specific analyses. For the design of future broad-based infectious disease countermeasures such as lockdowns, knowing whether excess deaths in vulnerable age groups arises from direct COVID-19 deaths, indirect causes, or preventable deaths from unrelated causes would be useful.

The limitations of our analysis are the same as those for other excess-deaths studies (*15*,*31*). First, for this study, we did not take into account the cause of death, so the excess death estimates we present are not necessarily estimates of excess deaths caused by COVID-19. In addition, data from January–May 2020 are incomplete in the Prompt Vital Statistics report, especially in the most recent month. We have not considered the cause of the delay in reporting (e.g., delay mechanism) because we believe that adjusting for the delay by cause was impossible. Therefore, we selected a comprehensive adjustment method that does not depend on the cause of the delay by setting 3 assumptions (Appendix). We have also confirmed that validity is sufficient. Validity evaluation indicated that our adjustment for the reporting delay was reasonable to some extent, although this evaluation is within the scope of our 3 assumptions. Although waiting until Monthly Vital Statistics reports are published before analyzing the complete data would be ideal, during a public health emergency it is necessary to analyze the data in a timely manner and the limitations of data adjustment are a trade-off. Last, the method we used in this study is an algorithm for identifying excess deaths, which was not designed for assessing death reduction (*8*,*9*). If the expected number of deaths in a week was less than the actual number of deaths (negative value), the negative value was set to 0. However, as noted above, the effect of COVID-19 on mortality burden has not necessarily been positive (an increasing effect) but may be negative (a decreasing effect). For example, no deaths caused by COVID-19 were observed in Niigata Prefecture as of May 2020, and this study estimated 0–0 excess deaths in the prefecture during January–May 2020. In prefectures where the effect of COVID-19 is relatively small, an algorithm that identifies exiguous deaths might provide more suggestive data than an algorithm that identifies excess deaths. However, our aim with this study was to evaluate the increase in the mortality burden caused by COVID-19, using the methods of previous studies conducted in other countries; exiguous deaths will be evaluated in future analyses.

In conclusion, we found a much lower overall excess mortality burden from COVID-19 in Japan than in Europe and the United States. However, a weak prefecture and age structure consistency between the reported COVID-19 deaths and our estimates also suggest the need to distinguish between direct and indirect consequences of COVID-19 by cause-specific analyses, which can provide more information about the severity and progression of the COVID-19 pandemic. More detailed cause-specific analyses of excess deaths in Japan, especially among persons in older age groups, will enable better design of future interventions to protect vulnerable age groups and also offer lessons to other countries on proper management and implementation of movement restrictions. By paying careful attention to the excess death patterns in Japan, countries more heavily affected by COVID-19 can improve their own future response and better respond to the health needs of critically affected countries.

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Appendix

Appendix Table 1. Validity test results for reporting delays adjustment.

Area	Week ending date	Difference*	Percent difference, %
Hokkaido	February 2, 2020	1	0.074
Hokkaido	February 9, 2020	-1	-0.078
Hokkaido	February 16, 2020	2	0.148
Hokkaido	February 23, 2020	2	0.165
Aomori	February 2, 2020	0	0.000
Aomori	February 9, 2020	0	0.000
Aomori	February 16, 2020	1	0.292
Aomori	February 23, 2020	0	0.000
Iwate	February 2, 2020	0	0.000
Iwate	February 9, 2020	-1	-0.264
Iwate	February 16, 2020	0	0.000
Iwate	February 23, 2020	-1	-0.271
Miyagi	February 2, 2020	0	0.000
Miyagi	February 9, 2020	0	0.000
Miyagi	February 16, 2020	1	0.191
Miyagi	February 23, 2020	0	0.000
Akita	February 2, 2020	0	0.000
Akita	February 9, 2020	0	0.000
Akita	February 16, 2020	0	0.000
Akita	February 23, 2020	0	0.000
Yamagata	February 2, 2020	0	0.000
Yamagata	February 9, 2020	0	0.000
Yamagata	February 16, 2020	0	0.000
Yamagata	February 23, 2020	0	0.000
Fukushima	February 2, 2020	-1	-0.199
Fukushima	February 9, 2020	-1	-0.187
Fukushima	February 16, 2020	-1	-0.190
Fukushima	February 23, 2020	-1	-0.182
Ibaraki	February 2, 2020	1	0.137
Ibaraki	February 9, 2020	-1	-0.139
Ibaraki	February 16, 2020	-1	-0.138
Ibaraki	February 23, 2020	-1	-0.155
Tochigi	February 2, 2020	0	0.000
Tochigi	February 9, 2020	0	0.000
Tochigi	February 16, 2020	1	0.209
Tochigi	February 23, 2020	1	0.234
Gunma	February 2, 2020	-1	-0.222
Gunma	February 9, 2020	-1	-0.202
Gunma	February 16, 2020	-1	-0.207
Gunma	February 23, 2020	-1	-0.210
Saitama	February 2, 2020	3	0.198
Saitama	February 9, 2020	-3	-0.219
Saitama	February 16, 2020	1	0.068
Saitama	February 23, 2020	-2	-0.148
Chiba	February 2, 2020	0	0.000
Chiba	February 9, 2020	-1	-0.082

Area	Week ending date	Difference*	Percent difference, %
Chiba	February 16, 2020	0	0.000
Chiba	February 23, 2020	-1	-0.084
Tokyo	February 2, 2020	5	0.195
Tokyo	February 9, 2020	-2	-0.083
Tokyo	February 16, 2020	4	0.161
Tokyo	February 23, 2020	2	0.083
Kanagawa	February 2, 2020	3	0.167
Kanagawa	February 9, 2020	-3	-0.170
Kanagawa	February 16, 2020	1	0.054
Kanagawa	February 23, 2020	0	0.000
Niigata	February 2, 2020	0	0.000
Niigata	February 9, 2020	0	0.000
Niigata	February 16, 2020	1	0.168
Niigata	February 23, 2020	0	0.000
Toyama	February 2, 2020	-1	-0.415
Toyama	February 9, 2020	-1	-0.395
Toyama	February 16, 2020	0	0.000
Toyama	February 23, 2020	-1	-0.342
Ishikawa	February 2, 2020	0	0.000
Ishikawa	February 9, 2020	0	0.000
Ishikawa	February 16, 2020	0	0.000
Ishikawa	February 23, 2020	0	0.000
Fukui	February 2, 2020	0	0.000
Fukui	February 9, 2020	0	0.000
Fukui	February 16, 2020	0	0.000
Fukui	February 23, 2020	0	0.000
Yamanashi	February 2, 2020	0	0.000
Yamanashi	February 9, 2020	0	0.000
Yamanashi	February 16, 2020	1	0.478
Yamanashi	February 23, 2020	0	0.000
Nagano	February 2, 2020	-1	-0.189
Nagano	February 9, 2020	-1	-0.187
Nagano	February 16, 2020	-1	-0.182
Nagano	February 23, 2020	-1	-0.180
Gifu	February 2, 2020	0	0.000
Gifu	February 9, 2020	-1	-0.217
Gifu	February 16, 2020	-1	-0.200
Gifu	February 23, 2020	0	0.000
Shizuoka	February 2, 2020	-1	-0.111
Shizuoka	February 9, 2020	-1	-0.112
Shizuoka	February 16, 2020	-1	-0.107
Shizuoka	February 23, 2020	0	0.000
Aichi	February 2, 2020	1	0.067
Aichi	February 9, 2020	-1	-0.067
Aichi	February 16, 2020	2	0.134
Aichi	February 23, 2020	0	0.000
Mie	February 2, 2020	1	0.237
Mie	February 9, 2020	0	0.000
Mie	February 16, 2020	0	0.000
Mie	February 23, 2020	0	0.000
Shiga	February 2, 2020	0	0.000
Shiga	February 9, 2020	0	0.000
Shiga	February 16, 2020	0	0.000
Shiga	February 23, 2020	0	0.000
Kyoto	February 2, 2020	-1	-0.177
Kyoto	February 9, 2020	-1	-0.178
Kyoto	February 16, 2020	0	0.000
Kyoto	February 23, 2020	-1	-0.189
Osaka	February 2, 2020	2	0.109
Osaka	February 9, 2020	0	0.000
Osaka	February 16, 2020	1	0.051
Osaka	February 23, 2020	1	0.055
Hyogo	February 2, 2020	1	0.079
Hyogo	February 9, 2020	-1	-0.085
Hyogo	February 16, 2020	1	0.081
Hyogo	February 23, 2020	0	0.000
Nara	February 2, 2020	-1	-0.294
Nara	February 9, 2020	-1	-0.300
Nara	February 16, 2020	-1	-0.326

Area	Week ending date	Difference*	Percent difference, %
Nara	February 23, 2020	-1	-0.353
Wakayama	February 2, 2020	0	0.000
Wakayama	February 9, 2020	0	0.000
Wakayama	February 16, 2020	0	0.000
Wakayama	February 23, 2020	0	0.000
Tottori	February 2, 2020	1	0.694
Tottori	February 9, 2020	0	0.000
Tottori	February 16, 2020	0	0.000
Tottori	February 23, 2020	0	0.000
Shimane	February 2, 2020	-1	-0.503
Shimane	February 9, 2020	-1	-0.446
Shimane	February 16, 2020	-1	-0.461
Shimane	February 23, 2020	0	0.000
Okayama	February 2, 2020	0	0.000
Okayama	February 9, 2020	0	0.000
Okayama	February 16, 2020	0	0.000
Okayama	February 23, 2020	0	0.000
Hiroshima	February 2, 2020	0	0.000
Hiroshima	February 9, 2020	-1	-0.166
Hiroshima	February 16, 2020	-1	-0.156
Hiroshima	February 23, 2020	0	0.000
Yamaguchi	February 2, 2020	-1	-0.252
Yamaguchi	February 9, 2020	-1	-0.253
Yamaguchi	February 16, 2020	-1	-0.248
Yamaguchi	February 23, 2020	-1	-0.256
Tokushima	February 2, 2020	0	0.000
Tokushima	February 9, 2020	0	0.000
Tokushima	February 16, 2020	0	0.000
Tokushima	February 23, 2020	0	0.000
Kagawa	February 2, 2020	0	0.000
Kagawa	February 9, 2020	0	0.000
Kagawa	February 16, 2020	0	0.000
Kagawa	February 23, 2020	0	0.000
Ehime	February 2, 2020	0	0.000
Ehime	February 9, 2020	0	0.000
Ehime	February 16, 2020	0	0.000
Ehime	February 23, 2020	0	0.000
Kochi	February 2, 2020	-1	-0.426
Kochi	February 9, 2020	-1	-0.433
Kochi	February 16, 2020	-1	-0.431
Kochi	February 23, 2020	-1	-0.498
Fukuoka	February 2, 2020	5	0.441
Fukuoka	February 9, 2020	-1	-0.092
Fukuoka	February 16, 2020	-1	-0.088
Fukuoka	February 23, 2020	1	0.092
Saga	February 2, 2020	0	0.000
Saga	February 9, 2020	0	0.000
Saga	February 16, 2020	0	0.000
Saga	February 23, 2020	0	0.000
Nagasaki	February 2, 2020	1	0.287
Nagasaki	February 9, 2020	0	0.000
Nagasaki	February 16, 2020	0	0.000
Nagasaki	February 23, 2020	0	0.000
Kumamoto	February 2, 2020	0	0.000
Kumamoto	February 9, 2020	1	0.220
Kumamoto	February 16, 2020	0	0.000
Kumamoto	February 23, 2020	0	0.000
Oita	February 2, 2020	0	0.000
Oita	February 9, 2020	0	0.000
Oita	February 16, 2020	0	0.000
Oita	February 23, 2020	0	0.000
Miyazaki	February 2, 2020	0	0.000
Miyazaki	February 9, 2020	0	0.000
Miyazaki	February 16, 2020	1	0.351
Miyazaki	February 23, 2020	0	0.000
Kagoshima	February 2, 2020	0	0.000
Kagoshima	February 9, 2020	0	0.000
Kagoshima	February 16, 2020	1	0.199
Kagoshima	February 23, 2020	0	0.000

Area	Week ending date	Difference*	Percent difference, %
Okinawa	February 2, 2020	-1	-0.403
Okinawa	February 9, 2020	-1	-0.385
Okinawa	February 16, 2020	-1	-0.388
Okinawa	February 23, 2020	-1	-0.389

*Difference is the observed number of all-cause deaths for all ages in February based on up to the May prompt vital statistics with no adjustment for the reporting delay minus those based on up to the April prompt vital statistics with the adjustment for delays in reporting in May. Proportion difference refers to the proportion of the difference to the latter.

Appendix Table 2. Results of sensitivity analyses, excess all-cause death, and percent all-cause excess deaths for all ages, December 30, 2019 through May 31, 2020*

Area	(a) b=3, w=2		(b) b=4, w=2		(c) b=3, w=4		(d) b=4, w=4	
Japan	360–5363	0.06–0.90	358–5307	0.06–0.89	353–5843	0.06–0.98	324–5489	0.05–0.92
Hokkaido	0–95	0.00–0.34	0–109	0.00–0.39	0–115	0.00–0.42	0–134	0.00–0.48
Aomori	0–21	0.00–0.27	0–25	0.00–0.32	0–30	0.00–0.39	0–34	0.00–0.44
Iwate	0–82	0.00–1.08	0–93	0.00–1.23	1–100	0.01–1.32	0–100	0.00–1.32
Miyagi	0–46	0.00–0.43	0–44	0.00–0.41	0–58	0.00–0.54	0–60	0.00–0.56
Akita	0–61	0.00–0.92	0–89	0.00–1.34	0–80	0.00–1.20	0–92	0.00–1.38
Yamagata	0–44	0.00–0.67	0–57	0.00–0.86	0–50	0.00–0.76	0–60	0.00–0.91
Fukushima	0–86	0.00–0.80	0–53	0.00–0.49	0–93	0.00–0.87	0–59	0.00–0.55
Ibaraki	3–107	0.02–0.74	8–107	0.06–0.74	2–102	0.01–0.71	4–97	0.03–0.67
Tochigi	15–159	0.16–1.65	16–167	0.17–1.74	25–177	0.26–1.84	27–180	0.28–1.87
Gunma	25–129	0.25–1.27	35–176	0.34–1.73	39–164	0.38–1.61	46–190	0.45–1.87
Saitama	22–394	0.07–1.29	20–365	0.07–1.20	39–445	0.13–1.46	32–390	0.11–1.28
Chiba	55–277	0.20–1.03	49–241	0.18–0.90	40–289	0.15–1.08	35–247	0.13–0.92
Tokyo	73–459	0.14–0.88	80–438	0.15–0.84	62–466	0.12–0.89	58–424	0.11–0.81
Kanagawa	0–103	0.00–0.28	0–113	0.00–0.31	0–92	0.00–0.25	0–94	0.00–0.26
Niigata	0–0	0.00–0.00	0–0	0.00–0.00	0–5	0.00–0.04	0–0	0.00–0.00
Toyama	39–186	0.69–3.27	33–158	0.58–2.78	36–179	0.63–3.15	28–151	0.49–2.65
Ishikawa	0–50	0.00–0.90	0–60	0.00–1.08	0–57	0.00–1.03	0–67	0.00–1.21
Fukui	0–39	0.00–0.96	0–78	0.00–1.93	0–42	0.00–1.04	0–77	0.00–1.90
Yamanashi	0–52	0.00–1.22	0–52	0.00–1.22	0–65	0.00–1.52	0–52	0.00–1.22
Nagano	0–75	0.00–0.67	0–81	0.00–0.73	0–81	0.00–0.73	0–84	0.00–0.75
Gifu	0–40	0.00–0.40	0–34	0.00–0.34	0–47	0.00–0.48	0–38	0.00–0.38
Shizuoka	17–127	0.09–0.68	15–120	0.08–0.65	11–186	0.06–1.00	11–155	0.06–0.84
Aichi	14–232	0.05–0.76	13–240	0.04–0.78	8–236	0.03–0.77	12–235	0.04–0.77
Mie	0–49	0.00–0.54	0–70	0.00–0.77	0–66	0.00–0.73	0–77	0.00–0.85
Shiga	1–97	0.02–1.73	2–86	0.04–1.53	0–92	0.00–1.64	0–78	0.00–1.39
Kyoto	0–94	0.00–0.80	0–87	0.00–0.74	0–105	0.00–0.89	0–100	0.00–0.85
Osaka	16–280	0.04–0.70	22–295	0.05–0.74	11–284	0.03–0.71	11–271	0.03–0.68
Hyogo	0–108	0.00–0.42	0–106	0.00–0.42	0–135	0.00–0.53	0–118	0.00–0.46
Nara	30–129	0.46–1.99	26–108	0.40–1.67	30–140	0.46–2.16	22–110	0.34–1.70
Wakayama	0–91	0.00–1.64	0–76	0.00–1.37	0–103	0.00–1.86	0–82	0.00–1.48
Tottori	0–34	0.00–1.08	0–39	0.00–1.24	0–45	0.00–1.43	0–45	0.00–1.43
Shimane	5–101	0.12–2.40	0–83	0.00–1.97	2–96	0.05–2.28	0–82	0.00–1.95
Okayama	0–54	0.00–0.57	0–71	0.00–0.75	0–59	0.00–0.62	0–72	0.00–0.76
Hiroshima	0–65	0.00–0.49	0–67	0.00–0.51	0–58	0.00–0.44	0–61	0.00–0.46
Yamaguchi	0–65	0.00–0.80	0–70	0.00–0.86	0–72	0.00–0.88	0–72	0.00–0.88
Tokushima	8–96	0.18–2.21	8–87	0.18–2.01	7–99	0.16–2.28	7–90	0.16–2.07
Kagawa	13–170	0.24–3.16	9–143	0.17–2.66	7–176	0.13–3.28	4–156	0.07–2.90
Ehime	0–90	0.00–1.14	0–80	0.00–1.01	0–110	0.00–1.39	0–94	0.00–1.19
Kochi	2–75	0.05–1.71	2–86	0.05–1.96	1–80	0.02–1.83	0–90	0.00–2.05
Fukuoka	2–159	0.01–0.68	5–142	0.02–0.61	10–148	0.04–0.63	11–124	0.05–0.53
Saga	0–94	0.00–2.13	0–74	0.00–1.68	0–105	0.00–2.38	0–80	0.00–1.81
Nagasaki	0–138	0.00–1.80	0–105	0.00–1.37	0–145	0.00–1.89	0–112	0.00–1.46
Kumamoto	0–118	0.00–1.26	0–128	0.00–1.37	0–131	0.00–1.40	1–138	0.01–1.48
Oita	10–78	0.16–1.24	10–81	0.16–1.29	9–87	0.14–1.39	8–89	0.13–1.42
Miyazaki	10–182	0.16–2.98	5–156	0.08–2.56	13–191	0.21–3.13	7–167	0.11–2.74
Kagoshima	0–77	0.00–0.83	0–107	0.00–1.15	0–86	0.00–0.92	0–102	0.00–1.10
Okinawa	0–55	0.00–1.03	0–60	0.00–1.12	0–71	0.00–1.33	0–59	0.00–1.11

*In the sensitivity analyses, the reference period was changed to confirm the robustness of the results ('b' years ago, 'w' weeks before and after).

Appendix Table 3. Number of observed and excess all-cause deaths from December 30, 2019 to May 31, 2020, by age groups*

Age group, area	Observed all-cause deaths	Excess all-cause deaths	Percent all-cause excess deaths
(1) under 25 years			
Japan	2915	47–751	1.61–25.76
Hokkaido	103	0–19	0.00–18.45
Aomori	35	0–16	0.00–45.71
Iwate	29	0–14	0.00–48.28
Miyagi	52	1–14	1.92–26.92
Akita	27	2–12	7.41–44.44
Yamagata	26	0–7	0.00–26.92
Fukushima	53	1–19	1.89–35.85
Ibaraki	82	1–25	1.22–30.49
Tochigi	53	0–10	0.00–18.87
Gunma	41	0–10	0.00–24.39
Saitama	148	2–24	1.35–16.22
Chiba	130	1–15	0.77–11.54
Tokyo	262	3–20	1.15–7.63
Kanagawa	168	0–16	0.00–9.52
Niigata	44	0–15	0.00–34.09
Toyama	19	0–6	0.00–31.58
Ishikawa	31	1–14	3.23–45.16
Fukui	29	1–16	3.45–55.17
Yamanashi	14	0–3	0.00–21.43
Nagano	70	0–21	0.00–30.00
Gifu	52	3–22	5.77–42.31
Shizuoka	103	4–33	3.88–32.04
Aichi	198	5–48	2.53–24.24
Mie	53	2–27	3.77–50.94
Shiga	41	2–20	4.88–48.78
Kyoto	47	0–12	0.00–25.53
Osaka	191	0–7	0.00–3.66
Hyogo	127	1–32	0.79–25.20
Nara	34	1–16	2.94–47.06
Wakayama	13	2–6	15.38–46.15
Tottori	11	0–4	0.00–36.36
Shimane	21	2–11	9.52–52.38
Okayama	57	1–23	1.75–40.35
Hiroshima	53	1–12	1.89–22.64
Yamaguchi	31	0–15	0.00–48.39
Tokushima	25	1–13	4.00–52.00
Kagawa	29	1–14	3.45–48.28
Ehime	30	1–12	3.33–40.00
Kochi	22	1–9	4.55–40.91
Fukuoka	114	0–9	0.00–7.89
Saga	17	0–6	0.00–35.29
Nagasaki	36	1–16	2.78–44.44
Kumamoto	51	0–21	0.00–41.18
Oita	22	1–12	4.55–54.55
Miyazaki	28	0–11	0.00–39.29
Kagoshima	52	3–22	5.77–42.31
Okinawa	41	1–22	2.44–53.66
(2) 25–44 years			
Japan	7815	66–1302	0.84–16.66
Hokkaido	344	0–32	0.00–9.30
Aomori	91	0–14	0.00–15.38
Iwate	78	0–18	0.00–23.08
Miyagi	183	4–49	2.19–26.78
Akita	67	1–21	1.49–31.34
Yamagata	88	2–36	2.27–40.91
Fukushima	133	0–22	0.00–16.54
Ibaraki	225	10–54	4.44–24.00
Tochigi	133	0–22	0.00–16.54
Gunma	122	3–21	2.46–17.21
Saitama	450	0–24	0.00–5.33
Chiba	414	0–56	0.00–13.53

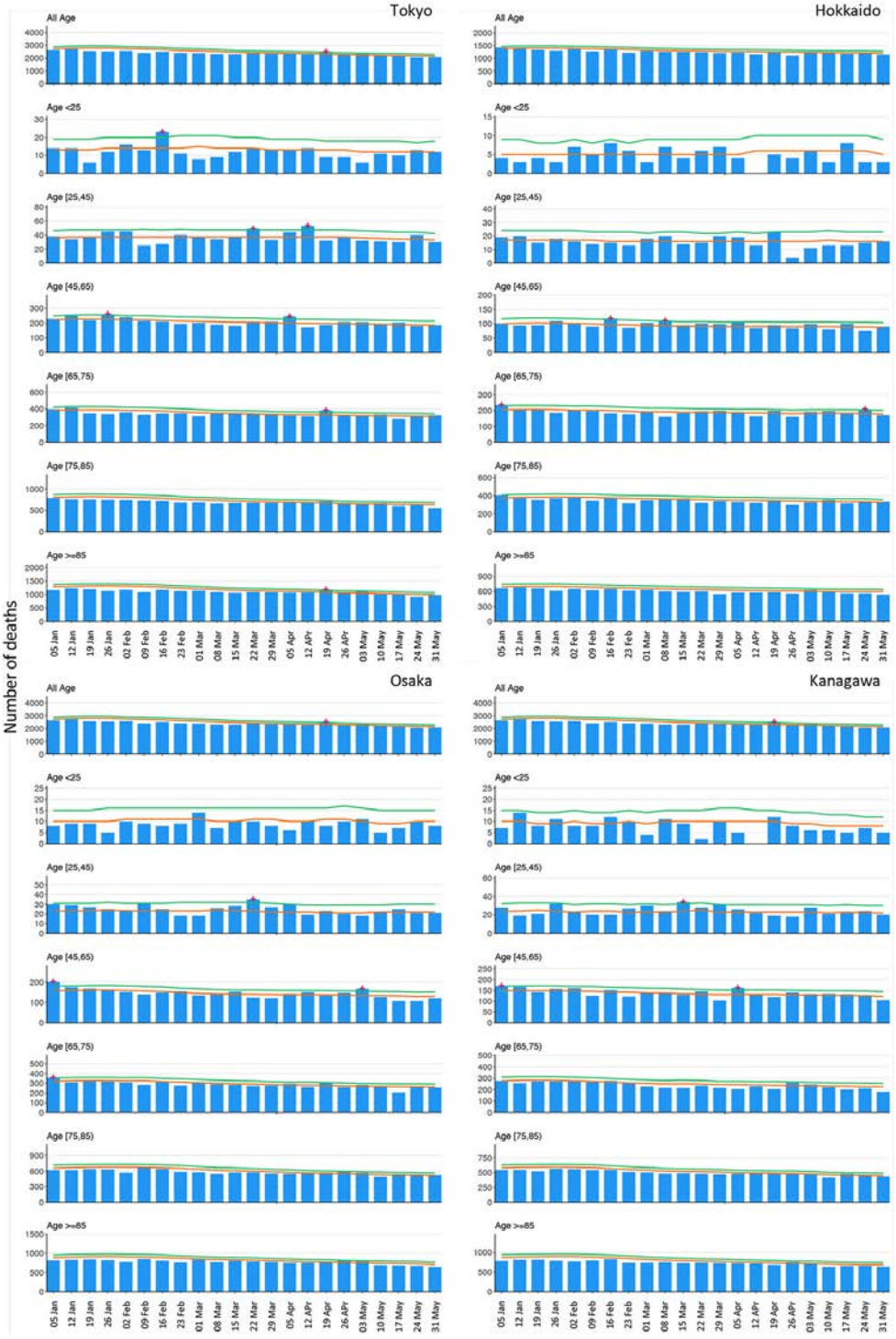
Age group, area	Observed all-cause deaths	Excess all-cause deaths	Percent all-cause excess deaths
Tokyo	809	8–67	0.99–8.28
Kanagawa	537	2–61	0.37–11.36
Niigata	130	0–16	0.00–12.31
Toyama	71	0–27	0.00–38.03
Ishikawa	63	6–24	9.52–38.10
Fukui	51	0–18	0.00–35.29
Yamanashi	47	1–19	2.13–40.43
Nagano	108	1–21	0.93–19.44
Gifu	101	1–14	0.99–13.86
Shizuoka	253	4–63	1.58–24.90
Aichi	423	0–30	0.00–7.09
Mie	106	0–28	0.00–26.42
Shiga	82	2–23	2.44–28.05
Kyoto	138	0–25	0.00–18.12
Osaka	542	3–73	0.55–13.47
Hyogo	289	4–39	1.38–13.49
Nara	74	1–18	1.35–24.32
Wakayama	60	0–10	0.00–16.67
Tottori	32	0–9	0.00–28.13
Shimane	45	2–21	4.44–46.67
Okayama	104	0–16	0.00–15.38
Hiroshima	156	1–20	0.64–12.82
Yamaguchi	81	1–28	1.23–34.57
Tokushima	47	0–11	0.00–23.40
Kagawa	65	1–23	1.54–35.38
Ehime	91	0–19	0.00–20.88
Kochi	45	0–17	0.00–37.78
Fukuoka	324	2–46	0.62–14.20
Saga	37	0–8	0.00–21.62
Nagasaki	75	0–15	0.00–20.00
Kumamoto	111	4–40	3.60–36.04
Oita	70	0–15	0.00–21.43
Miyazaki	84	2–31	2.38–36.90
Kagoshima	114	0–19	0.00–16.67
Okinawa	122	0–19	0.00–15.57
(3) 45–64 years			
Japan	44375	207–2958	0.47–6.67
Hokkaido	2118	5–131	0.24–6.19
Aomori	648	10–62	1.54–9.57
Iwate	530	3–44	0.57–8.30
Miyagi	817	4–73	0.49–8.94
Akita	435	0–48	0.00–11.03
Yamagata	432	9–73	2.08–16.90
Fukushima	781	0–37	0.00–4.74
Ibaraki	1120	3–72	0.27–6.43
Tochigi	794	13–77	1.64–9.70
Gunma	645	0–29	0.00–4.50
Saitama	2716	12–212	0.44–7.81
Chiba	2226	0–56	0.00–2.52
Tokyo	4579	23–183	0.50–4.00
Kanagawa	3054	11–162	0.36–5.30
Niigata	777	0–26	0.00–3.35
Toyama	332	1–18	0.30–5.42
Ishikawa	335	1–38	0.30–11.34
Fukui	240	7–43	2.92–17.92
Yamanashi	297	0–25	0.00–8.42
Nagano	639	0–47	0.00–7.36
Gifu	623	0–40	0.00–6.42
Shizuoka	1268	4–101	0.32–7.97
Aichi	2337	11–104	0.47–4.45
Mie	592	5–57	0.84–9.63
Shiga	341	0–19	0.00–5.57
Kyoto	736	0–19	0.00–2.58
Osaka	3178	32–156	1.01–4.91
Hyogo	1767	9–68	0.51–3.85
Nara	449	0–38	0.00–8.46
Wakayama	355	0–40	0.00–11.27

Age group, area	Observed all-cause deaths	Excess all-cause deaths	Percent all-cause excess deaths
Tottori	212	5–42	2.36–19.81
Shimane	219	0–21	0.00–9.59
Okayama	551	0–28	0.00–5.08
Hiroshima	926	2–71	0.22–7.67
Yamaguchi	532	8–75	1.50–14.10
Tokushima	270	0–32	0.00–11.85
Kagawa	328	0–39	0.00–11.89
Ehime	528	0–39	0.00–7.39
Kochi	281	13–51	4.63–18.15
Fukuoka	1740	9–89	0.52–5.11
Saga	316	0–43	0.00–13.61
Nagasaki	554	1–75	0.18–13.54
Kumamoto	635	0–69	0.00–10.87
Oita	339	0–6	0.00–1.77
Miyazaki	457	6–75	1.31–16.41
Kagoshima	686	0–79	0.00–11.52
Okinawa	640	0–26	0.00–4.06
(4) 65–74 years			
Japan	85102	143–2959	0.17–3.48
Hokkaido	4192	8–131	0.19–3.13
Aomori	1169	5–45	0.43–3.85
Iwate	1026	3–64	0.29–6.24
Miyagi	1492	0–59	0.00–3.95
Akita	877	4–89	0.46–10.15
Yamagata	776	0–26	0.00–3.35
Fukushima	1528	6–108	0.39–7.07
Ibaraki	2181	0–56	0.00–2.57
Tochigi	1480	1–56	0.07–3.78
Gunma	1491	0–56	0.00–3.76
Saitama	4951	0–113	0.00–2.28
Chiba	4143	2–77	0.05–1.86
Tokyo	7451	22–139	0.30–1.87
Kanagawa	5236	0–50	0.00–0.95
Niigata	1642	0–56	0.00–3.41
Toyama	755	2–50	0.26–6.62
Ishikawa	773	20–85	2.59–11.00
Fukui	500	1–56	0.20–11.20
Yamanashi	508	0–43	0.00–8.46
Nagano	1323	4–90	0.30–6.80
Gifu	1272	2–35	0.16–2.75
Shizuoka	2619	0–57	0.00–2.18
Aichi	4534	5–107	0.11–2.36
Mie	1160	0–24	0.00–2.07
Shiga	750	0–32	0.00–4.27
Kyoto	1613	0–67	0.00–4.15
Osaka	6312	5–105	0.08–1.66
Hyogo	3554	11–97	0.31–2.73
Nara	812	9–34	1.11–4.19
Wakayama	757	1–70	0.13–9.25
Tottori	440	0–44	0.00–10.00
Shimane	507	0–54	0.00–10.65
Okayama	1320	14–108	1.06–8.18
Hiroshima	1853	6–66	0.32–3.56
Yamaguchi	1152	2–65	0.17–5.64
Tokushima	580	0–53	0.00–9.14
Kagawa	761	2–79	0.26–10.38
Ehime	1101	0–28	0.00–2.54
Kochi	586	0–19	0.00–3.24
Fukuoka	3493	0–75	0.00–2.15
Saga	575	0–15	0.00–2.61
Nagasaki	1022	0–15	0.00–1.47
Kumamoto	1177	4–64	0.34–5.44
Oita	805	2–51	0.25–6.34
Miyazaki	781	0–36	0.00–4.61
Kagoshima	1245	0–63	0.00–5.06
Okinawa	827	2–47	0.24–5.68

Age group, area	Observed all-cause deaths	Excess all-cause deaths	Percent all-cause excess deaths
(5) 75–84 years			
Japan	166547	110–3100	0.07–1.86
Hokkaido	7635	0–86	0.00–1.13
Aomori	2157	3–69	0.14–3.20
Iwate	1991	0–63	0.00–3.16
Miyagi	2854	4–76	0.14–2.66
Akita	1702	5–107	0.29–6.29
Yamagata	1584	0–56	0.00–3.54
Fukushima	2654	3–41	0.11–1.54
Ibaraki	4059	0–38	0.00–0.94
Tochigi	2654	10–121	0.38–4.56
Gunma	2776	15–75	0.54–2.70
Saitama	9697	0–49	0.00–0.51
Chiba	8403	12–192	0.14–2.28
Tokyo	15123	0–86	0.00–0.57
Kanagawa	10953	0–31	0.00–0.28
Niigata	3172	0–18	0.00–0.57
Toyama	1524	2–90	0.13–5.91
Ishikawa	1437	5–57	0.35–3.97
Fukui	985	0–9	0.00–0.91
Yamanashi	1147	3–78	0.26–6.80
Nagano	2665	2–61	0.08–2.29
Gifu	2794	0–35	0.00–1.25
Shizuoka	5135	0–70	0.00–1.36
Aichi	9345	0–65	0.00–0.70
Mie	2513	0–37	0.00–1.47
Shiga	1495	10–60	0.67–4.01
Kyoto	3435	0–83	0.00–2.42
Osaka	12792	0–152	0.00–1.19
Hyogo	7320	0–88	0.00–1.20
Nara	1838	8–54	0.44–2.94
Wakayama	1509	0–31	0.00–2.05
Tottori	724	0–33	0.00–4.56
Shimane	983	5–66	0.51–6.71
Okayama	2432	0–62	0.00–2.55
Hiroshima	3535	0–76	0.00–2.15
Yamaguchi	2148	0–64	0.00–2.98
Tokushima	1075	7–48	0.65–4.47
Kagawa	1330	0–51	0.00–3.83
Ehime	2021	0–72	0.00–3.56
Kochi	1068	2–69	0.19–6.46
Fukuoka	6191	0–27	0.00–0.44
Saga	1085	2–54	0.18–4.98
Nagasaki	1959	6–95	0.31–4.85
Kumamoto	2119	0–44	0.00–2.08
Oita	1561	0–75	0.00–4.80
Miyazaki	1470	5–68	0.34–4.63
Kagoshima	2167	1–58	0.05–2.68
Okinawa	1331	0–60	0.00–4.51
(6) 85 years or older			
Japan	291637	73–2466	0.03–0.85
Hokkaido	13311	0–32	0.00–0.24
Aomori	3671	0–23	0.00–0.63
Iwate	3987	0–37	0.00–0.93
Miyagi	5384	0–26	0.00–0.48
Akita	3608	0–3	0.00–0.08
Yamagata	3737	0–39	0.00–1.04
Fukushima	5599	0–23	0.00–0.41
Ibaraki	6834	0–43	0.00–0.63
Tochigi	4565	0–39	0.00–0.85
Gunma	5135	5–108	0.10–2.10
Saitama	12512	0–129	0.00–1.03
Chiba	11583	21–185	0.18–1.60
Tokyo	24170	26–200	0.11–0.83
Kanagawa	16272	0–46	0.00–0.28
Niigata	7001	0–31	0.00–0.44
Toyama	3046	4–63	0.13–2.07

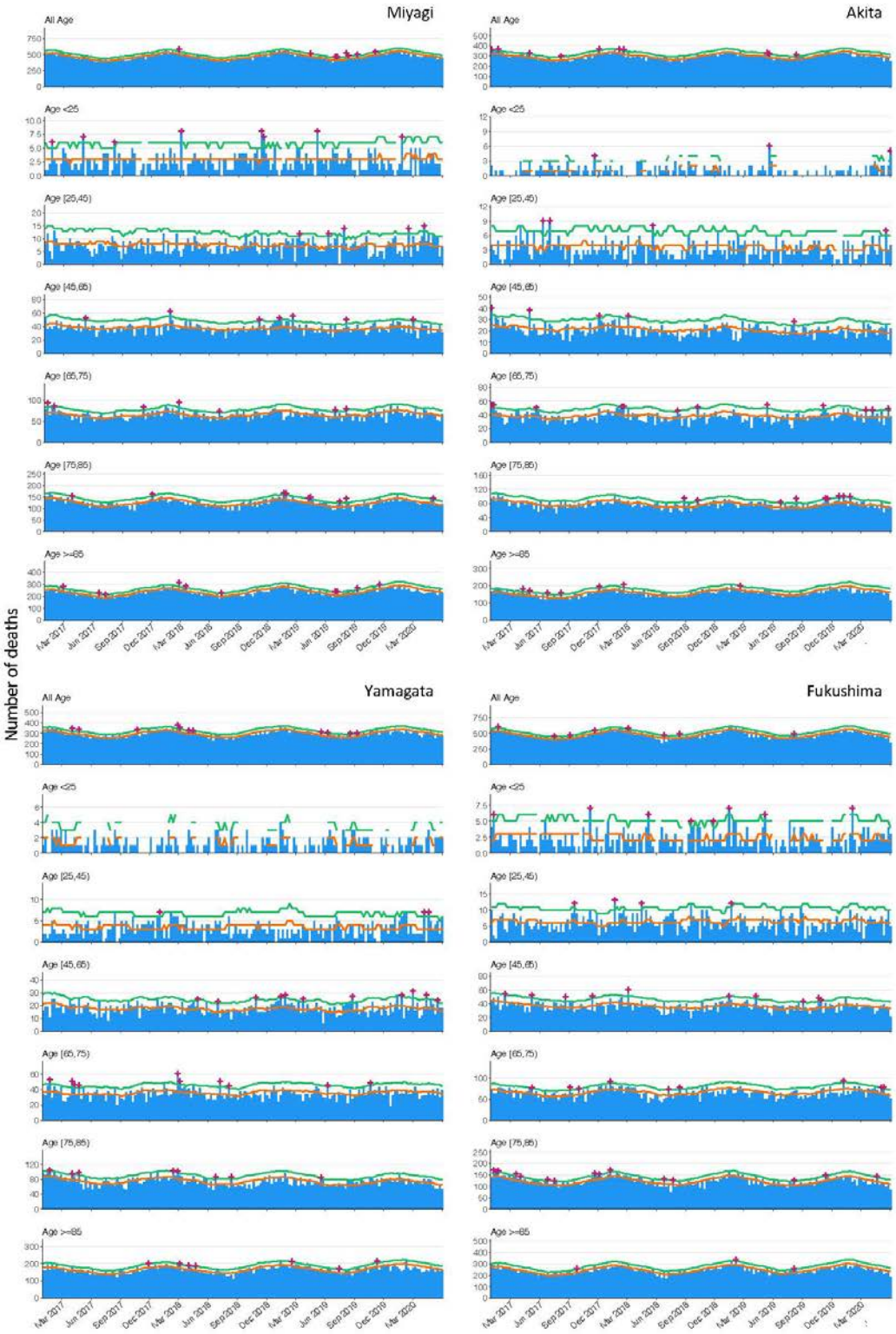
Age group, area	Observed all-cause deaths	Excess all-cause deaths	Percent all-cause excess deaths
Ishikawa	2938	0–24	0.00–0.82
Fukui	2274	7–34	0.31–1.50
Yamanashi	2316	6–40	0.26–1.73
Nagano	6378	0–11	0.00–0.17
Gifu	5106	0–37	0.00–0.72
Shizuoka	9232	0–42	0.00–0.45
Aichi	13794	0–106	0.00–0.77
Mie	4666	0–42	0.00–0.90
Shiga	2929	2–49	0.07–1.67
Kyoto	5900	0–51	0.00–0.86
Osaka	17046	0–104	0.00–0.61
Hyogo	12481	0–71	0.00–0.57
Nara	3300	0–69	0.00–2.09
Wakayama	2888	0–49	0.00–1.70
Tottori	1769	0–46	0.00–2.60
Shimane	2488	0–58	0.00–2.33
Okayama	5089	0–39	0.00–0.77
Hiroshima	6781	0–7	0.00–0.10
Yamaguchi	4261	0–7	0.00–0.16
Tokushima	2362	0–36	0.00–1.52
Kagawa	2903	2–78	0.07–2.69
Ehime	4201	0–16	0.00–0.38
Kochi	2417	0–40	0.00–1.65
Fukuoka	11542	0–141	0.00–1.22
Saga	2415	0–39	0.00–1.61
Nagasaki	4076	0–28	0.00–0.69
Kumamoto	5311	0–10	0.00–0.19
Oita	3521	0–29	0.00–0.82
Miyazaki	3339	0–78	0.00–2.34
Kagoshima	5102	0–9	0.00–0.18
Okinawa	2397	0–49	0.00–2.04

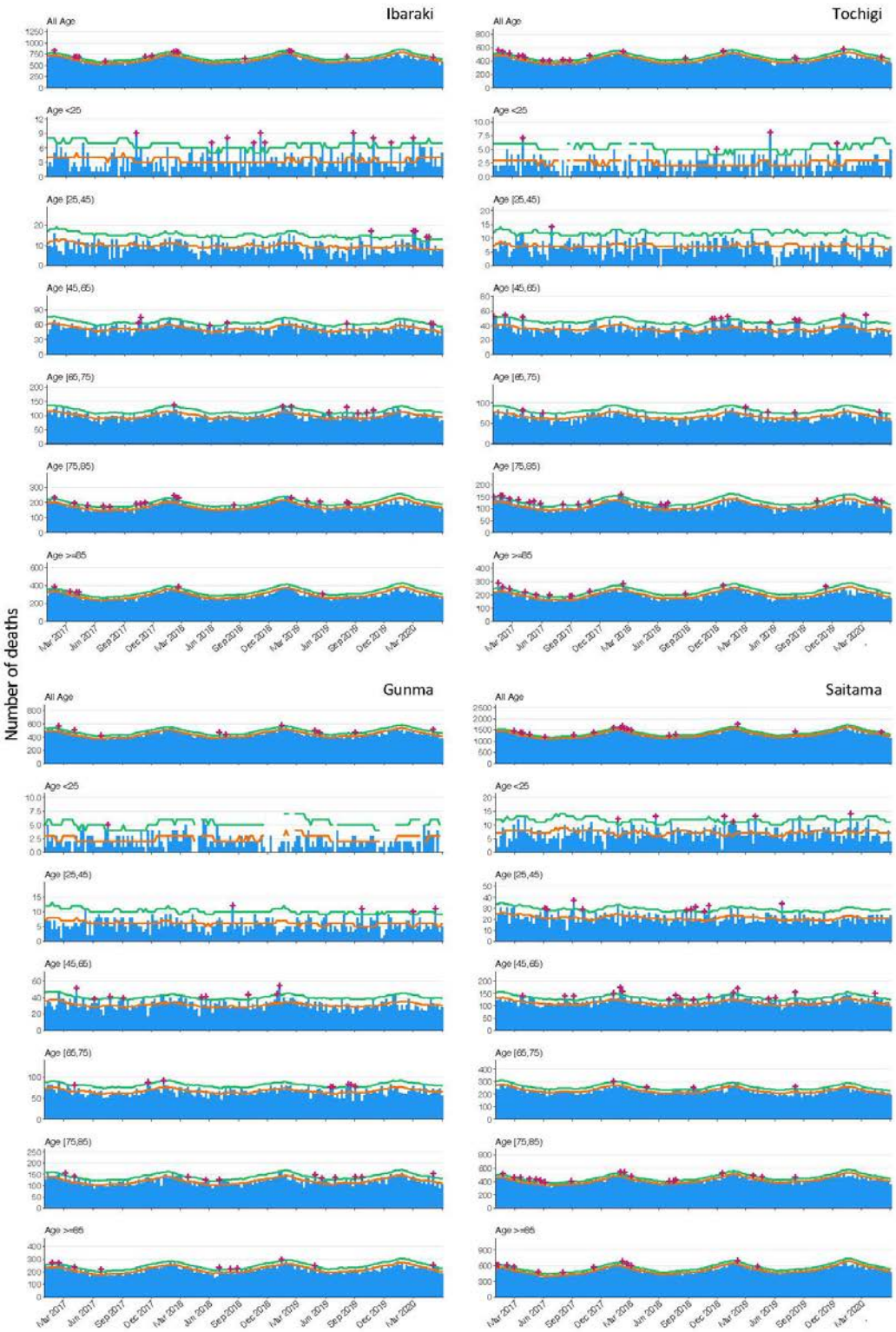
*The national-level cumulative number of excess all-cause deaths was calculated by summing those of 47 prefectures. Due to the fact that the adjusted number of deaths was rounded up to the integer, the sum of the values by age groups does not necessarily equal that of all ages.

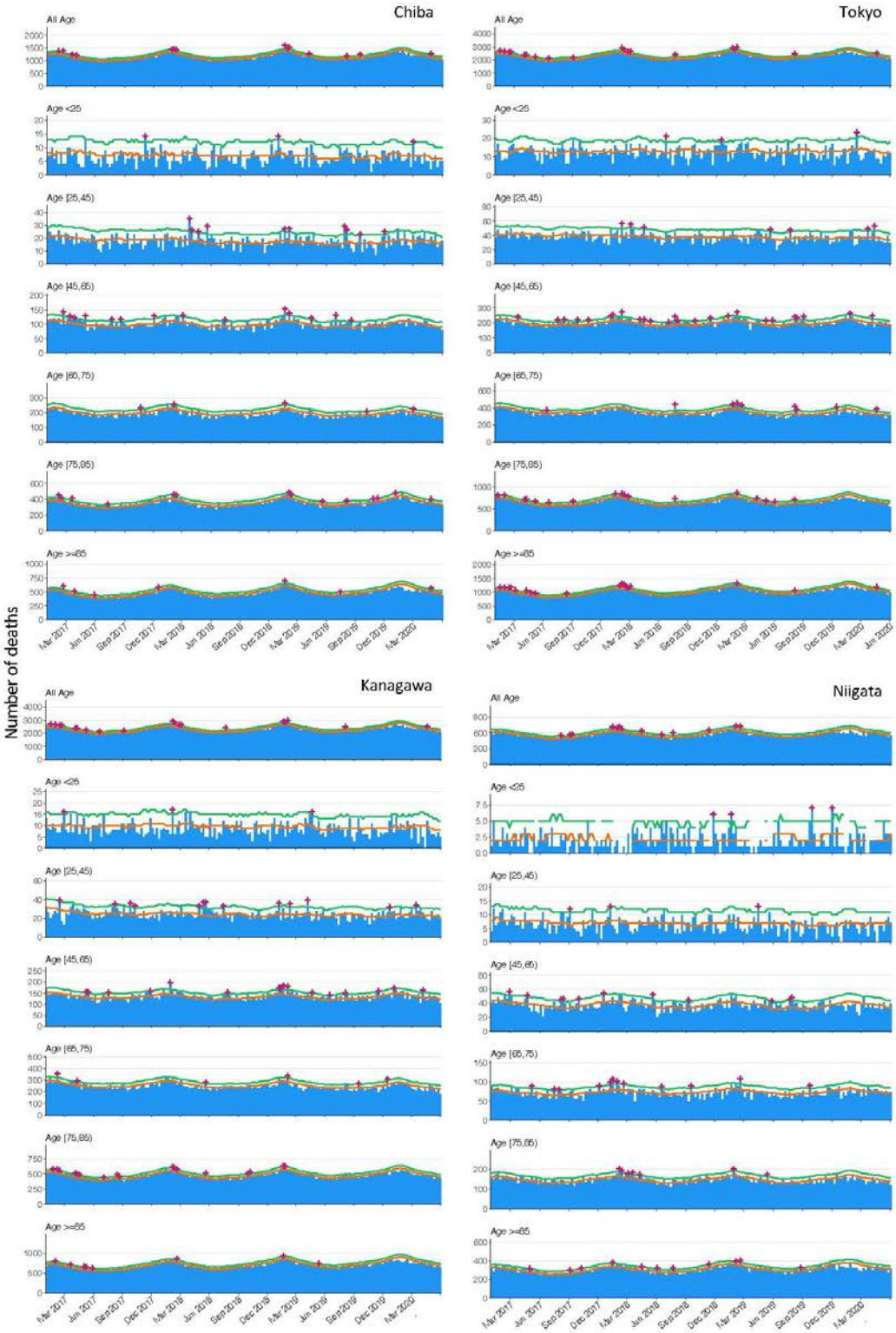


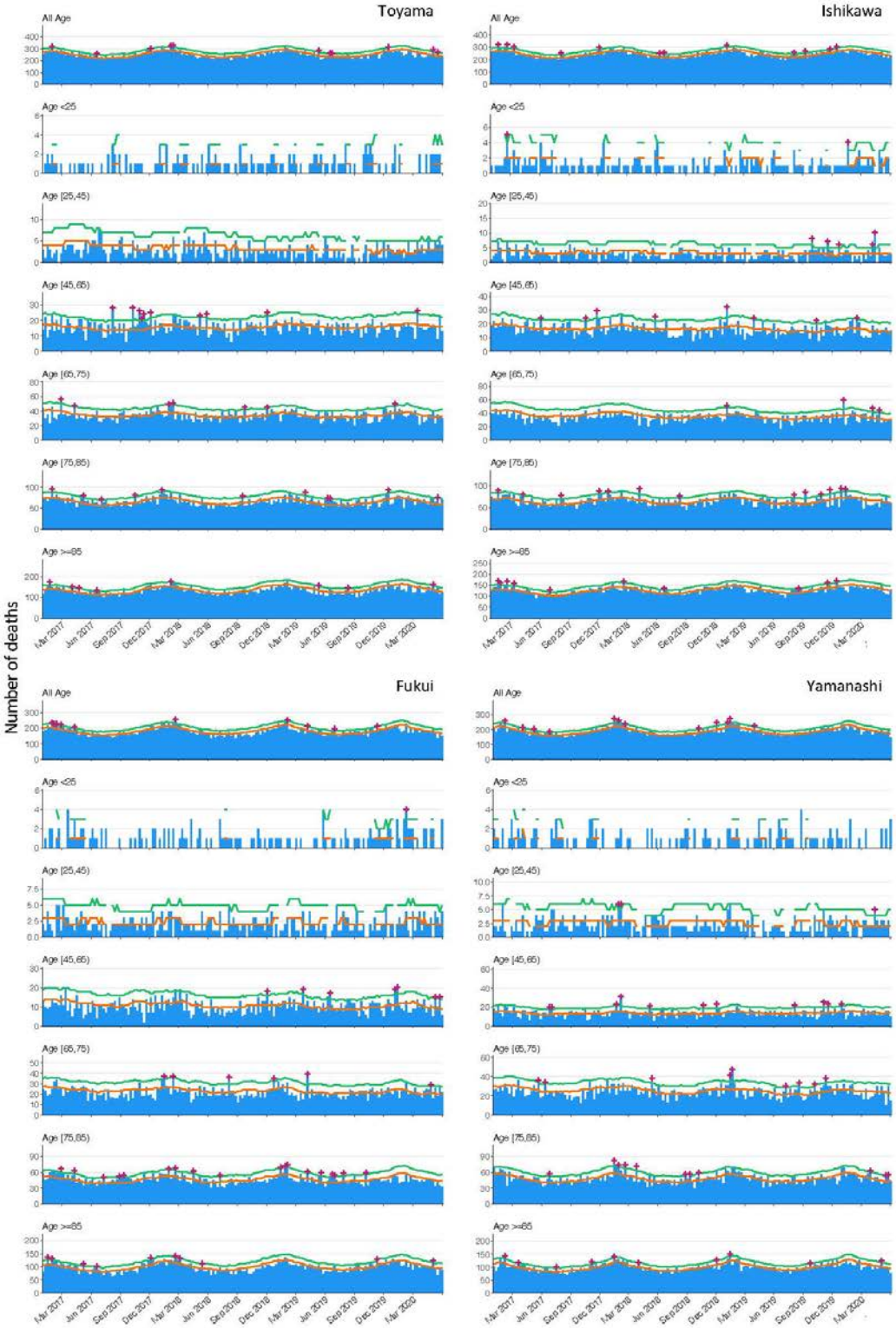
Appendix Figure 1. Observed and expected number of all-cause deaths in four prefectures with large number of reported COVID19 deaths for all ages and by age group, from January 2020 (December 30, 2019 to January 5, 2020) to May 2020 (May 25 to 31, 2020). Blue: observed; Green: upper bound;

Orange: point estimate; cross symbols indicate weeks with the observed exceeding the 95% upper bound. To the national-level data, the observed and expected number of all-cause deaths for each prefecture were summed for each week, which were then used to calculate the weekly national-level excess deaths.

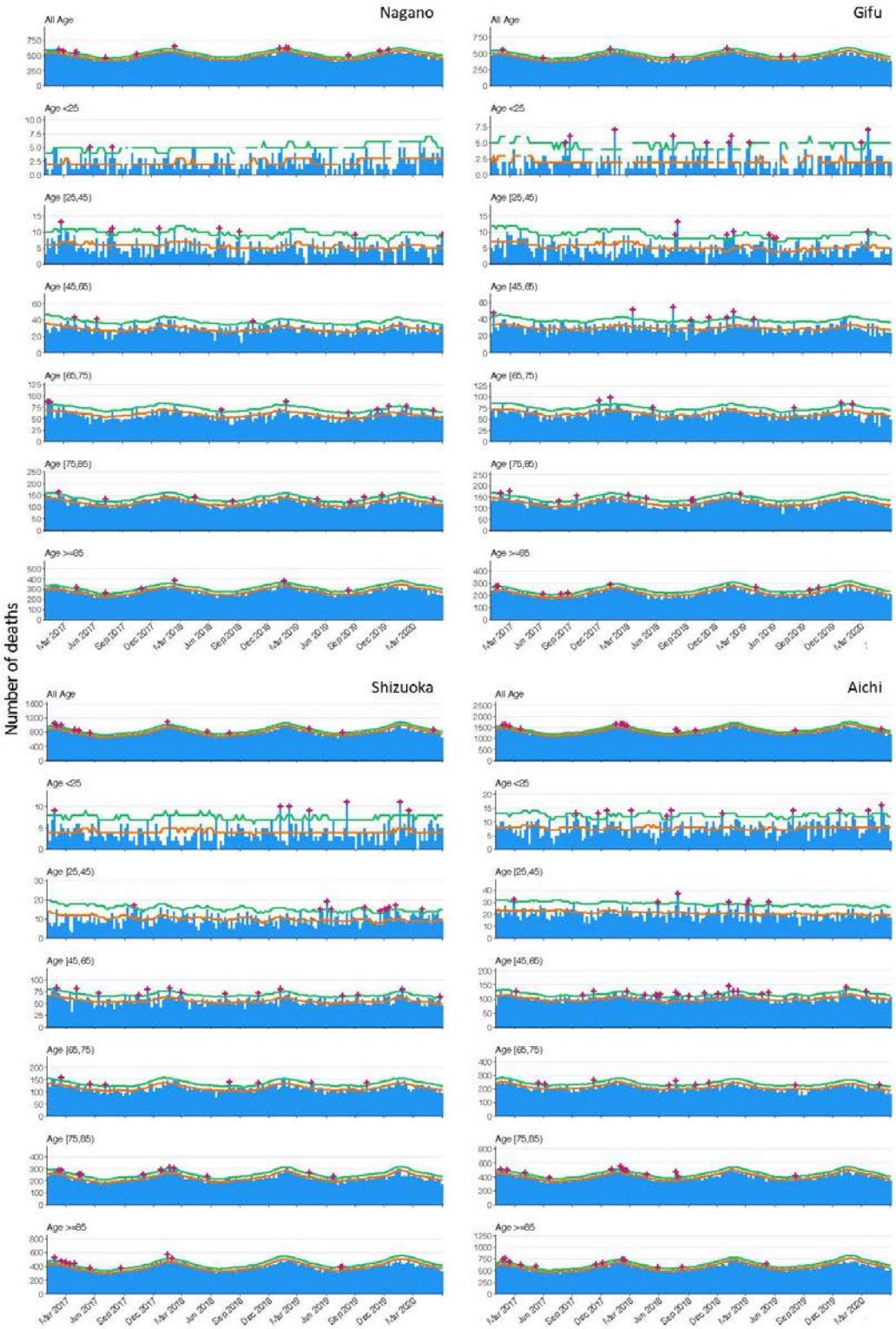

Miyagi
Akita
Yamagata
Fukushima
Number of deaths
All Age
Age <25
Age [25,45)
Age [45,65)
Age [65,75)
Age [75,85)
Age >=85
Mar 2017
Jun 2017
Sep 2017
Dec 2017
Mar 2018
Jun 2018
Sep 2018
Dec 2018
Mar 2019
Jun 2019
Sep 2019
Dec 2019
Mar 2020

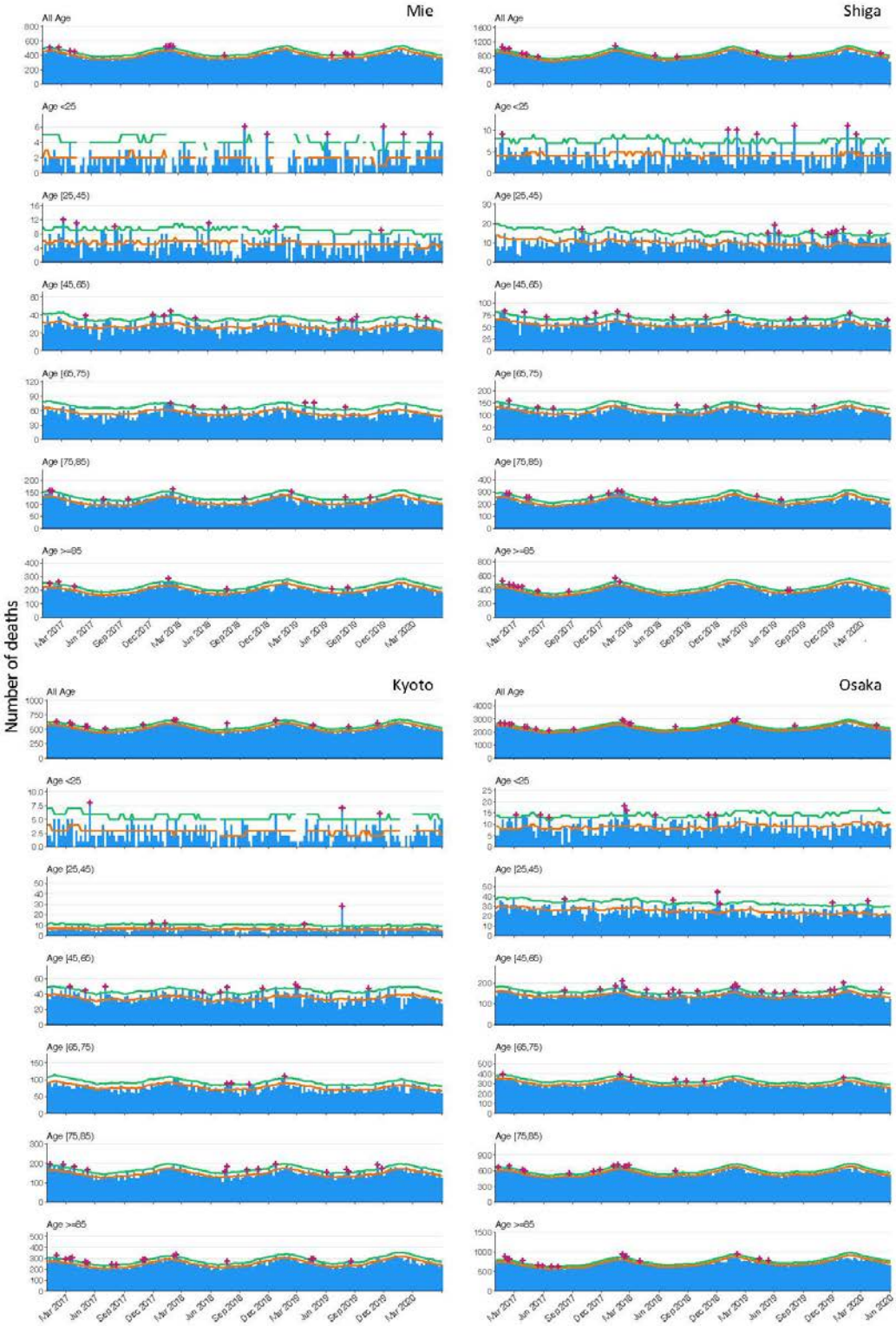

Ibaraki
Tochigi
Gunma
Saitama
Number of deaths
All Age
Age <25
Age [25,45)
Age [45,65)
Age [65,75)
Age [75,85)
Age >=85
Mar 2017
Jun 2017
Sep 2017
Dec 2017
Mar 2018
Jun 2018
Sep 2018
Dec 2018
Mar 2019
Jun 2019
Sep 2019
Dec 2019
Mar 2020

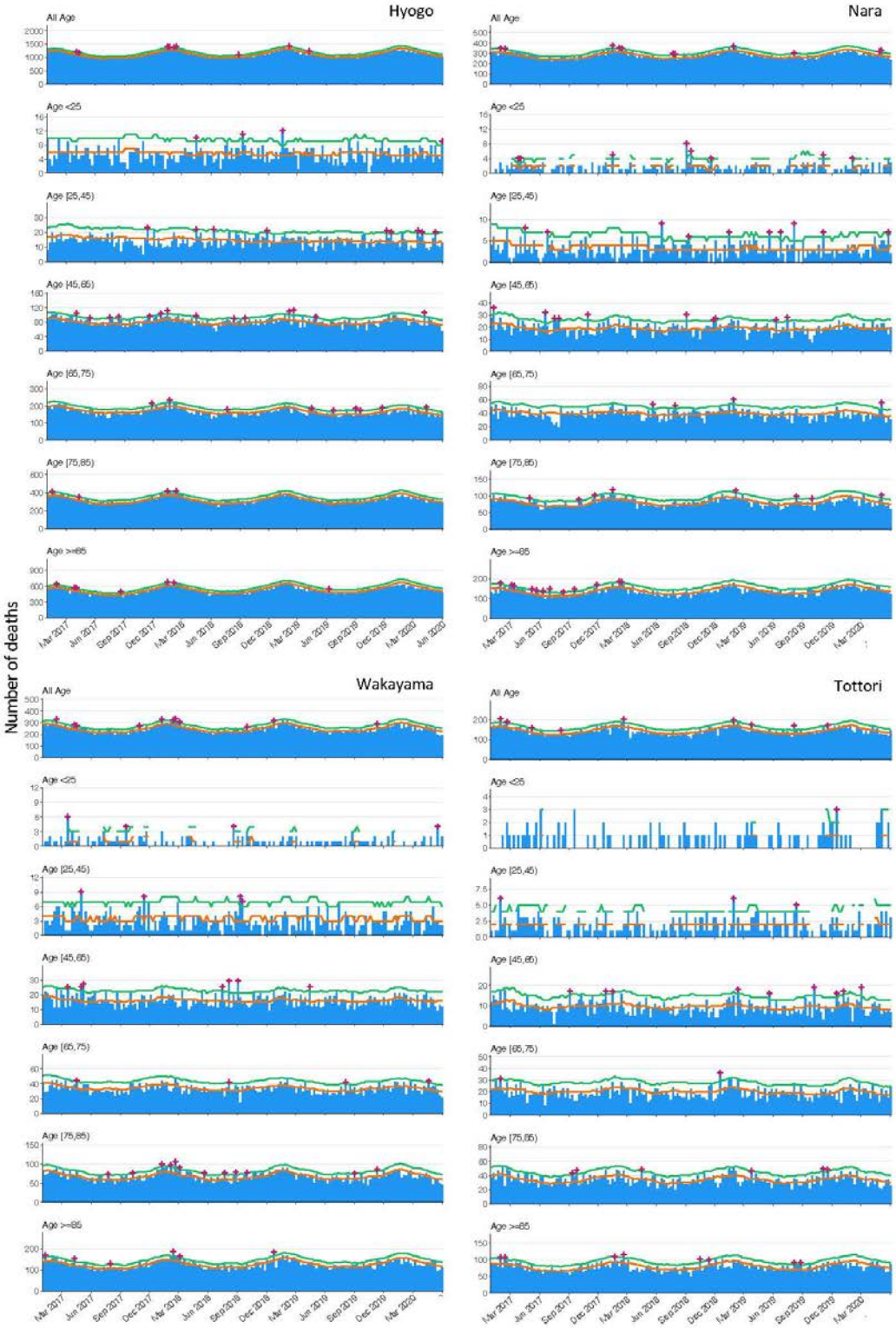

Chiba
Tokyo
Kanagawa
Niigata
Number of deaths
All Age
Age <25
Age [25,45)
Age [45,65)
Age [65,75)
Age [75,85)
Age >=85
Mar 2017
Jun 2017
Sep 2017
Dec 2017
Mar 2018
Jun 2018
Sep 2018
Dec 2018
Mar 2019
Jun 2019
Sep 2019
Dec 2019
Mar 2020
Jun 2020

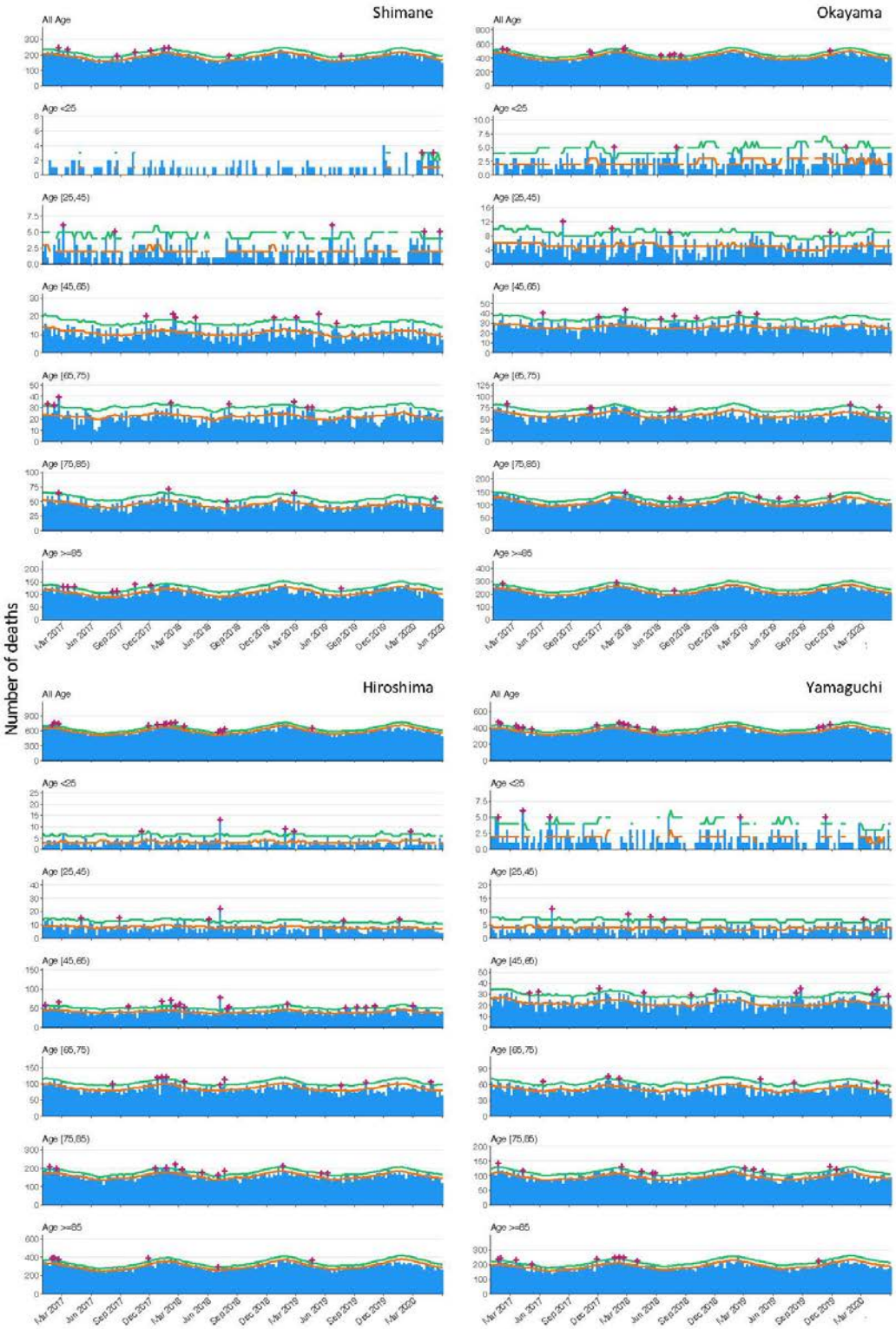

Toyama
Ishikawa
Fukui
Yamanashi
Number of deaths
All Age
Age <25
Age [25,45)
Age [45,65)
Age [65,75)
Age [75,85)
Age >=85
Mar 2017
Jun 2017
Sep 2017
Dec 2017
Mar 2018
Jun 2018
Sep 2018
Dec 2018
Mar 2019
Jun 2019
Sep 2019
Dec 2019
Mar 2020

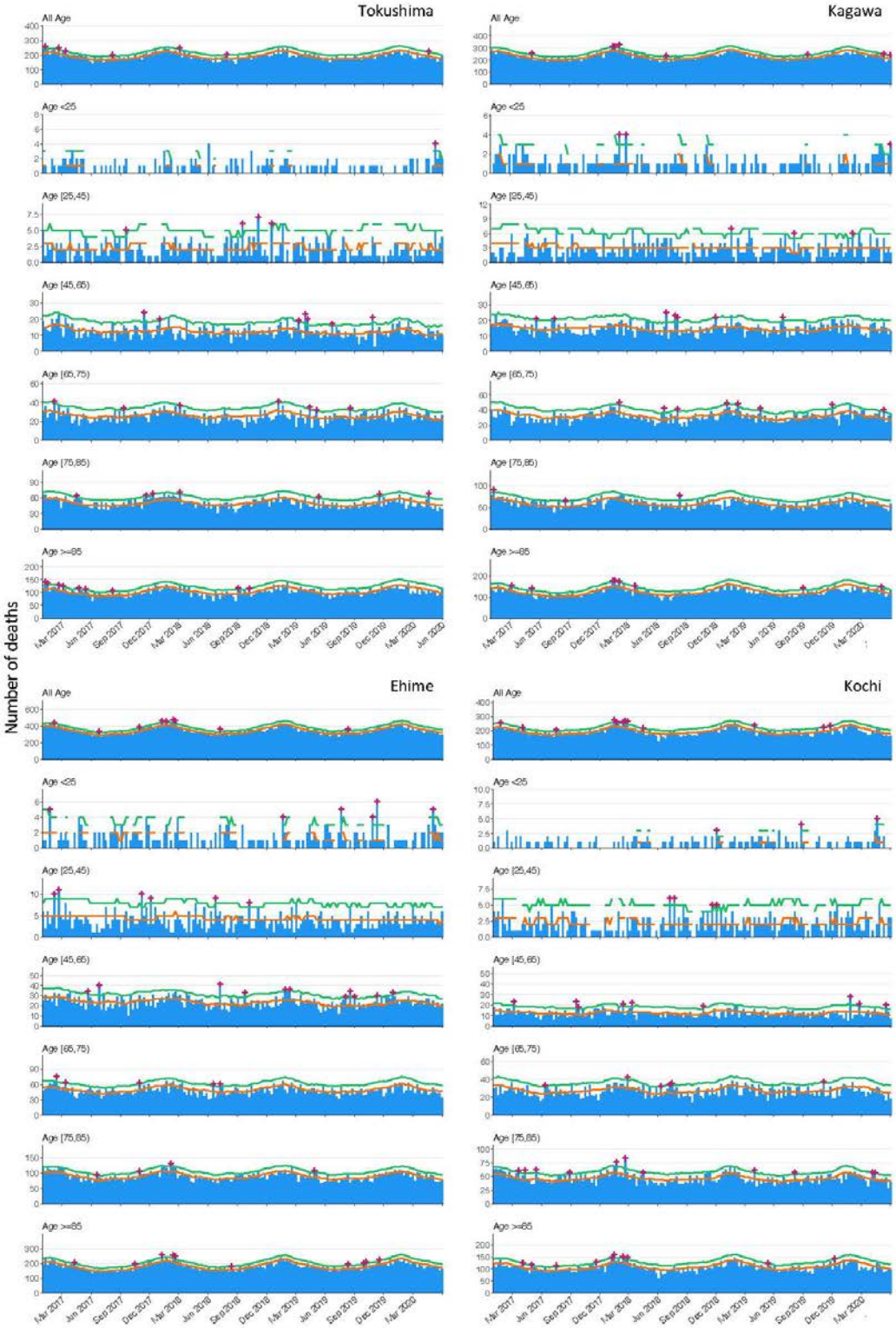
6

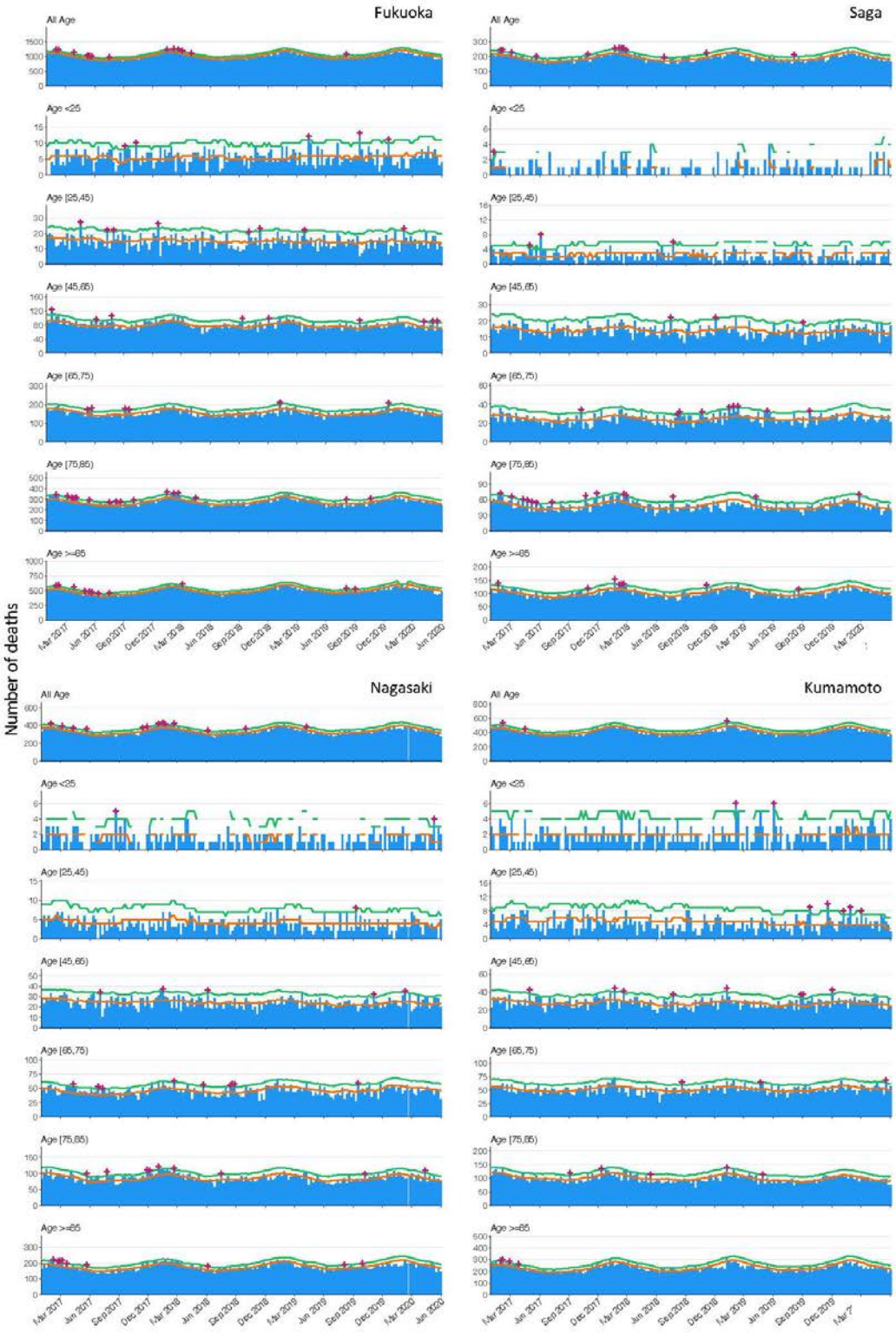

Nagano
Gifu
Shizuoka
Aichi
Number of deaths
All Age
Age <25
Age [25,45)
Age [45,65)
Age [65,75)
Age [75,85)
Age >=85
Mar 2017
Jun 2017
Sep 2017
Dec 2017
Mar 2018
Jun 2018
Sep 2018
Dec 2018
Mar 2019
Jun 2019
Sep 2019
Dec 2019
Mar 2020

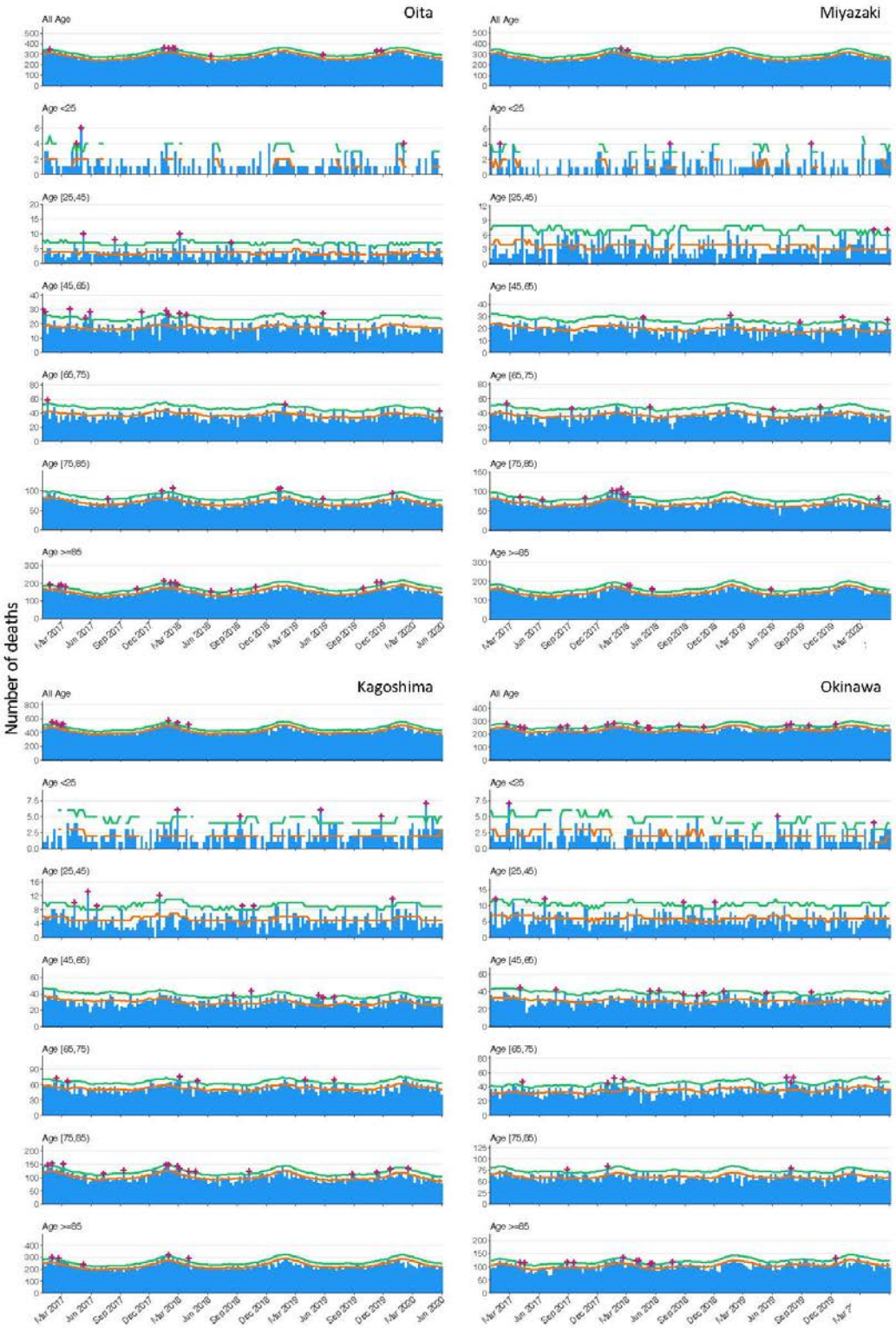

Mie
Shiga
Kyoto
Osaka
Number of deaths
All Age
Age <25
Age [25,45)
Age [45,65)
Age [65,75)
Age [75,85)
Age >=85
Mar 2017
Jun 2017
Sep 2017
Dec 2017
Mar 2018
Jun 2018
Sep 2018
Dec 2018
Mar 2019
Jun 2019
Sep 2019
Dec 2019
Mar 2020
Jun 2020


Hyogo
Nara
Wakayama
Tottori
Number of deaths
All Age
Age <25
Age [25,45)
Age [45,65)
Age [65,75)
Age [75,85)
Age >=85
Mar 2017
Jun 2017
Sep 2017
Dec 2017
Mar 2018
Jun 2018
Sep 2018
Dec 2018
Mar 2019
Jun 2019
Sep 2019
Dec 2019
Mar 2020
Jun 2020


Shimane
Okayama
Hiroshima
Yamaguchi
Number of deaths
All Age
Age <25
Age [25,45)
Age [45,65)
Age [65,75)
Age [75,85)
Age >=85
Mar 2017
Jun 2017
Sep 2017
Dec 2017
Mar 2018
Jun 2018
Sep 2018
Dec 2018
Mar 2019
Jun 2019
Sep 2019
Dec 2019
Mar 2020
Jun 2020


Tokushima
Kagawa
Ehime
Kochi
Number of deaths
All Age
Age <25
Age [25,45)
Age [45,65)
Age [65,75)
Age [75,85)
Age >=85
Mar 2017
Jun 2017
Sep 2017
Dec 2017
Mar 2018
Jun 2018
Sep 2018
Dec 2018
Mar 2019
Jun 2019
Sep 2019
Dec 2019
Mar 2020


Fukuoka
Saga
Nagasaki
Kumamoto
Number of deaths
All Age
Age <25
Age [25,45)
Age [45,65)
Age [65,75)
Age [75,85)
Age >=85
1 Mar 2017
Jun 2017
Sep 2017
Dec 2017
1 Mar 2018
Jun 2018
Sep 2018
Dec 2018
1 Mar 2019
Jun 2019
Sep 2019
Dec 2019
1 Mar 2020
Jun 2020


Oita
Miyazaki
Kagoshima
Okinawa
Number of deaths
All Age
Age <25
Age [25,45)
Age [45,65)
Age [65,75)
Age [75,85)
Age >=85
Mar 2017
Jun 2017
Sep 2017
Dec 2017
Mar 2018
Jun 2018
Sep 2018
Dec 2018
Mar 2019
Jun 2019
Sep 2019
Dec 2019
Mar 2020
Jun 2020

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Appendix Figure 2. Observed and expected number of all-cause deaths in the national level and 47 prefectures for all ages and by age group, from January 2017 (December 26, 2016 to January 1, 2017) to May 2020 (May 25 to 31, 2020). Blue: observed; Green: upper bound; Orange: point estimate; cross symbols indicate weeks with the observed exceeding the 95% upper bound. To obtain the national-level data, the observed and expected number of all-cause deaths for each prefecture were summed for each week, which were then used to calculate the weekly national-level excess deaths.